B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

Big Eddy-Knight Transmission Project

Draft Environmental Impact Statement

DOE/EIS-0421

December 2010

Cooperating Agencies:
State of Washington, Energy Facility Site Evaluation Council
State of Oregon, Oregon Department of Energy

Bonneville Power Administration
DOE/BP-4161 ▪ December 2010

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Responsible Agency: U.S. Department of Energy, Bonneville Power Administration (BPA)

Cooperating Agencies: Washington Energy Facility Site Evaluation Council, Oregon Department of Energy

Title of Proposed Project: Big Eddy-Knight Transmission Project, DOE/EIS - 0421

States Involved: Oregon and Washington

Abstract: BPA is proposing to build a new 500-kilovolt (kV) transmission line in Wasco County, Oregon and Klickitat County, Washington and a new substation in Klickitat County. The new BPA transmission line would extend generally northeast from BPA's existing Big Eddy Substation in The Dalles, Oregon, to a new substation (Knight Substation) proposed to be connected to an existing BPA line about 4 miles northwest of Goldendale, Washington. The proposed Big Eddy-Knight Transmission Project is needed to increase transmission capacity to respond to requests for transmission service in this area.

BPA is considering three routing alternatives and a no action alternative for the proposed transmission line. The transmission line routing alternatives all would use a combination of existing BPA and new 150-foot wide right-of-way. The routing alternatives range from about 27 to 28 miles long. BPA is considering different tower combination options (single-circuit and double-circuit) including paralleling existing transmission lines. Two substation sites are being considered for the proposed Knight Substation; the sites are on adjacent properties along an existing BPA transmission line. Two fiber optic cable options are also being considered. BPA's preferred alternative is the East Alternative using some double-circuit towers (Option3), Substation Site 1 and the Wautoma Option for the fiber optic cable.

The proposed project could create impacts to land use and recreation, visual resources, vegetation, geology and soils, water resources and wetlands, wildlife, fish, cultural resources, social and economic resources, public health and safety, transportation, air quality, and greenhouse gases. Chapter 3 of the EIS describes the affected environment and potential impacts in detail.

Public review of and comment of this Draft EIS will continue through January 28, 2011.

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Summary

This chapter summarizes the draft environmental impact statement (EIS) prepared for the Big Eddy-Knight Transmission Project:

- Purpose of and need for action
- Project overview, including the Proposed Action Alternatives and No Action Alternative
- Affected environment and environmental impacts

S.1 Purpose of and Need for Action

S.1.1 Background

Bonneville Power Administration (BPA) is a federal agency within the U.S. Department of Energy that owns and operates more than 15,000 circuit miles of high-voltage transmission lines in the Pacific Northwest. These lines move most of the Northwest's high-voltage power from facilities that generate the power to power users throughout the region and to nearby regions such as Canada and California.

BPA has a statutory obligation to ensure it has sufficient capability to serve its customers through a safe and reliable transmission system. The Federal Columbia River Transmission Act directs BPA to construct improvements, additions, and replacements to its transmission system that the BPA Administrator determines are necessary to provide service to BPA's customers and maintain electrical stability and reliability (16 United States Code [USC] Section [§] 838b[b-d]). If there is not enough available transmission capacity on the system to accommodate new transmission requests, new transmission facilities may be proposed. These proposed projects are subject to appropriate environmental review under the National Environmental Policy Act (NEPA).

Based on Network Open Season (NOS) marketing processes conducted in 2008, BPA has determined there is a need to increase the capacity of the 500-kilovolt (kV) transmission system in the proposed project area to respond to requests that BPA has received to move power across its system. The need is partly due to wind generation facilities in the region, which have greatly increased the amount of power being produced east of the Cascade Mountains. This power needs to move to load centers west of the Cascades, but there is not sufficient capacity available on existing transmission lines. Without new transmission facilities, BPA's system would likely become overloaded at certain times of the year, which could cause outages on BPA's and local utilities' transmission service grids.

As a result, BPA is proposing to build a 500-kV lattice-steel-tower transmission line that would run from its Big Eddy Substation near The Dalles, Oregon, to a new Knight Substation about 4 miles northwest of Goldendale, Washington. This proposed project would eliminate an electrical bottleneck in this area, provide an additional electrical pathway, and increase the system capacity to accommodate the requested transmission service and allow additional power to flow through the region. Three action alternatives are being considered for the transmission line, along with two (adjacent) site options for the proposed substation, and a No Action Alternative. The project also includes two options for stringing fiber optic cable to enhance transmission system communications (see Map S-1).

In addition to accommodating requests for firm transmission service, the proposed project would address reliability issues on BPA's system. The proposed new line and substation would help redistribute the flow of power, which would increase the capacity of the overall system. This increase in overall system capacity would include being able to increase the capacity to serve the Portland, Oregon metropolitan area during winter. In addition, the project is consistent with long-range system plans and would defer the need for future reinforcement projects that would be needed in its absence.

S.1.2 Public Involvement

Early in the development of this EIS, BPA solicited comments from the public; Tribes; federal, state, regional, and local agencies; interest groups and others to help determine what issues should be studied. Comments were requested by publishing notices in the *Federal Register,* mailing a letter to about 400 potentially interested and affected persons, holding two public open-house style meetings, placing ads in and sending press releases to local media about the comment period and public meetings, and meeting with Tribes, state agencies, congressional, county and city staffs, and interest groups. Comments received were posted on the project's Web site, which provided additional information and other means for providing comments.

Based on initial public comments and additional studies of the transmission system, BPA refined the proposed transmission line routing alternatives. In December 2009, BPA mailed the public a factsheet that described the refinements and requested more comments.

In all, more than 400 people provided comments by mail, fax, telephone, via the project Web site, or at public meetings.

S.2 Project Overview

The proposed 500-kV transmission line would run from BPA's Big Eddy Substation near The Dalles to a proposed Knight Substation about 4 miles northwest of Goldendale . The project also includes installation of new fiber optic cable for system communications. BPA is considering three routing alternatives for the transmission line: a West Alternative, a Middle Alternative, and an East Alternative (see Map S-1). All routing alternatives are located in Wasco County, regon, and Klickitat County, Washington and would cross the Columbia River and portions of the eastern end of the Columbia River Gorge National Scenic Area. The three routing alternatives are about 27 or 28 miles long, and cross varying amounts of private, state, federal and Tribal lands.

If a decision is made to build the project, construction would likely begin in summer 2011 and take about 20 months. The transmission line and substation would be built by one or more construction crews of about 50-60 workers each (70 to 100 at the peak of construction). Work would begin at the substations, followed by construction of the line.

A total of 125-135 towers would be installed. About 16-21 miles of new access roads would be constructed; in addition, 11-16 miles of existing access roads and 5 miles of existing county roads would need improvements; and some 3-5 miles of temporary roads would be built. Where stream and drainage crossings are unavoidable, some 25-30 culverts would be installed. If a decision is made to construct the line, it would be energized and operating by February 2013.

The total estimated project cost ranges between $90-115 million depending on the routing alternative and tower option.

BPA is also considering a No Action Alternative.

S.2.1 Proposed Action Alternatives

Big Eddy Substation. Each of the three action alternatives would start at Big Eddy Substation. Big Eddy Substation would require a new 500-kV bay to connect the proposed line into the electrical system. All work would occur and all equipment would be installed within the existing electrical yard and control house.

Transmission Line Alternatives. The transmission line alternatives use a combination of existing and new rights-of-way. In general, BPA would need a 150-foot wide right-of-way for the new transmission line and a 50 foot-wide easement for access roads. For each routing alternative, BPA is considering different tower combinations, including paralleling or replacing existing transmission lines.

- **West Alternative.** The West Alternative route extends north from Big Eddy Substation, within mostly vacant BPA right-of-way to the Columbia River. The route then crosses the river and heads west and then north, paralleling BPA's existing Spearfish Tap 115-kV wood-pole transmission line for about 1 mile. The route then angles northeast next to BPA's existing Chenoweth-Goldendale 115-kV wood-pole line for about 12 miles, to a point just south of the Little Klickitat River. At this point, the West Alternative turns east and continues to follow the Chenoweth-Goldendale line for about 1 mile before separating from that line and veering north to connect with either proposed Knight Substation site. This alternative is about 27 miles long.
- **Middle Alternative.** From Big Eddy Substation, the Middle Alternative route runs east and slightly north in existing right-of-way next to BPA's existing Harvalum-Big Eddy 230-kV lattice-steel transmission line for about 7 miles before crossing the Columbia River. The route crosses the river just west of the Harvalum-Big Eddy line near Wishram, Washington, and continues to parallel this existing line for about 1.5 miles before heading north in new right-of-way. The Middle Alternative then heads generally north for about 15 miles to the Knight Substation sites, with two jogs east along the way – one for about 1.5 miles along BPA's existing Big Eddy-Spring Creek 230-kV lattice steel transmission line, and the other for about 2 miles partially along BPA's existing Chenoweth-Goldendale line. This alternative is about 27 miles long.
- **East Alternative (Preferred).** The East Alternative route follows the same path as the Middle Alternative for about the first 9 miles to a point just north of Wishram, at which point the routes separate. The East Alternative continues east next to two existing BPA lines that parallel each other – BPA's Harvalum-Big Eddy 230-kV lattice-steel line and BPA's McNary-Ross 345-kV lattice-steel line – for an additional 5 miles before turning north in new right-of-way. The East Alternative then generally runs north for about 14 miles to the proposed Knight Substation sites. This alternative is about 28 miles long. The East Alternative is BPA's Preferred Alternative.

Knight Substation Options. The project would include a new Knight Substation in Klickitat County. BPA is considering two adjacent sites for Knight Substation, both under the transmission line corridor that contains BPA's Wautoma-Ostrander 500-kV line and the North Bonneville-Midway 230-kV line. The substation would require about 30 acres, of which 10 acres would be fenced to contain the yard and control house.

- **Knight Substation Site 1 (Preferred).** Site 1 is the most western site, located about 0.5 mile west of Knight Road. The property is currently privately owned and being farmed, but is for sale. Because siting the substation on the property would likely sever it from the remaining ownership and agricultural use, 80 acres would likely be purchased (the parcel is 80 acres, but BPA presently owns 8 acres of it for the right-of-way of the existing lines crossing through it). Construction at Substation Site 1 would require temporary road access, likely off Hill Road from the west, Butts Road from the south, or from Pine Forest Road from the north. These county roads may require upgrading. Permanent access would be required for operations after construction, likely from Knight Road.

- **Knight Substation Site 2.** Site 2 is adjacent to Site 1 on the east, and is currently part of a 544-acre parcel owned by the Washington Department of Natural Resources (DNR) that abuts Knight Road. The parcel is leased for agriculture and is currently fallow. BPA would purchase a 30-acre portion of the parcel. Site 2 would be accessed from the east off Knight Road.

Fiber Optic Cable Options. The proposed transmission line would require a fiber optic cable for communications between substations. Two options are being considered (see Map S-1). For the **Loop Back Option**, cable would be strung on the proposed transmission line towers from Big Eddy Substation to Knight Substation and then loop back to Big Eddy Substation on the same towers. For the **Wautoma Option (Preferred)**, the fiber optic cable could follow the same route to Knight Substation but then continue an additional 72 miles on BPA's Wautoma-Ostrander transmission line through Klickitat and Yakima counties to BPA's Wautoma Substation in northwest Benton County, Washington. Existing access roads would be used for construction of the Wautoma Option, which is preferred because it would optimize the transmission communications system by creating a large communications loop used by multiple substations.

S.2.2 No Action Alternative

Under the No Action Alternative, BPA would not build the proposed Big Eddy-Knight transmission line, Knight Substation, or install fiber optic cable. Without building these facilities, BPA would be unable to provide long-term firm transmission service for the service requests that the proposed line is intended to accommodate. However, BPA may be able to provide other forms of transmission service to some of these customers, such as non-firm transmission service (non-firm is not guaranteed to be available and is only available after commitments for firm service have been met).

S.3 Affected Environment

The proposed transmission line alternatives would all begin within the National Scenic Area in Wasco County, Oregon, and cross the Columbia River, either near The Dalles or about 6 miles to the east. Each alternative would then travel through the National Scenic Area for several more miles, climbing up and over the Columbia Hills ridgeline in Klickitat County, Washington. Descending down the north side of the Columbia Hills, the alternatives would cross gently rolling agricultural plateau for several miles before crossing the Little Klickitat River and some wooded ravines. Where the alternatives would traverse the Klickitat County plateau, views can be expansive and include Mount Adams to the northwest and Mount Hood to the south. After crossing the Little Klickitat River, the alternatives would continue north to connect with Knight Substation, which would be located south of the Simcoe Mountain foothills. Elevation across the project area ranges from 160 feet above sea level at normal pool elevation of Lake Celilo behind The Dalles Dam to 2,628 feet at the crest of the Columbia Hills.

Populated areas include the cities of The Dalles in Oregon and Goldendale in Washington; rural unincorporated communities such as Celilo and Biggs in Oregon; and Wishram and Centerville in

Washington; and several existing and future large-lot residential subdivisions, such as River Crest, near the Little Klickitat River in Washington. However, the project area is predominantly rural and dominated by privately owned farms interspersed with a few parcels of federal, state and Tribal lands. Soils are typically silty varieties of loam, much of which are considered prime farmland or support "farmlands of statewide importance." Most of the land is used as rangeland, interspersed with some cropland, primarily nonirrigated. Some land is in conservation programs. There are also several small orchards and a vineyard located in the project area's southern portion, near the Columbia River, where there are also an abundance of parks and recreation sites.

Agriculture is a major economic force in the area, although retail sales generate the most revenue in both counties. Also driving the local economy are lumber production, health care, manufacturing, professional services, recreation and tourism, food services and – a fast growing sector – electric power generation. Several wind farms have been built near the project area and several others are planned.

As is typical of a mostly rural area, local motorists are served primarily by two-lane county roads. Four scenic highways run through or by the project area on the south and east. Other local transportation facilities include those of the Burlington Northern Santa Fe, Union Pacific, and Amtrak railroads, two public airports (north of The Dalles and west of Goldendale), and two private airstrips.

Besides the Columbia River, the area's main waterways include Fifteenmile Creek in Oregon, which drains into the Columbia, and Swale Creek and the Little Klickitat River, both tributaries of the Klickitat River in Washington. Fifteenmile has a small 100-year floodplain and Swale Creek a much wider one. In addition, there are many scattered, intermittent streams and dry washes throughout the area. The four main waterways are all fish-bearing and some intermittent streams may contain fish seasonally. The Columbia and Klickitat river segments and Fifteenmile Creek segment spanned by the project provide critical habitat for certain fish species, including several federally protected salmon, steelhead and bull trout populations in the Columbia River.

Reflecting the arid climate, vegetation in the project area includes grassland, shrub-steppe (including scabland lithosols), disturbed grassland/shrub-steppe, cropland, woodlands (including riparian woodlands), and wetlands. High-quality grassland and shrub-steppe are now rare, but a few "priority ecosystems" containing them are identified in the project area – in the Columbia Hills and along the Little Klickitat River. Disturbed grassland/shrub-steppe is the predominant vegetation type (as mentioned, this is largely used as rangeland or pasture), followed by cropland. A few small woodlands can be found along some waterways and dry washes. Because the area is arid, there are few wetlands and they are widely scattered throughout the project area; only a handful are of high-quality.

Ten Washington-listed special-status vegetation species are found in the project area, two of which are also federal species of concern (clustered lady's slipper and obscure buttercup). No federally protected or candidate plant species are known to be within the project area.

The area's vegetation provides habitat for a variety of wildlife. Common mammals are coyote, deer, elk, rabbits, squirrels, and various rodents. Common birds that live in or pass through the area include game birds such as pheasant and partridge; migrating waterfowl such as geese and ducks; birds of prey; and many species of passerines (songbirds). There are no federally listed wildlife species likely to occur in the project area, but several federal "species of concern" or state-listed species are likely to occur because of habitat types found. These species include certain birds of prey and game birds; the Western gray squirrel; and some species of deer, jackrabbits, bats, reptiles, turtles and frogs.

Several historic and culturally significant sites and artifacts can be found in the area, particularly along the Columbia River where abundant fisheries attracted native people to establish villages. Upland areas and the Klickitat plateau were visited seasonally by native people in search of roots and herbs, or used for spiritual activities. Later, Euro-Americans would settle here, establishing homesteads, planting crops and building roads, fences and other infrastructure. Remnants of these activities, from petroglyphs to a fish wheel, provide a living history of the area's former inhabitants.

If the Wautoma Option is selected for fiber optic cable installation, the project would affect an additional 72 miles of land in Washington within the existing Wautoma-Ostrander transmission line corridor. Cable would run from Knight Substation across 18 miles of Klickitat County and 51 miles of Yakima County before crossing the northwest tip of Benton County to reach Wautoma Substation. Generally, the route is sparsely populated. About half of the line's corridor crosses the Yakama Indian Reservation; remaining land is mostly privately owned with some federal land, including Brooks Memorial State Park.

The existing transmission line crosses mostly shrublands and grasslands. It spans the Yakima River, several fish-bearing streams and creeks, and runs near priority habitat for some wildlife, including mule and black-tailed deer, the Western gray squirrel and wild turkey.

S.4 Environmental Impacts

Construction and installation of tall lattice-steel towers, new access roads and the new substation, and related counterpoise installation, pulling/tensioning sites, and staging areas, would all create temporary and permanent impacts on area resources. Construction would require the use of heavy vehicles, helicopters, and equipment like cranes and bulldozers. Construction activities could impact local roads, delay motorists, and create dust and noise. Some land would be removed from current uses or restricted from future uses, although landowners are generally compensated. Some vegetation would be cleared, trees removed and wildlife habitat disrupted to accommodate road, tower and substation construction. Construction activities themselves could disturb wildlife and disrupt breeding. Soil would be disturbed and/or compacted around tower footings and access roads, potentially causing erosion and water runoff. Excavation could disturb unmapped cultural resources. Although the area's major waterways would be spanned, some intermittent streams would be crossed, requiring culvert installation to maintain seasonal flow, and some small patches of wetlands may be disturbed. Besides physical impacts, new towers and some roads would be highly visible in a few areas, affecting scenic views particularly where they would travel within the National Scenic Area, across the skyline or in viewers' foreground.

Additions made to Big Eddy Substation would have minimal, if any, impacts to resources because all work would occur within the substation's yard. The only impact would be due to noise during construction.

Environmental impacts on resources by each alternative and the proposed Knight Substation are summarized below. Estimated impact totals (measured in acres, miles, etc.) are both temporary and permanent impacts combined. Where each resource is discussed in Chapter 3, more detailed impact assessments are offered, broken down by temporary/permanent and project component (e.g., tower footings, access roads).

Environmental impacts created by the Loop Back fiber optic cable option are not summarized below because they would be the same as described for each alternative. Impacts on resources by the Wautoma Option are summarized collectively under S.4.15.

S.4.1 Land Use and Recreation

Each action alternative would cross primarily privately owned land, as well as a mix of state and federal lands. The Middle and East alternatives also cross some Tribal lands. Project area land uses are predominantly agriculture (primarily rangeland but some cropland), with some recreation areas and land in conservation programs. Construction of the line would temporarily disrupt land uses in staging areas and at pulling/tensioning sites; it would permanently remove land from use for tower footings, roads, and Knight Substation, and permanently limit land uses and activities within the right-of-way. Generally, however, existing agricultural uses could continue along the line after construction.

West Alternative. Would follow existing BPA right-of-way for 16 of its 27 miles; about 21 miles cross private land and 6 miles cross state land. (A fraction, 0.4 mile, crosses federal [BPA] land). No tribal lands would be crossed. Some 233-432 acres of new right-of-way would be required, depending on the selected tower option. The West Alternative would convert the most state land (31-106 acres) to right-of-way and would require the greatest amount of land in the National Scenic Area (72-119 acres) for new right-of-way. No homes would be within the right-of-way. Tower and road construction under this alternative would impact the most parks and conservation land (32-56 acres), and the most agricultural land (about 138-213 acres) compared to the other action alternatives. Overall impacts on land use would be ***moderate-to-high.***

Middle Alternative. Would follow existing BPA right-of-way for 9 of its 27 miles; about 24 miles cross private land, 1 mile federal, 0-1 mile state and 1 mile Tribal land. Some 284-309 acres of new right-of-way would be required, depending on the selected tower option. The Middle Alternative would convert the least state land (0-14 acres) to right-of-way and would require much less land in the National Scenic Area (40-43 acres) for new right-of-way compared to the West Alternative. No homes would be within the right-of-way. Tower and road construction under this alternative would impact few (less than 4) acres of parks and conservation land and about 155-175 acres of agricultural land. Overall impacts on land use would be ***low-to-moderate.***

East Alternative. Would follow existing BPA right-of-way for 14 of its 28 miles; about 25 miles cross private land, 1 mile federal, 0.5-1.5 mile state and 1.5 mile Tribal land. Some 258-269 acres of new right-of-way would be required, depending on the selected tower option. The East Alternative would convert a small amount of state land (9-23 acres) to right-of-way and would require the least amount of land in the National Scenic Area (1-5 acres) of all action alternatives. No homes would be within the right-of-way. Tower and road construction would impact few (less than 4) acres of parks and conservation land and about 166-210 acres of agricultural land. About 0.5 mile of the line would pass through the Windy Flats Energy Production Area, but would not impact wind turbines or preclude future development. Overall impacts on land use would be ***low-to-moderate.***

Knight Substation Options. Site 1 would convert more than 70 acres of prime farmland to nonagricultural use and require a 0.75-mile new access road. Site 2 would convert 30 acres of prime farmland to nonagricultural use, with a relatively short access road. Both sites would have ***moderate*** land use impacts.

S.4.2 Visual Resources

Each action alternative would place steel towers in the National Scenic Area along the Columbia River – appearing most visible where the towers cross the skyline or are in viewers' foregrounds – as well as near scenic byways and small populated areas, and through pastoral landscapes. Some new access roads would also need to be built in the National Scenic Area, occasionally on steep slopes where necessary cut-and-fill or benching would make them more visible.

West Alternative. Longest route (of the action alternatives) running through the National Scenic Area – 9.6 miles. Potentially visible from the highest number of local parks (8), scenic highways (3) and trails (4) because it would traverse the Columbia River at a new crossing, climb up steep slopes and place tall steel towers where there are currently wood-pole structures. Also, due to tower heights and proximity to a local airport, some towers would need lighting or painting, and conductors spanning the river would require marker balls. Farther north, where it would run across the Klickitat plateau and link to Knight Substation, the West Alternative would cross the Little Klickitat River and run near several existing and future large-lot subdivisions, potentially interfering with expansive views. However, it would run near (within 1,000 feet of) the fewest number of homes and businesses – 17-24 – of the action alternatives. Because of its impact in the National Scenic Area, overall visual impacts would be ***high***, the highest impact among the action alternatives.

Middle Alternative. Shortest route running through the National Scenic Area – 5.5 miles. In this area, it would primarily run next to (or replace) an existing transmission line in an area that already contains industrial infrastructure (railroad tracks, highways, other development). The Middle Alternative would parallel or share on existing transmission line crossing over the Columbia River, but would require placing towers and access roads in new right-of-way where it climbs the Columbia Hills' steep terrain; some towers in this area would need to be lighted or painted and conductors spanning the river would require marker balls. Overall, it would be potentially visible from three state parks, two scenic highways and one trail. The Middle Alternative would run near the greatest number of homes and businesses – 42-46 – of which 25 are in the Washington community of Wishram, and would run near several large-lot "view" subdivisions. Overall visual impacts would be ***moderate-to-high***.

East Alternative. About 7.3 miles of its route would run through the National Scenic Area. The East Alternative would have the same route as the Middle Alternative for the first 9 miles, but would continue to follow (or replace) an existing line through the National Scenic Area for several more miles (i.e., it would have no new right-of-way within the scenic area). Some towers in this area would need to be lighted or painted and conductors spanning the river would require marker balls. The East Alternative would run near 39-42 homes and businesses, including 25 in Wishram, and be potentially visible from four parks, three scenic highways and one trail. Because it has more right-of-way within existing transmission line corridors than the Middle Alternative, and fewer visual impacts in the National Scenic Area, overall visual impacts would be ***moderate***, the lowest of the action alternatives.

Knight Substation Options. Both Sites 1 and 2 would be in agricultural fields crossed by BPA's existing North Bonneville-Midway 230-kV and Wautoma-Ostrander 500-kV steel tower transmission lines. On either site, the substation would be mostly seen by local motorists on Knight Road. Few residents are nearby (none within 1,000 feet), although a parcel east of Knight Road has been subdivided into eight view lots. Visual impacts by the substation would be ***moderate*** for Site 2, because it is closest to Knight Road and the future housing development, and ***low-to-moderate*** for Site 1.

S.4.3 Vegetation

Impacts to vegetation would include removal, disturbance, changes in vegetation type, and the potential spread of noxious weeds. In some right-of-way areas, trees would have to be removed. At tower sites and along new access roads, vegetation would be permanently removed and soils would be compacted; impacts would depend on the amount and quality of vegetation removed. In addition, habitat fragmentation could occur where new or expanded rights-of-way or access roads would cross through sensitive plant communities. Although most disturbed vegetation would be allowed to reestablish, these would be vulnerable to noxious weed infestations in the interim. However, mitigation measures would be taken to reduce weed spread.

West Alternative. Could impact eight of nine special-status species found or likely to be present along the proposed line. Would impact 133-199 acres of disturbed shrub-steppe/grassland, the predominant vegetation cover; 31-53 acres of high-quality grassland (the only alternative that crosses this vegetation type); and 9-15 acres of high-quality shrub-steppe. The Idaho fescue-houndstongue hawkweed and Oregon white oak-ponderosa pine priority ecosystems would be impacted. Eight of 11 woodland areas would be impacted by tree removal; about 93-130 trees would be removed, although none near water bodies. Greatest vegetation impact of the action alternatives; impacts would be ***high.***

Middle Alternative. Could impact two special-status species found or likely to be present along the proposed line. Would impact 125-140 acres of disturbed shrub-steppe/grassland – including some in relatively good condition where it would cross over the Columbia Hills – and about 4-11 acres of high-quality shrub-steppe, but would not disturb any high-quality grassland or priority ecosystems. Three of seven woodland areas would be impacted by tree removal; about 26 trees would be removed in upland areas. Impacts on vegetation would be ***moderate.***

East Alternative. Could impact one special-status species likely to be present along the proposed line. Would impact 142-153 acres of disturbed shrub-steppe/grassland, but no high-quality shrub-steppe or grasslands and no priority ecosystems. Two of six woodland areas would be impacted by tree removal; about 16 trees would be removed in upland areas. Least vegetation impact of the action alternatives; impacts would be ***low.***

Knight Substation Options. There would be ***no*** impacts on special-status species, priority ecosystems, any type of shrub-steppe/grassland, or woodlands on either site. The 10-acre substation yard would disturb nonirrigated cropland only.

S.4.4 Geology and Soils

Construction of the transmission line would expose soil to rain and wind, causing erosion; compact soil; and remove soil from use either by taking it off-site or covering it with impervious surfaces. Impacts would be greatest during and immediately after construction, until revegetation, drainage and erosion control measures are established. While some landslide areas would be crossed, most are inactive.

West Alternative. Building the line and about 40 miles of access roads would disturb about 169-268 acres of land, depending on the selected tower option. This could cause soil to erode at a rate of about 28-41 tons/year along the project corridor, similar to naturally occurring erosion rates for the area. This alternative has the lowest disturbance within potential landslide areas – about 2.5 acres. Overall geology and soils impact: ***low.***

Middle Alternative. Building the line and about 37 miles of access roads would disturb about 159-179 acres, depending on the selected tower option. This could cause soil to erode at a rate of about 33-35 tons/year along the project corridor, equivalent to the natural erosion rate. Disturbance within potential landslide areas – about 8-9 acres – would be more than the West Alternative, but much less than the East Alternative. Overall geology and soils impact: ***low-to-moderate.***

East Alternative. Highest erosion impact because of steeper terrain crossed; building the line and about 37 miles of access roads would disturb about 169-212 acres, depending on the selected tower option. Because of topography, this could cause soil to erode at a rate of about 42-57 tons/year along the project corridor, slightly higher than the natural erosion rate. This alternative has the highest disturbance within potential landslide areas: about 22-30 acres.   Overall geology and soils impact: ***moderate-to-high.***

Knight Substation Options. About 1 ton of soil would be subject to erosion at Site 1 compared with 0.5 ton at Site 2. Erosion rates differ because Site 1 has slightly more rolling terrain. Site 1 would also require a longer access road than Site 2. Still, soil impacts on both sites would be ***moderate***. There would be ***no*** landslide impacts.

S.4.5 Water Resources and Wetlands

Transmission line construction would cause ground disturbance that could affect waterways and groundwater. To minimize this impact, no towers would be located in waterways, floodplains or within 50 feet of the Columbia River and other primary creeks and rivers, which would be spanned from bank-to-bank high above the water level. No new access roads would cross the area's primary waterways (the Columbia and Little Klickitat rivers, Fifteenmile and Swale creeks), but some access roads could cross intermittent tributaries or drainages, where culverts would be used to ensure continued water passage. No new access roads would be built in floodplains; one existing road needing improvement is within a floodplain. There would be some wetland impacts where tower footings or access roads would encroach slightly on these resources (measured in hundredths and tenths of an acre).

Although there would be some vegetation removed in new rights-of-way, there would be no shade reduction to waterways.

There would be some groundwater impacts, although BPA would work to minimize these. Erosion control measures taken wherever soils would be exposed during construction would minimize sediment transportation to groundwater recharge areas, including intermittent streams.

West Alternative. Least disturbance within 50 feet of streams – about 2 acres would be disturbed for 9 permanent tower footings. Highest number of stream crossings by roads; 17 new and 15 improved access roads would cross intermittent streams, drainages or dry washes, but lowest number of new culverts (25) required. No towers or new or improved access roads would be built in floodplains. Most riparian areas would be left untouched with the exception of Threemile Creek, where some shade tree removal could have a low impact on water temperatures when water level is low. Overall impact on water courses: ***low***.

Highest impact on wetlands – some 1.7-3.0 acres would be permanently or temporarily disturbed by tower footings or road fill. Three potentially impacted wetlands have been identified as high-quality because of their special characteristics. Four impacted wetlands could have more than 0.1 acre disturbed. Overall impact on wetlands: ***high***.

Middle Alternative. Would disturb slightly more land within 50 feet of streams than the West Alternative – about 2.2 acres for up to 12 permanent tower footings. Lowest number of stream crossings by roads – 10 new and 10 improved access roads would cross intermittent streams, drainages or dry washes, requiring 28 new culverts. No towers or new access roads would be built in floodplains. One existing access road paralleling the southeast bank of Fifteenmile Creek and within a portion of its floodplain would need to be improved. Riparian areas would not be disturbed. Overall impact on water courses: ***low***.

Slightly lower impact on wetlands than the West Alternative – about 1.4-1.7 acres would be permanently or temporarily disturbed. One identified high-quality wetland could be impacted slightly by access road construction. Six impacted wetlands could have more than 0.1 acre disturbed. Overall impact on wetlands: ***moderate-to-high***.

East Alternative. Greatest disturbance within 50 feet of streams – about 2.7-2.9 acres would be disturbed for 4-5 permanent towers. New access roads would cross 22 streams/drainages and improved access roads 8 streams/drainages; similar to the West Alternative. Up to 30 new culverts would need to be installed. No towers or new access roads would be built in floodplains. One existing access road paralleling Fifteenmile Creek and within a portion of its floodplain would be improved. Riparian areas would not be disturbed. Overall impact on water courses: ***low.***

Lowest impact on wetlands – about 0.9 acre would be disturbed. No high-quality wetlands have been identified along the East Alternative, although two impacted wetlands could have more than 0.1 acre disturbed. Overall impact on wetlands: ***low-to-moderate.***

Knight Substation Options. There are no creeks or drainages on either substation site and neither is in a designated floodplain; both are relatively flat. With implementation of erosion control measures, construction at either site would have minimal impacts on surface water. There are no wetland areas on Site 1. A potential wetland near Site 2 would not be impacted by substation or road construction. Both sites would have ***no*** impacts on waterways and wetlands.

S.4.6 Wildlife

None of the action alternatives would impact federal threatened or endangered wildlife species. However, some federal species of concern and state-list species could be impacted by construction disturbance, habitat loss, and potential collisions with lines. BPA would take various mitigation steps to minimize these impacts, including scheduling construction around certain breeding seasons and installing bird diverters on overhead ground wires.

West Alternative. Would impact some high-quality habitat – including grasslands, shrub-steppe, woodlands, rock and cliff, and wetlands (see S.4.3 Vegetation) – and some special-status species. Slight impacts would be likely on the Western gray squirrel; amphibians, turtles, and wetland invertebrate species ; the sage lizard; and some common species of birds and wildlife. Overall impacts would be ***moderate-to-high***.

Middle Alternative. Would primarily impact common habitat that is abundant in the area. It would impact a small amount of high-quality habitats (the fringe of one shrub-steppe area, but no grasslands or rock and cliff areas) and only slightly impact woodlands and wetlands. There would be few potential impacts on special–status species (amphibians, turtles, bald eagle, white pelican, and mule and black-tailed deer). Overall impact would be ***low-to-moderate*.**

East Alternative. Would mostly impact common habitat that is abundant in the area. It would not impact high-quality habitats (grasslands, shrub-steppe, or rock and cliff), would only slightly impact woodlands and wetlands, and would have few potential impacts to special–status species (golden eagle, prairie falcon, peregrine falcon, bald eagle, white pelican, and mule and black-tailed deer). Overall impacts would be ***low-to-moderate***.

Knight Substation Options. Substation construction on either site would remove 10 acres of cropland from use, a small percentage of this widespread and relatively low quality habitat. No special-status species, nests, or burrows were found on Site 1 or 2. Impacts would be ***low*** at either substation site.

S.4.7 Fish

Fish would be impacted if the water quality and habitat in which they live were changed. Impacts could be due to erosion causing sedimentation of streams, pollution from petroleum spills, stream alterations, and riparian vegetation (shade) removal. However, none of the action alternatives would directly alter fish habitat or require culverts in fish-bearing streams. All tree removal would be upland from stream edges and would not impact shading on water surfaces. Mitigation measures would be taken to prevent spills and minimize erosion.

West Alternative. Would cross four fish-bearing streams, but towers would be placed well away from the water's edge, no culverts would be required, and no riparian trees would be removed. The Columbia and Little Klickitat rivers and Fifteenmile Creek have special-status fish species present where crossed. Construction work would not occur near these waterways; there would be no impacts to these fish. Culverts (25) would be placed only in seasonal non-fish-bearing tributary streams or dry washes. There would be ***no-to-low*** impact on fish***.***

Middle Alternative. Would cross the same four fish-bearing streams as the West Alternative, with no towers near streams, no culverts required, and no riparian trees removed. There would be no impacts on special-status fish species where it crosses the Columbia and little Klickitat rivers and Fifteenmile Creek. An existing access road along Fifteenmile Creek would require upgrading; mitigation measures would ensure no sediment reaches the creek. Culverts (28) would be placed only in seasonal non-fish-bearing tributary streams or dry washes. There would be ***no-to-low*** impact on fish***.***

East Alternative. Would cross the same four fish-bearing streams as the other alternatives, with no towers near streams, no culverts required, and no riparian trees removed. There would be no impacts on special-status fish species where it crosses the Columbia and Little Klickitat rivers and Fifteenmile Creek. An existing access road along Fifteenmile Creek would require upgrading; mitigation measures would ensure no sediment reaches the creek. Culverts (30) would be placed only in seasonal non-fish-bearing tributary streams or dry washes. There would be ***no-to-low*** impact on fish***.***

Knight Substation Options. No fish-bearing streams are located in the vicinity of Knight Substation Sites 1 or 2. A dry wash tributary to Blockhouse Creek – about 4 miles and 1 mile downstream of Sites 1 and 2, respectively – is located nearby, but no fish occur in Blockhouse Creek in the vicinity of the confluence with the dry wash. There would be ***no*** impact on fish.

S.4.8 Cultural Resources

Because the project transects areas significant to Columbia River Tribes and the general area has a rich history, construction of the line could potentially disturb cultural sites. It would also introduce visual elements that could alter the character of sensitive cultural and spiritual resource sites. However, towers and access roads would be sited to avoid known sensitive areas whenever possible and trained cultural resource monitors would be consulted during construction to ensure unidentified sites are not inadvertently impacted.

West Alternative. Would pass within 1 mile of 157 cultural resource sites, including pre-contact sites such as rock images and burial sites, and historic sites such as trails and a fishwheel location. Of these, 11 sites are within the West Alternative's right-of-way and include scattered and isolated pre-contact artifacts, a pre-contact rock alignment, a pre-contact cairn, and an historic rock alignment. The line would also cross through Homesteads of the Dalles Mountain Ranch Historic District and an area of the Columbia Hills that could contain unknown cultural resources. While surveys conducted before construction would help identify these, potential impacts on cultural resources are higher than the other two alternatives. Potential impacts would be ***moderate.***

Middle Alternative. Would pass within 1 mile of 133 cultural resource sites, including pre-contact and historic sites similar to the West Alternative. Of these, nine sites are within the Middle Alternative's right-of-way and include three scatters of historic artifacts, two pre-contact isolated artifacts, an historic railroad grade, an historic rock alignment, and a large site with pre-contact artifacts, pictographs, and burial sites. The line would also cross over an Oregon Trail segment (no longer visible) at two places due to a 90-degree bend where the line crosses the Columbia River. Because the most significant cultural site would be separated by a vertical distance that precludes disturbance, and other sites would be avoided, potential impacts on cultural resources would be ***low.***

East Alternative. Would pass within 1 mile of 123 cultural resource sites, including pre-contact and historic sites similar to the West and Middle alternatives. Of these, 10 sites are within the East Alternative's right-of-way and include two scatters of historic artifacts, an historic railroad grade, pre-contact lithic artifact scatters, a pre-contact burial site, an historic rock alignment, and a large site with pre-contact artifacts, pictographs, and burial sites. Like the Middle Alternative, the East Alternative crosses over an Oregon Trail segment at two points. Because the most significant cultural site would be separated by a vertical distance that precludes disturbance, and other sites would be avoided, potential impacts on cultural resources would be ***low.***

Knight Substation Options. There are no known cultural resource sites near either proposed Knight Substation site. However, only limited cultural resource surveys have been conducted in the vicinity of either location in the past. BPA recently conducted limited archaeological testing of portions of Site 1; no cultural resources were identified. Because the substation would be located where there is a low likelihood of cultural resources, there would be ***no-to-low*** potential impact**.**

S.4.9 Socioeconomics

The proposed project would impact private farms, ranches, and residences; some state lands; and possibly recreational lands. The action alternatives would not result in the loss of large amounts of land from any single property or fragment any local communities, although concerns about the line's impact on property values could potentially create a sense of loss of the agrarian, cultural, and natural resource aesthetic in the area.

The action alternatives would have similar impacts on certain economic elements. During construction, workers would be hired, would need housing and would buy goods and services locally; this would have temporary positive impacts on employment, housing, retail and Washington State (state sales tax revenues). In addition, the state and Klickitat County would benefit from one-time gains in tax revenues of about $1.95 million and $150,000, respectively, through "use" taxes levied on the value of out-of-state materials purchased for the project. BPA would reimburse landowners for lands required for new right-of-way or access road easements. Potential impacts on property values would be variable; some low, temporary negative impacts on values (and salability) might occur on an individual basis for some properties along or near the transmission line. There would be no impact on public services.

West Alternative. Most agricultural economic impacts would occur in rangelands and nonirrigated cropland. Maximum permanent reduction in direct agricultural output would be about $5,845 per year, of which $631 would be labor income. Indirect earnings reductions by related sectors would be about $9,580 per year for Klickitat and Wasco counties, $1,615 of which would be labor income. This is a small proportion of the two counties' overall output, which is measured in tens of millions of dollars. Impacts on the local and regional economy would be ***low***.

The West Alternative tower option that would include permanently removing the Chenoweth-Goldendale line could affect Klickitat County Public Utility District (PUD). Klickitat PUD uses this line as a backup to the Goldendale Substation when other lines are down for maintenance. Other means for backup would need to be found as needed. Impact on Klickitat PUD would be ***moderate***.

Middle Alternative. Similar to the West Alternative, most agricultural economic impacts would occur in rangelands and nonirrigated croplands, although relatively more cropland would be impacted. Maximum permanent reduction in direct agricultural output would be about $8,280 per year, of which $835 would be labor income. Indirect earnings reductions by related sectors would be about $12,237 per year for Klickitat and Wasco counties, of which $1,996 would be labor income. This is a small proportion of overall output; impacts on the local and regional economy would be ***low***.

East Alternative. Similar to the other alternatives, most agricultural economic impacts would occur in rangelands and nonirrigated croplands; like the Middle Alternative, relatively more cropland would be impacted. Maximum permanent reduction in direct agricultural output would be about $7,380 per year, of which $785 would be labor income. Indirect earnings reductions by related sectors would be about $11,303 per year for Klickitat and Wasco counties, of which $1,893 would be labor income. This is a small proportion of overall output; impacts on the local and regional economy would be ***low***.

Knight Substation Options. Building the substation on Site 1 would remove 80 acres of privately owned, nonirrigated cropland from production. Total reduction in economic output would be about $20,984/year for Klickitat County, of which $2,937/year would be labor income. Direct effects to the individual landowner would be slightly smaller. However, the landowner would be compensated by purchase of the property by BPA, and 50–70 acres could potentially be leased out for cultivation in the future. Placing this privately-owned land into federal ownership would also remove it from the Klickitat County tax base, for a loss of about $142 annually in property taxes. These losses would be considered a permanent ***low*** impact on all parties.

Building the substation on Site 2 would permanently remove about 30 acres of DNR land leased for crop production. Total reduction in economic output would be about $7,880/year for Klickitat County, of which $1,103/year would be labor income. Direct effects on DNR and its sharecroppers would be slightly less. Sharecroppers would not be compensated for losses. Revenues to DNR would be reduced by about $900–2,100 per year, about a thousandth of a percent of 2009 revenues from State Trust Lands. DNR would be compensated by purchase of the land rights, and since the state does not pay property tax, this would have no impact on the county tax base. These losses would be a permanent ***low*** impact on all parties.

S.4.10 Transportation

During construction of the line, motorists on local roads would temporarily experience increased traffic and possible delays. In the long-term, motorists and the county would benefit from improvements to small segments of county roads. Development of BPA access roads could have positive or negative impacts on affected landowners. Installation of tall towers along the transmission line corridor could pose air traffic hazards if not properly marked. The Federal Aviation Administration (FAA) will review all towers and wires exceeding 200 feet above ground or water to determine which require marking (painting or lighting for towers and marker balls for wires).

West Alternative. Would require the greatest amount of new access roads (about 21 miles) among the alternatives. Also requires 11 miles of existing access road upgrades, 3 miles of temporary access roads, and 5 miles of county road upgrades. It would pass relatively close to two airports and have at least 11 towers exceeding 200 feet. Overall impacts would be ***low-to-moderate.***

Middle Alternative. Would require about 19 miles of new access road, 15 miles of existing access road upgrades, and 3 miles of temporary roads. Would have at least five towers exceeding 200 feet. Overall impacts would be ***low.***

East Alternative. Would require about 16 miles of new access road, 16 miles of existing access road upgrades, and 5 miles of temporary roads. Would have at least eight towers exceeding 200 feet. Overall impacts would be ***low.***

Knight Substation Options. Knight Road would provide primary access to either Site 1 or 2 during construction. However, for Site 1, construction vehicles would likely travel from Knight Road onto either Hill Road, Butts Road, or Pine Forest Road to connect with a temporary access road to the site. The selected county road may require upgrades to accommodate expected heavy loads. When construction is complete, the temporary access road would be removed. Permanent access to either site would be from Knight Road. The substation would be remotely controlled, with only periodic visits by BPA personnel. Overall substation impacts on transportation would be ***low.***

S.4.11 Noise

Sources of noise would be construction equipment used to build the line and, after completion, "corona" noise (hum and/or crackling) from the energized conductors. Noise impacts during construction would be the same for all action alternatives: ***moderate-to-high.*** Construction noise would be localized (affecting a few residents or business owners at a time) and temporary as crews would complete line segments and move on.

West Alternative. Corona noise would be rare (it occurs most often during foul weather, which happens only 1 percent of the time in the project area). In areas where homes or businesses are already near existing lines and the new line would parallel or replace these lines, the potential for corona noise would remain the same or decrease. (Newer transmission lines are configured to reduce corona.) In areas where homes or businesses would be near new right-of-way (e.g., no transmission line currently exists), corona could be audible at the edge of the right-of-way in foul weather, but would be masked by ambient noise the rest of the time. Overall permanent noise impact: ***none-to-low***.

Middle and East Alternatives. Same corona noise impacts as the West Alternative, with the exception of one home in Wishram that could be as close as 71 feet to the centerline of either alternative (if the single-circuit option were used). While this house is already close to an existing line, it would be even closer to the new line, with the potential for higher corona noise impacts. Using a double-circuit tower option in this area would place towers farther from this home. Overall permanent noise impact: ***none-to-low,*** with the potential exception of one home where it could be higher.

Knight Substation Options. Construction noise impacts would be ***low-to-moderate***, because there are no residences within 1,000 feet of either Site 1 or 2. The substation would create ***no-to-low*** permanent noise impacts on either site because the existing adjacent transmission line would remain the predominant source of environmental noise.

S.4.12 Public Health and Safety

General safety impacts would be the same for all action alternatives: ***low***. Contractors would be required to follow all safety standards. Impacts from electric and magnetic fields (EMF) generated by the new line would be similar for each action alternative. Construction standards and grounding requirements would minimize the potential for nuisance shocks from electric fields for anyone near the right-of-way. Even with the addition of the transmission line, magnetic field levels in the area would remain comparable to ambient levels, with one exception: if a single-circuit option were used, the Middle or East alternatives would run within 71 feet of one home, potentially boosting magnetic fields there slightly over ambient levels, for a potentially higher impact on that one home.

EMF levels at the perimeter of the Knight Substation yard, on either Site 1 or 2, would reflect fields generated by the new 500-kV line. The magnitudes and impacts would be similar to those for the transmission lines alone. Within a few hundred feet, these fields would dissipate to ambient levels. Since there are no residences near either substation site, there would be ***no*** EMF impacts.

S.4.13 Air Quality

There are no major industrial facilities along the action alternatives and no significant existing air quality problems in these portions of Wasco and Klickitat counties. Local air pollutant emissions are mainly windblown dust from agricultural operations and tailpipe emissions from traffic along state highways and local roads. Construction of any action alternative would generate a temporary increase in such pollutants; specifically, heavy equipment would create dust and add to exhaust emissions, and removal of some trees and vegetation would create fugitive dust. However, the amount of pollutants emitted from construction vehicles and equipment would be relatively small and comparable to typical conditions when agricultural equipment is operated in the project vicinity. Once the line is operational, maintenance vehicles would make infrequent trips in the area, travelling primarily on rocked access roads that may temporarily kick up a small amount of dust. There would be ***no-to-low*** air quality impacts for all alternatives.

S.4.14 Greenhouse Gases

Construction of the transmission line would contribute to greenhouse gas (GHG) concentrations in several ways. Removal or disturbance of trees, vegetation and soil (which absorb gases), and exhaust from construction equipment and vehicles, would incrementally increase carbon dioxide, methane, and nitrous oxide emissions. Lesser emissions due to once-annual ground inspections (maintenance vehicles) and twice-annual helicopter inspections would occur when the line is operational. Analysis has determined GHG contributions from these activities would be very small. The impact of any action alternative would be ***low***.

S.4.15 Fiber Optic Cable – Wautoma Option

Stringing cable on and under the existing Wautoma-Ostrander transmission line would disturb a small patch of land around some tower footings. About 16 splice boxes would be placed on the transmission towers or in the ground next to the towers. At each site, about 0.25 acre of ground would be temporarily disturbed by a reeling truck and tensioning equipment. All equipment would stay within existing right-of-way and use existing access roads. There would be no staging areas.

In addition, outside the yard of the Knight and Wautoma substations, concrete vault boxes (4 feet x 4 feet x 4 feet) would be installed. Other fiber optic cable equipment needed as part of the communications network would also be installed within existing substation yards.

Impacts by the Wautoma Option would be ***low*** on:

- Land use and recreation because, while some crops could be damaged, the amount of affected acreage is small and only one state park is in the vicinity;
- Visual resources, because the area is sparsely populated and the addition of the fiber optic cable would likely not be noticed;
- Noise, because use of loud equipment or helicopters would only be allowed during daylight hours and would be short-term at any one location; and

- Cultural resources, because new ground disturbance would be minimal. (BPA is also surveying the area and consulting Tribes.)

The Wautoma Option would have ***no-to-low*** impacts on vegetation, because vegetation that would be disturbed would be next to existing towers legs, the vegetation has been previously disturbed, and it is not comprised of trees or special-status species. There would also be ***no-to-low*** impacts on soils because limited digging and compaction would occur and mitigation would help alleviate these impacts.

It would have ***low-to-moderate*** impacts on wildlife because it could cause temporary displacement in some areas. While not expected to impact any federal threatened or endangered species, some state-listed and other species could be impacted by construction activities or collisions with lines. The higher impact would occur only if construction took place during breeding seasons for migratory birds or the Western gray squirrel.

The Wautoma Option would have ***no*** impacts on waterways, wetlands and fish, because all waterways and wetlands would be avoided (spanned). It would also have ***no*** impact on the area's socioeconomics, transportation facilities, public health and safety, air quality, or GHG emissions.

S.4.16 Cumulative Impacts

Cumulative impacts are environmental impacts that result from the incremental impact of an action, such as one of the Proposed Action Alternatives, when added to other past, present and reasonably foreseeable future actions.

Past actions that have affected natural and human resources in the project area include construction and operation of The Dalles Dam, several BPA transmission lines and Big Eddy Substation; agricultural activities; railroad, highway and road construction and use; commercial and residential development; National Scenic Act designation; conservation lands and park designations; airport construction and operation; and wind energy development.

Currently and in the reasonably foreseeable future, it is expected that many of these activities will continue and grow. For example, more "wind farms" are under construction and planned in Klickitat County. Several large parcels of agricultural land near the Little Klickitat River have been subdivided for large-lot residential subdivisions. If a decision is made to build one of the action alternatives, the selected alternative would add to these impacts with construction and operation of additional transmission line facilities and the new Knight Substation.

The Big Eddy-Knight Transmission Project's incremental contribution to impacts on resources would vary. Generally, it would have ***no-to-low*** additional impacts on waterways, fish, public health and safety, air quality, greenhouse gas emissions and long-term noise; and ***low-to-moderate*** additional impacts on geology and soils, transportation, and cultural resources. For other resources, including vegetation, wildlife, wetlands, and land use and recreation, cumulative impacts could range from low to high, depending on the action alternative selected and portion of transmission line corridor discussed. Overall, construction and operation of the Big Eddy-Knight Transmission Project would contribute most to incremental impacts on visual resources, particularly in the National Scenic Area, with the greatest cumulative visual impact expected from the West Alternative.

Chapter 1
Purpose of and Need for Action

The Bonneville Power Administration (BPA) is proposing to build a 500-kilovolt (kV) lattice-steel-tower transmission line that would run from BPA's Big Eddy Substation near The Dalles, Oregon, to a new Knight Substation about 4 miles northwest of Goldendale, Washington. The proposed Big Eddy-Knight Project would increase the electrical capacity of BPA's transmission system. BPA is considering three transmission line routing alternatives, two adjacent sites for the proposed substation, two fiber optic cable options, and a No Action Alternative for the project (see Map 1-1).

This chapter describes the need for BPA to increase the electrical capacity of its transmission system in response to requests for use of its system. This chapter also identifies the purposes that BPA is attempting to achieve in meeting this need, transmission system benefits from BPA's proposal, and the agencies involved in development of this environmental impact statement (EIS). The end of the chapter provides a summary of the public scoping process conducted for the EIS and information about the scope and organization of this EIS.

As a federal agency, BPA is required by the National Environmental Policy Act (NEPA) to take into account the potential environmental consequences of its proposal and take action to protect, restore, and enhance the environment during and after construction. Preparation of this EIS assists in meeting whose requirements.

1.1 Background

BPA is a federal agency within the U.S. Department of Energy that owns and operates more than 15,000 circuit miles of high-voltage transmission lines in the Pacific Northwest. BPA's electrical transmission lines serve customers in Idaho, Oregon, Washington, western Montana, and small parts of eastern Montana, California, Nevada, Utah, and Wyoming. These lines move most of the Northwest's high-voltage power from facilities that generate the power to power users throughout the region and to nearby regions such as Canada and California. Buyers of high-voltage power include public utility districts, municipalities and investor-owned utilities which, in turn, provide electricity to homes, businesses, industries and farms throughout the Pacific Northwest. Direct service industries (e.g., aluminum plants) also are purchasers of power that is moved by BPA's transmission lines.

To move this power on BPA's transmission lines, BPA sells transmission service that allows the use of these lines. BPA's transmission customers, typically utilities, power generators, and power marketers, use this service by transferring power over the transmission lines to their buyers. BPA has a statutory obligation to ensure it has sufficient capability to serve its customers through a safe and reliable transmission system. The Federal Columbia River Transmission Act directs BPA to construct improvements, additions, and replacements to its transmission system that the BPA Administrator determines are necessary to provide service to BPA's customers and maintain electrical stability and reliability (16 United States Code [USC] Section [§] 838b[b-d]).

Most requests for transmission service are for long-term firm service. Long-term firm service is an agreed-upon use of the system at specific times of day and year. To help guide its approach to receiving, managing, and responding to requests for long-term, firm transmission service over its transmission system, BPA has adopted an Open Access Transmission Tariff[1] for its transmission system (BPA 2008a). The tariff has procedures that provide access to BPA's transmission system for all eligible service requests on a first-come, first-served basis, subject to a determination that there is sufficient available transmission capacity (ATC) on BPA's transmission system. ATC is a measure of the transfer capability remaining in the physical transmission network for additional commercial activity, over and above existing commitments for service. If there is not enough available transmission capacity on the system, new transmission facilities, such as an additional transmission line, may be proposed to increase the capacity to grant new transmission requests. Any new transmission facilities proposed must meet all BPA requirements and are subject to appropriate environmental review under NEPA.

Consistent with its tariff, BPA accepts requests for transmission service in a transmission service request queue. In the past few years, the amount of requested service in this queue, measured in megawatts (MW), has far exceeded projected load growth (increase in electrical demand) in the Pacific Northwest. For example, in March 2008, BPA's transmission service request queue contained about 9,200 MW of requests for service. At the same time, BPA forecasted only 2,500 average MW of load growth for all utilities within the Pacific Northwest through 2017. Because the amount of requests in the queue far exceeded the forecasted load growth for the region, it was clear to BPA that some transmission service requests in the queue were speculative, but the speculative requests were impossible for BPA to identify. This uncertainty made it difficult for BPA to accurately plan for truly necessary system upgrades, and the sheer volume of requests was making the queue congested and unmanageable.

To help address this issue, BPA developed and initiated a Federal Energy Regulatory Commission (FERC)-approved Network Open Season (NOS) marketing process to help manage the queue and eliminate speculative requests. In 2008, BPA conducted the first NOS process and utilities, power generators (including wind generators), power marketers, and others were asked to resubmit their requests to use BPA's transmission system to transmit their power. BPA then was able to determine which of these requests could be served by existing available transmission capacity, and which of these requests would require system upgrades to provide the requested service.

For transmission service requests requiring system upgrades, BPA conducted electric powerflow studies of separate "clusters" of requests to determine where the system was congested and what upgrades were needed to accommodate the most requests. In conducting these studies, BPA took into consideration reliability criteria established by the North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) (see boxes). NERC, the national electric reliability organization, and WECC, the regional reliability organization, help coordinate the operation and planning of the bulk transmission system in the region. Utilities are required to meet the standards of both organizations when planning new facilities.

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[1] BPA's tariff is generally consistent with the Federal Energy Regulatory Commission (FERC) *pro forma* open access tariff. More information about the Federal Energy Regulatory Commission is available on its Web site: www.ferc.gov/. More information about BPA's tariff is available on BPA's Transmission Web site: http://www.transmission.bpa.gov/business/ts_tariff/.

About the North American Electric Reliability Corporation

NERC is a self-regulatory organization that has statutory responsibility to regulate bulk power system users, owners, and operators through the adoption and enforcement of standards for fair, ethical, and efficient practices.

NERC develops and enforces reliability standards; assesses adequacy annually via a 10-year forecast and winter and summer forecasts; monitors the bulk power system; and educates, trains, and certifies industry personnel. NERC is subject to oversight by FERC and governmental authorities in Canada.

As of June 18, 2007, FERC granted NERC the legal authority to enforce reliability standards with all U.S. users, owners, and operators of the bulk power system, and made compliance with those standards mandatory and enforceable. More information is available on NERC's Web site: http://www.nerc.com (NERC 2010).

About the Western Electricity Coordinating Council

WECC is the regional entity responsible for coordinating and promoting bulk electric system reliability in the West. WECC's service territory extends from Canada to Mexico. It includes the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 western states.

In addition to coordinating system reliability, WECC assures open and non-discriminatory transmission access among members, provides a forum for resolving transmission access disputes, and provides an environment for coordinating the operating and planning activities of its members as set forth in its bylaws.

Membership in WECC is open to all entities with an interest in the operation of the bulk electric system in the West. All meetings are open and anyone may participate in WECC's standards development process. More information is available on WECC's Web site: http://www.wecc.biz/ (WECC 2009).

One of the service request clusters that BPA studied involved requests for long-term firm transmission service in the project area. There currently are several existing BPA high-voltage transmission lines that pass through this area. Under BPA's tariff, all existing lines that were originally used to move power from the Columbia River hydrosystem to the load centers west of the Cascades are now also required to provide transmission service to power marketers, wind generators, and others. As a result, these transmission paths have become increasingly congested.

BPA's powerflow cluster studies determined that there is not enough available capacity to accommodate requests received through the 2008 NOS process to move power from the east side of the Cascade Mountains (along the Oregon/Washington border) to load centers (such as Portland, Oregon) on the west side of the Cascades and to major transmission lines serving California. Wind generation facilities built and proposed in the region have greatly increased the amount of power being produced on the east side of the Cascade Mountains. Most requests have come from wind developers throughout the region. Some requests are for power already integrated into BPA's transmission system, but the power is unable to flow unrestricted due to bottle necks and lack of capacity, and some requests are from developers waiting for capacity to plan for additional wind projects throughout the region.

BPA's study of this cluster also found that a new 500-kV transmission line from BPA's existing Big Eddy Substation in Oregon to a point on BPA's existing Wautoma-Ostrander 500-kV transmission line in Washington would allow BPA to accommodate up to 1,150 MW of service requests (see Map 1-1).

BPA also has taken the proposed Big Eddy-Knight project through the WECC Regional Planning Project Review (Regional Review) process. The Regional Review process is the initial development phase of a project in which regional interest is expressed for a possible new transmission line project. BPA coordinated the review through ColumbiaGrid (see box) and worked with other interested regional parties in developing the proposed project.

About ColumbiaGrid

ColumbiaGrid is a non-profit membership corporation formed in 2006 to improve the operational efficiency, reliability, and planned expansion of the Pacific Northwest transmission grid. The corporation itself does not own transmission, but its members and the parties to its agreements own and operate an extensive network of transmission facilities.

ColumbiaGrid has substantive responsibilities for transmission planning, reliability, the Open-Access Same-Time Information System (OASIS), and other development services. These tasks are defined and funded through agreements with members and other participants. Development of these agreements is carried out in a public process with broad participation. More information about ColumbiaGrid is available on its Web site: http://www.columbiagrid.org/ (ColumbiaGrid 2009).

During the Regional Review process, BPA shared study results and proposed alternate plans of service with other Northwest utilities. This provided other utilities an opportunity to review and comment on BPA's plans with the goal of developing the best plan of service with respect to regional benefits and impacts. The Regional Review process for Big Eddy-Knight concluded in February 2008.

1.2 Need for Action

BPA needs to increase the electrical capacity of the 500-kV transmission system in response to requests that BPA has received to move power across its system. Through the 2008 NOS process, BPA received about 1,150 MW of requests for transmission service in the project area from multiple customers. BPA has received additional requests for service in this area though the 2009 NOS process. There is insufficient existing available transmission capacity on the 500-kV transmission system to accommodate these requests.

A new 500-kV transmission line between BPA's Big Eddy Substation in Oregon and BPA's existing Wautoma-Ostrander 500-kV transmission line in Washington would increase the 500-kV transmission capacity from the east side of the Cascade Mountains (along the Oregon/Washington border) to the west side of the Cascades and allow BPA to provide the requested long-term, firm transmission service in the region. Connecting these two 500-kV facilities would eliminate a bottleneck in this area, provide an additional electrical pathway, and increase the system capacity allowing additional power to flow through the region. Using BPA's existing transmission system in this area without a new transmission line to respond to the service requests would likely result in BPA's transmission system becoming overloaded at certain times of the year. This could lead to cascading outages affecting BPA facilities and triggering outages on other utility transmission lines in the area, and possibly other portions of the regional transmission system.

1.3 Purposes

In meeting the need for action, BPA will attempt to achieve the following purposes:

- Optimize electrical capacity and performance of the transmission system
- Maintain reliability of BPA's transmission system to BPA and industry standards
- Meet BPA's contractual and statutory obligations
- Minimize project costs where practical
- Minimize impacts to the natural and human environment
- Minimize future impacts

1.4 Transmission System Benefits

In addition to being able to accommodate requests for firm transmission service, the proposed project would address reliability issues on BPA's system. The proposed new line and substation would help redistribute the flow of power, which would increase the capacity of the overall system, including the capacity to serve the Portland area during the winter. In addition, the project is consistent with long-range system plans and would defer the need for future reinforcement projects that would be needed in its absence.

1.5 Agency Roles

1.5.1 Lead and Cooperating Agencies

BPA is the lead agency responsible for preparing this EIS under NEPA. BPA will use the EIS, along with comments from the public, to inform the following BPA decisions:

- Whether to build a new 500-kV transmission line to meet the need.
- If the decision is to build the transmission line, which routing alternative, substation site, and fiber optic option would be constructed and operated. (See Chapter 2 for descriptions of the alternatives.)

The Council on Environmental Quality (CEQ) regulations implementing NEPA allow for the designation of other federal, state, and local agencies and Indian tribes as cooperating agencies for an EIS where appropriate. In furtherance of existing cooperative agreements between BPA and the states of Washington and Oregon, the Washington Energy Facility Site Evaluation Council (Washington EFSEC) and the Oregon Department of Energy will participate in preparation of this EIS as cooperating agencies under NEPA. Among other things, these state agencies will assist BPA in the environmental evaluation of transmission line routes, develop possible mitigation measures, and identify state interests that should be addressed in the EIS.

1.5.2 Other Agencies That May Use This EIS

Chapter 5 of this EIS identifies other federal agencies that may have permitting, review, or other approval responsibilities related to certain aspects of the proposed project. For instance, the U.S. Forest Service (USFS) is responsible under the Columbia River Gorge National Scenic Area Act (16 USC 544-544p) for making a determination concerning the consistency of portions of the proposed project that would be located in the Columbia River Gorge National Scenic Area (National Scenic Area) with the provisions of the Scenic Act (see Section 5.22 and Chapter 7 of this EIS). In addition, to the extent that the proposed project would cross land managed or owned by the USFS, this agency also may need to conduct appropriate environmental review before authorizing this proposed use. Federal agencies such as the USFS thus may use all or part of this EIS to fulfill their NEPA responsibilities for their actions related to the proposed project.

Certain state, regional and local agencies also may use all or part of this EIS to fulfill their applicable environmental review requirements for any actions they may need to take for the proposed project. For example, portions of the routing alternatives cross land owned by the State of Washington and managed by the Washington State Department of Natural Resources (DNR), the Washington State Parks Department, as well as the Washington Department of Fish and Wildlife. In addition, any crossing of the Columbia River by the proposed transmission line would be subject to DNR’s Aquatic Permit program and an easement from Oregon’s Department of State Lands. Before the Washington state agencies can take action to authorize use of state-managed lands or issue aquatic permits, the state agencies must comply with the requirements of the Washington’s State Environmental Policy Act (SEPA), Chapter 43.21C RCW. BPA is coordinating with the state of Washington to attempt to ensure that environmental issues relevant to the Washington state agencies and their SEPA needs are addressed, to the fullest extent practicable, in BPA’s NEPA process. Accordingly, it is expected that these agencies will use relevant information from this EIS to help fulfill their SEPA requirements for their actions related to the proposed project.

See Chapters 5, 6 and 7 for additional information on federal, state, regional and local agencies with potential involvement in the proposed project.

1.6 Public Involvement and Major Issues

Early in the development of this EIS, BPA solicited comments from the public, Tribes, federal, state, regional, and local agencies, interest groups and others to help determine what issues should be studied in this EIS. Because these issues help define the scope of the EIS, this process is called “scoping.” Public comments were received by mail, via fax, by telephone, through the BPA Web site, and at scoping meetings.

1.6.1 EIS Scoping Outreach

During the scoping period for the EIS, BPA requested comments through the following means:

- On June 3, 2009, BPA published a Notice of Intent (NOI) to prepare an EIS and conduct public meetings for the Big Eddy-Knight Transmission Project in the *Federal Register* (Vol. 74, No. 105). The NOI initiated a 30-day public scoping period.
- Also in June 2009, BPA sent a letter to about 400 potentially interested and affected persons, requesting comments and inviting the public to a scoping meeting. The letter was sent to people who live along the proposed transmission line routes; federal, state, regional,

and local agencies that may have expertise or require permits for the project; Tribes with interest in the area; and other interest groups.

- BPA sent a press release to local media, and placed paid ads in the following newspapers about the public scoping meetings and the comment period:
  - The Dalles Chronicle – Tuesday, June 23 and Sunday, June 28, 2009
  - Tri-City Herald – Monday, June 22 and Sunday, June 28, 2009
  - Goldendale Sentinel – Thursday, June 25, 2009.
- Two open-house style public meetings were held – in The Dalles, Oregon on June 30, 2009 and in Goldendale, Washington on July 1, 2009. At each meeting BPA received comments on the proposed alternatives.
- Additional meetings were held with tribes; state agencies; congressional, city, and county staffs; and interest groups.
- BPA established a project Web site with information about the project and the EIS process www.bpa.gov/go/BEK/. BPA posted a link to all comments it received on the project Web site.
- In December 2009, BPA sent the public a factsheet that described refined routing alternatives based on comments received during the public scoping process and additional studies of the transmission system, and requested public comment on those refinements.

More than 100 people attended the public scoping meetings held in The Dalles and Goldendale in summer 2009. The open house-style meetings featured topic-specific stations and information. BPA staff was available to answer questions and help landowners locate their property on maps in relation to the proposed project routes. BPA staff recorded verbal public comments in notes and on flip charts and members of the public had an opportunity to provide written comments on comment forms.

In addition, the BPA project manager, environmental coordinator, and other staff held meetings with state agencies (EFSEC, DNR, Fish and Wildlife, Parks, Ecology, and Department of Archaeology and Historic Preservation in Washington and the Oregon Department of Energy); representatives of tribes with interests in the area (the Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe of Idaho, and the Confederated Tribes of the Umatilla Indian Reservation); staff for members of Congress; Klickitat County, Washington and Wasco County, Oregon officials and planning departments; the Columbia River Scenic Gorge Commission (CRGC); the USFS; and the Friends of the Gorge.

1.6.2 EIS Scoping Comment Summary

Over 400 people commented on the project during the scoping period for the EIS. People expressed opinions about a wide range of issues for BPA to consider. Questions and concerns included the following:

- Questions about the underlying need for the project; for example, whether the project is needed for the wind farms in the area, and where the power on a new line would go.
- Questions about the design of the proposed transmission line–how big the towers would be, how much right-of-way would be needed, how close the line could be to existing lines.
- Opinions and data supporting a particular route for the line.
- Concern about the visual impact on views in the Columbia River Gorge National Scenic Area, other recreation areas and homes.

- Concern about how the line would affect farming, such as possible irrigation and aerial spraying disruptions and effects on crops during construction.
- Concern about impacts to natural preserve areas, wildlife habitat, and protected animal and plant species.
- Concern about potential human health risks associated with electromagnetic fields.
- Concern that the project would impact property values, the ability to sell land being subdivided, and the inherent value of family homesteads.

This is a partial list of issues identified from the comments received. All comments received were logged in and forwarded to resource specialists to include in their environmental impact analyses for the EIS.

Thirty-eight individuals submitted comments in response to the December 2009 factsheet that described the project refinements. Issues raised in comments were similar to the issues raised during the scoping period.

All comments submitted, the Public Scoping Comment Report (June 2009 through September 2009), and other project information are on the project Web site: www.bpa.gov/go/BEK.

1.7 Issues Outside the Scope of the Proposed Action or this EIS

Most issues raised during the scoping process are considered to be within the scope of the Proposed Action and are addressed in this EIS. However, some issues are considered to be either beyond the scope of this EIS (and thus are not addressed in this EIS) or are outside the scope of the Proposed Action. The following describes these issues.

1.7.1 Regional Generation Development

BPA received a suggestion that BPA undertake a programmatic review of all energy generation projects, including new and proposed wind development, that may occur throughout the region related to any increased capacity on BPA's transmission system. BPA does not have a region-wide program or plan related to wind or other generation projects, and does not dictate or direct where these projects are proposed. In addition, none of these generation projects are proposed, constructed, or operated by BPA; instead, they are proposed and undertaken by private entities, and their siting is controlled by state or local jurisdictions. BPA's role is typically limited to simply considering whether to interconnect these proposed projects, in compliance with its Open Access Transmission Tariff and after an evaluation of the environmental effects of the proposed interconnection under NEPA.

Furthermore, decisions by BPA on whether to interconnect a particular proposed generation project to its transmission system would be made independently of a decision on whether to construct the proposed Big Eddy-Knight Transmission Project. More specifically, a decision to interconnect any generation project is not dependent on construction of this proposed transmission line. In addition, this transmission line is being proposed to respond to requests for transmission service from a variety of existing and proposed generation sources, as well as from entities simply looking to move their electrical power from one point to another. These requests are already in BPA's queue for transmission service. A decision to proceed with the Big Eddy-Knight Transmission Project thus would not be fully dependent on decisions related to interconnection of any new or proposed generation development projects in the region.

Therefore, new and proposed generation development projects are not considered to be within the scope of the Proposed Action, i.e., development of the proposed Big Eddy-Knight Transmission Project analyzed in this EIS. However, to the extent that the potential environmental impacts of any new or proposed generation projects in the vicinity of the Proposed Action are cumulatively additive to the potential environmental impacts of the Proposed Action, these impacts are discussed and considered in the cumulative analysis in this EIS (see Chapter 4 Cumulative Impacts).

1.7.2 Regional Transmission Development

A comment suggested that BPA undertake a programmatic review of all of its proposed transmission infrastructure projects in the region. BPA does not have a region-wide program or plan to take actions related to its transmission system. These actions are proposed on a project-specific basis, when needed, to address various transmission reliability and service issues on certain portions of BPA's transmission system. In addition, increases in capacity that may occur on BPA's existing transmission system from proposed infrastructure improvements would be in response to already existing requests for transmission service, rather than designed to provide significant additional, unsubscribed capacity. Finally, while there may be synergies among the various proposed transmission infrastructure projects in the region, none of the proposed projects are dependent on any other project for its viability or success. Other proposed BPA transmission infrastructure projects in the region are therefore outside of the scope of the Proposed Action and this EIS.

1.7.3 Conservation

Another comment stated that BPA should consider creating a regional energy strategy that depends on energy conservation, energy efficiency, and demand reduction to meet future energy needs as an alternative to the Proposed Action. As discussed in Section 1.2 of this EIS, BPA is proposing the Big Eddy-Knight Transmission Project to respond to requests for transmission service. While BPA actively supports and helps facilitate a variety of energy conservation programs and activities in the region, energy conservation, energy efficiency, and demand reduction are not feasible methods for responding to these existing requests for transmission service. Also see Section 2.6, Alternatives Considered but Eliminated from Detailed Study.

1.8 Organization of this EIS

The remainder of this EIS is organized as follows:

- Chapter 2 describes the Proposed Action Alternatives, the No Action Alternative, and alternatives considered but eliminated from detailed consideration. It summarizes and compares the differences between the various Action Alternatives and the No Action Alternative, in particular concerning potential environmental impacts.
- Chapter 3 describes the existing environment that could be affected by the proposed project and the possible environmental consequences of the Proposed Action Alternatives and No Action Alternative. An assessment of the direct, indirect, and cumulative effects on land use and recreation, visual resources, vegetation, geology and soils, water resources and wetlands, wildlife, fish, cultural resources, socioeconomics, transportation, noise, public

health and safety, air quality, and greenhouse gases is provided. Impacts can range from no or low to high impact.

- Chapter 4 discusses cumulative impacts.
- Chapter 5 discusses the permits and other approvals that must be obtained to implement the Proposed Action.
- Chapter 6 discusses the project's consistency with state substantive standards.
- Chapter 7 discusses the project's consistency with the USFS Management Plan for the Columbia River Gorge National Scenic Area.
- Chapters 8 through 11 list the individuals who helped prepare the EIS, the references used, and the individuals, agencies, and groups notified of the availability of this EIS, and a glossary.
- An index is included as Chapter 12.
- Supporting technical information is in appendices.

Chapter 2
Proposed Action and Alternatives

This chapter describes the proposed Action Alternatives, the No Action Alternative, and alternatives that were considered but eliminated from detailed study. More specifically, this chapter provides the following information:

- An overview of the Action Alternatives
- A summary of how transmission lines are sited
- A description of project components
- A description of each Action Alternative
- A description of the No Action Alternative
- A discussion of alternatives that were considered but eliminated from detailed study
- A summary comparison of the Action Alternatives and the No Action Alternative

2.1 Overview of the Action Alternatives

BPA is proposing to build a 500-kilovolt (kV) lattice-steel-tower transmission line that would run from BPA's existing Big Eddy Substation near The Dalles, Oregon, to a proposed Knight Substation about 4 miles northwest of Goldendale, Washington. The project also includes installation of new fiber optic cable for system communications. This section provides an overview of these facilities. The transmission line routing alternatives, substation site options and fiber optic cable options define the project area (see Map 1-1).

Transmission Line Routing Alternatives. BPA is considering three routing alternatives for the transmission line: a West Alternative, a Middle Alternative, and an East Alternative (see Map 2-1). All routing alternatives are located in Wasco County, Oregon, and Klickitat County, Washington and would cross the Columbia River and portions of the eastern end of the Columbia River Gorge National Scenic Area. The three routing alternatives are about 27 or 28 miles long, and cross varying amounts of private, state, federal and Tribal lands.

The transmission line routing alternatives all would use a combination of existing BPA and new 150-foot wide right-of-way. BPA is considering different tower combination options including paralleling existing transmission lines. Because all alternatives would parallel portions of existing lines, there is the option to build next to those lines with single-circuit towers (towers that would carry one set of wires, in this case the wires that make up the proposed line) or to remove the existing line and build with double-circuit towers (towers that would carry two sets of wires, in this case the wires that make up the proposed and existing lines). (See Section 2.3 for more information about the project components—towers, wires, rights-of-way, access roads, etc.—and Section 2.4 for more detail about the routing alternatives and tower combination options.)

Substations. The project would include equipment additions within BPA's Big Eddy Substation; all proposed work would be within the existing fenced electrical yard. BPA is also proposing a new Knight

Substation in Klickitat County, Washington. BPA would acquire about 30 acres for the substation, with the fenced substation facility occupying about 10 acres of the acquired property.

BPA is considering two adjacent sites for Knight Substation; both sites would be under BPA's existing Wautoma-Ostrander transmission line (see Map 2-1). Site 1 is the most western site and is on private land. Site 2 is near Site 1 on state DNR land. (See Section 2.3 for more information about the project components, including substations, and Section 2.4 for more detail about Big Eddy Substation and the two proposed Knight Substation sites.)

Fiber Optic Cable. The proposed transmission line would require fiber optic cable to provide a communications link between the substations. BPA is considering two options for cable placement. For one option, the fiber optic cable would be strung on the proposed transmission line towers from Big Eddy Substation to Knight Substation then loop back to Big Eddy Substation on the same towers. For the second option, the cable would follow the same route to Knight Substation, but would then continue an additional 72 miles on BPA's existing Wautoma-Ostrander transmission line through Klickitat and Yakima counties, Washington to BPA's Wautoma Substation in northwest Benton County, Washington (see Map 1-1). The second option would cross about 30 miles of the Yakama Indian Reservation, as well as other private and state lands over which BPA has an existing easement for the Wautoma-Ostrander line. For more information about the proposed fiber optic cable see Sections 2.3 and 2.4.

2.2 Transmission Line Siting

Many factors are considered when siting transmission lines. BPA's transmission system planners and engineers are usually the first to begin the process of developing potential routes for a proposed new line. First, transmission system planners determine the size or voltage needed and the beginning and end points for the proposed transmission line. Engineers then determine the type of towers required and the amount of right-of-way needed for safety clearances. In general, a 150-foot wide right-of-way is typically required for 500-kV transmission lines. Each potential location for individual towers must also be accessible for construction and for maintenance, so road access is required.

With the technical requirements outlined, routing engineers use available information to consider how a new line and substation could impact people, plants and animals, farms and other businesses, and important local, cultural and regional features. They look for ways to site new transmission facilities to avoid or minimize these potential impacts to the extent practicable. Some of the factors considered in this initial transmission facility siting exercise include:

- **Electrical feasibility**. New electrical facilities must work electrically with the existing transmission system. Transmission lines placement may be restricted near or next to existing lines (see **Line separation**), and the line length may be limited due to effects the length can have on electrical performance and power distribution across the system. Substations are strategically placed to accommodate and enhance the flow of power. For this project, the proposed Knight Substation sites are in a location on BPA's Wautoma-Ostrander line that would provide the maximum system performance together with a new transmission line.
- **Existing corridors and roads**. Engineers determine if BPA or other utilities have any existing corridors with vacant right-of-way or whether a new line could parallel another existing or proposed line, facility or road. Building in an established corridor tends to have incremental impacts to visual resources, land use and habitats. Existing access roads can be used, though they often need to be upgraded. Building adjacent to an existing line can also be

less expensive because often there is extra right-of-way to accommodate a new line so there may be little or no need to purchase new easements, and it is easier for maintenance crews to maintain two lines next to each other, rather than two lines in different areas.

- **Line separation**. While use of existing transmission corridors has its advantages, there are situations in which BPA cannot build next to existing lines for reliability reasons. If utilities want to build a transmission line adjacent to an existing line, they are required by WECC and NERC reliability criteria to determine the likelihood and consequences of an outage that could affect both lines. Utilities determine the likelihood that the following events could cause a simultaneous outage of lines:

  - An aircraft flying into both lines
  - Fire in the right-of-way producing smoke, which can cause a flashover between lines
  - Sequential lightning strikes
  - A line conductor failing and falling into an adjacent line.

  The consequences of a simultaneous outage are greater with the loss of two critical lines in an area. These outages could be beyond what the system can withstand and greatly increase the chances for a blackout of the system. To reduce the chances of a cascading blackout resulting from outages of multiple critical lines in an area, transmission service could need to be significantly curtailed.

  If it is determined that the likelihood and consequence of an outage would not meet WECC and NERC reliability criteria, special design considerations are required. A new line would be required to be separated by at least one span length (about 1,200 feet) from the adjacent line or the distance the lines would be allowed to parallel each other would be limited to less than 1 mile.

- **Houses, other structures, and sensitive cultural resources**. Homes, schools, businesses, historic structures and sensitive cultural resource areas are avoided if possible. Since structures (houses, buildings, sheds) are not allowed to be within the right-of-way for safety reasons, BPA looks to avoid structures so they need not be removed.
- **Existing land uses**. In addition to existing houses and structures, land use is an important consideration. Engineers try to find more compatible land uses such as industrial and agricultural lands, while trying to minimize impacts to residential land, parks and any special districts or areas of local or regional interest. Gravel pits are also avoided, since the earth can be dug away around towers, leaving them exposed and unstable. BPA also avoids airstrips; tries to follow fence lines; and spans agricultural fields, orchards or vineyards where possible.
- **Terrain.** BPA looks for gentle terrain if available. When transmission towers are placed on steep slopes, it is harder to construct both the towers and the access roads, and there may be a greater likelihood of erosion or landslides. For this project, crossing the Columbia River is also an engineering challenge because it requires a long span, which in turn requires taller towers. BPA looks for high points on either side of the narrowest points in the river for crossing locations.
- **Visual impacts.** The size of transmission towers and the potential need to clear trees and develop new roads can increase the visibility of a new line. BPA considers avoiding locations from which people would likely view the proposed line and substation such as homes and roads, river crossings, and parks and other recreation areas.

- **Sensitive habitats.** Engineers consider potential impacts to plants and animals and try to avoid wetlands, nesting sites, habitats of threatened and endangered species, and other sensitive areas wherever possible.
- **Costs.** BPA tries to find the lowest cost alternatives. Shorter transmission line routes usually decrease overall project costs. Straight transmission lines are less costly than lines that turn because when lines turn, stronger, heavier and more expensive towers are needed. Included in project costs are the costs of easements; easements across agricultural or forest lands are usually less expensive than easements across residential land.

2.3 Project Components

A transmission line project requires various components (rights-of-way, towers, conductors, substations, fiber optic cables, etc.). This section describes these components. (Please see Section 2.4 Proposed Action Alternatives, for specific descriptions of the proposed alternatives.)

2.3.1 Easements and Land

Much of the project area is private property, with some federal, state and Tribal ownership. Construction of the project would require easements for transmission line rights-of-way and access roads in some locations. Some portions of the transmission line routing alternatives are within existing BPA rights-of-way; some of these areas of existing BPA right-of-way are vacant and have no towers built in the right-of-way. Other sections are next to existing lines, but there is room to build another line in the right-of-way. In some locations, an existing line could be torn down and both the existing line and a new line could be carried together on one new double-circuit tower (see Figure 2-1).

In general, BPA would need a 150-foot wide right-of-way for the new transmission line and a 50 foot-wide easement for access roads. The width needed (150 feet) for the transmission line right-of-way is the BPA-standard width for 500-kV transmission line rights-of-way, and is intended to ensure that the line is a safe distance from other objects and structures such as trees and buildings. If BPA has existing right-of-way that can be used for the transmission line, fewer acres of new right-of-way would be needed.

In locations for the transmission line right-of-way and access roads outside any BPA existing right-of-way, BPA would purchase easements from the underlying landowner. Most easements for the transmission line would give BPA the rights to construct, operate, and maintain the line in perpetuity. However, easements for use of Tribal trust lands are negotiated with individual Tribes and may be for different lengths of time. On USFS property where BPA has no existing land rights for its transmission facilities, BPA would apply to the USFS to secure the necessary land rights. Although the underlying landowner would still own and use the property, BPA would not permit any uses of the transmission line right-of-way that are unsafe or might interfere with constructing, operating, or maintaining the transmission facilities. These restrictions would be part of the legal rights that BPA would acquire for the transmission line.

Construction of the project also would require the purchase of land for the proposed Knight Substation. Through this purchase, BPA would own fee (absolute) title to the property required for Knight Substation. BPA would acquire about 30 acres for the proposed substation depending on the parcel selected.

2.3.2 Transmission Line

Transmission Towers

BPA is proposing to use either single or double-circuit 500-kV lattice steel towers for the proposed transmission line (see Figure 2-1). In general, single-circuit 500-kV towers would be between 105-205 feet tall (depending on terrain). Double-circuit towers are about 50 feet taller than the single-circuit towers, and would range from 170 to 250 feet tall. Tower heights would vary depending on the terrain, need for road and river crossings, and other factors. Towers required for the line to cross the Columbia River could be up to 440 feet tall and would be on high ground on either side of the river (see Figure 2-2). Any towers taller than 200 feet (generally, double-circuit towers and towers used at river crossings) and transmission lines exceeding that height are considered an obstruction by the Federal Aviation Administration (FAA). Shorter towers and line clearances can also be considered obstructions depending on their proximity to airport runways. As obstructions, they must be marked according to FAA rules, which may require lighting on each tower and marker balls on the transmission line.

Spans between individual towers are typically about 1,150 feet, with about five towers needed for each mile of line. Towers would be made of galvanized steel and may appear shiny for 2 to 4 years before they dull from weathering. About 125-135 transmission towers would be needed for the proposed transmission line. The actual number of towers would depend on the length of the action alternative selected.

Figure 2-1. Typical 500-kV Lattice Steel Towers

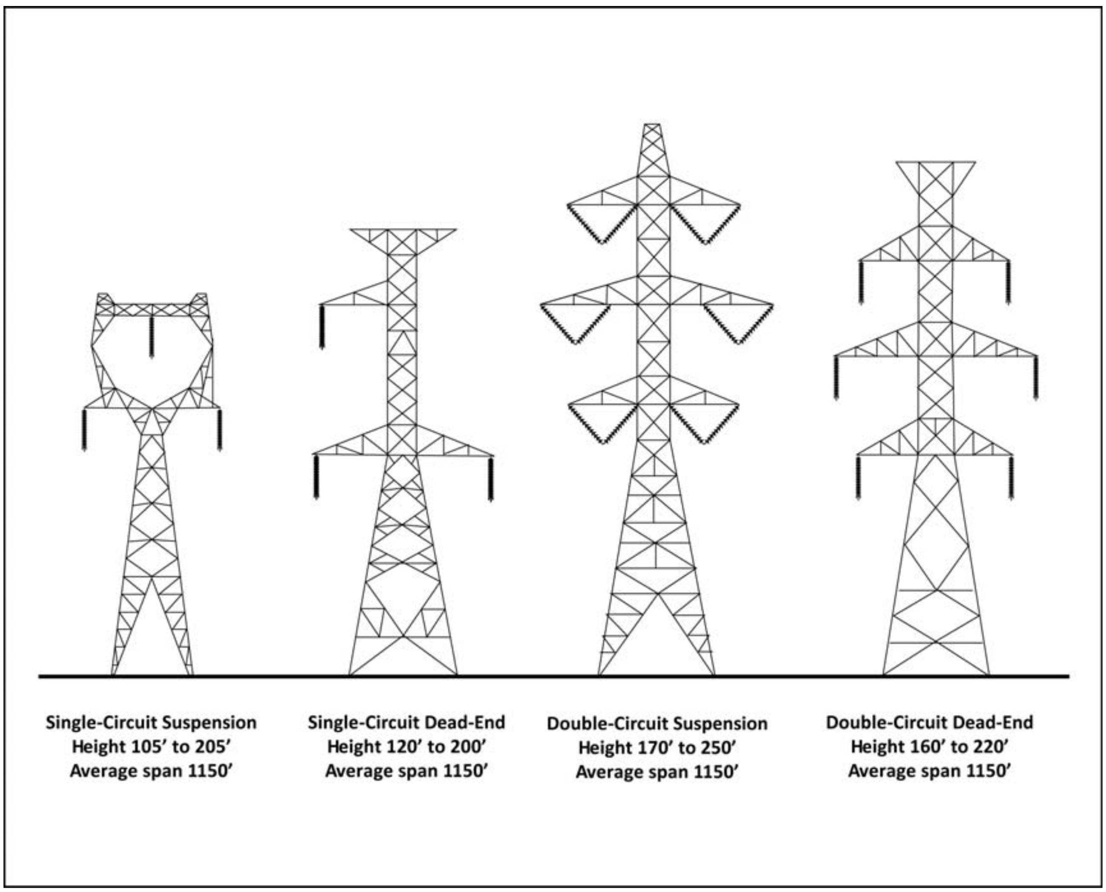
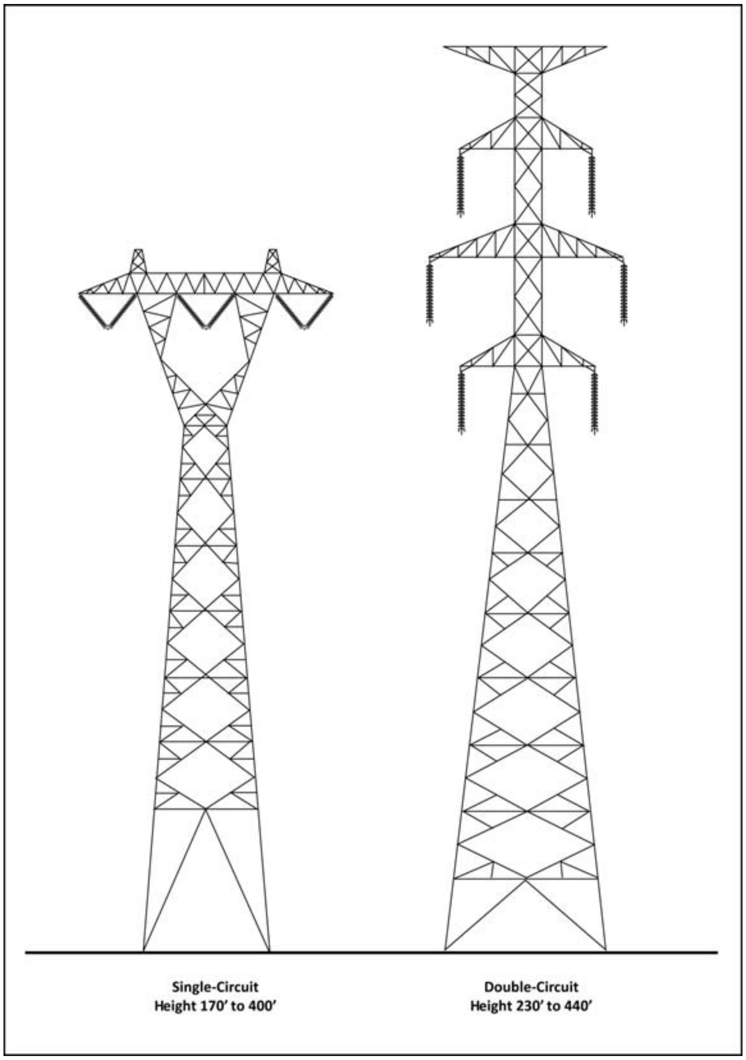


Figure 2-2. Columbia River Crossing Towers



The single-circuit transmission line towers proposed would have a delta configuration where one set of conductors hangs above the other two (see Figure 2-1). Double-circuit towers would have three sets of conductors on either side of the tower (see **Conductors**). Using the single-circuit delta configuration towers or using double-circuit towers helps reduce electric and magnetic field levels (see Section 3.12 Public Health and Safety).

In addition, there are two types of towers used for both single and double-circuit towers: suspension towers and dead-end towers. When the line is on a straight path, suspension towers would be used to hold the conductors. Dead-end towers would be used where the line turns or enters a substation. Dead-end towers are stronger and heavier than suspension towers (see Figure 2-1).

Footings

Transmission towers would be securely attached to the ground with footings. Footings are an assembly of metal in the ground at each of the four tower corners. Four types of footings could be used to secure the towers: plate, grillage, rock anchor, and concrete shaft.

- **Plate footings** are used for suspension towers. A plate footing is a 4-foot by 4-foot steel plate buried about 11 feet deep at the foot of each tower leg. The overall area excavated for a tower with plate footings would be up to 60 feet by 60 feet (this would be the area of permanent impact).
- **Grillage footings** are used for dead-end towers. A grillage footing is a 15-foot by 15-foot assembly of steel I-beams that have been welded together and buried about 14-16 feet deep at each tower foot. The overall area excavated for dead-end tower with grillage footings would be about 75 feet by 75 feet (this would be considered the area of permanent impact).
- **Rock anchor footings** are required when a tower is built on solid bedrock that is less than 2 feet below the surface. Six-inch diameter holes are drilled into the bedrock about 11 feet deep and steel anchor rods are secured within the hole with concrete. The area of permanent impact would be slightly less than for plate footings.
- **Concrete shaft footings** are used for towers at river crossings, on steep slopes, or in areas where the tower must sustain a higher load and requires additional support. Concrete shaft footings can be built on solid bedrock or in soils unfavorable for grillage footings. Concrete shaft footings are engineered columns of concrete about 4-8 feet in diameter reinforced by steel rods. Footing depth depends on site-specific engineering requirements including terrain and load on the towers. Total disturbance for these footings would be more than for plate footings.

For plate and grillage footings, a trackhoe would be used to excavate an area for the footings. The excavated area would be at least 2 feet larger than the plate or grillage footings to be installed (if the soil is loose or sandy, then a wider hole may be necessary). Soil and rock removed for plate or grillage footings would be used to backfill the excavated area once the footings are installed.

For rock anchor or concrete shaft footings, a drill would be used to make an appropriately-sized vertical shaft for the footings. Soil and rock removed for rock anchor or concrete shaft footings would either be spread out onto an approved location or removed from the project area.

With the larger grillage footings, single-circuit towers would occupy a permanent area of about 0.13 acre, with a temporary disturbance during construction of about 0.5 acre (equipment, soils, etc.); double-circuit towers would occupy a permanent area of about 0.17 acre, with a temporary disturbance during construction of about 0.69 acre (see Table 2-1). Rock anchor or concrete shaft footings have a smaller footprint than the typical plate or grillage footings.

All the transmission line alternatives have options that include removing existing lines. Where existing lines would be removed, the tower footings under the ground could also be removed. Wood pole lines would be completely removed (including the 7 to 9 feet of pole below the ground), The area disturbed for removal of wood pole towers would be about 0.11 acre. The lattice steel tower footings could be left in place; the steel would be cut-off about 2 feet below ground or deeper in cultivated areas. If the footings would interfere with construction of the proposed line, the footings would be removed; excavation would disturb about 0.43 acre.

Table 2-1. Disturbance Areas for Single- and Double-Circuit Towers (in Acres)

Types of Disturbance	Single-Circuit 500-kV	Double-Circuit 500-kV	Wood Pole 115-kV	Single-Circuit 230- or 345-kV
Permanent tower footprint	0.13 (based on grillage footing)	0.17	*N/A*	*N/A*
Temporary disturbance during tower construction	0.37 (based on grillage footing)	0.52	*N/A*	*N/A*
Total tower disturbance	0.5	0.69	*N/A*	*N/A*
Temporary counterpoise disturbance	0.1	0.09	*N/A*	*N/A*
Tower removal disturbance	*N/A*	*N/A*	0.11	0.43

Conductors

The wires that carry the electrical current on the transmission line are called conductors. The proposed transmission towers would support these conductors. The towers would carry three sets (called phases) of conductors arranged in a triangular design (see Figure 2-3). Each phase would consist of a bundle of three, 1.3-inch diameter conductors held together by spacer brackets about 20 inches apart. From a distance, a bundle looks like a single wire.

The conductors would be attached to the towers using insulators (see Figure 2-3). Insulators are bell-shaped devices that prevent electricity from jumping from the conductors to the tower and going to the ground. Insulators are made of porcelain or fiberglass and are non-reflective.

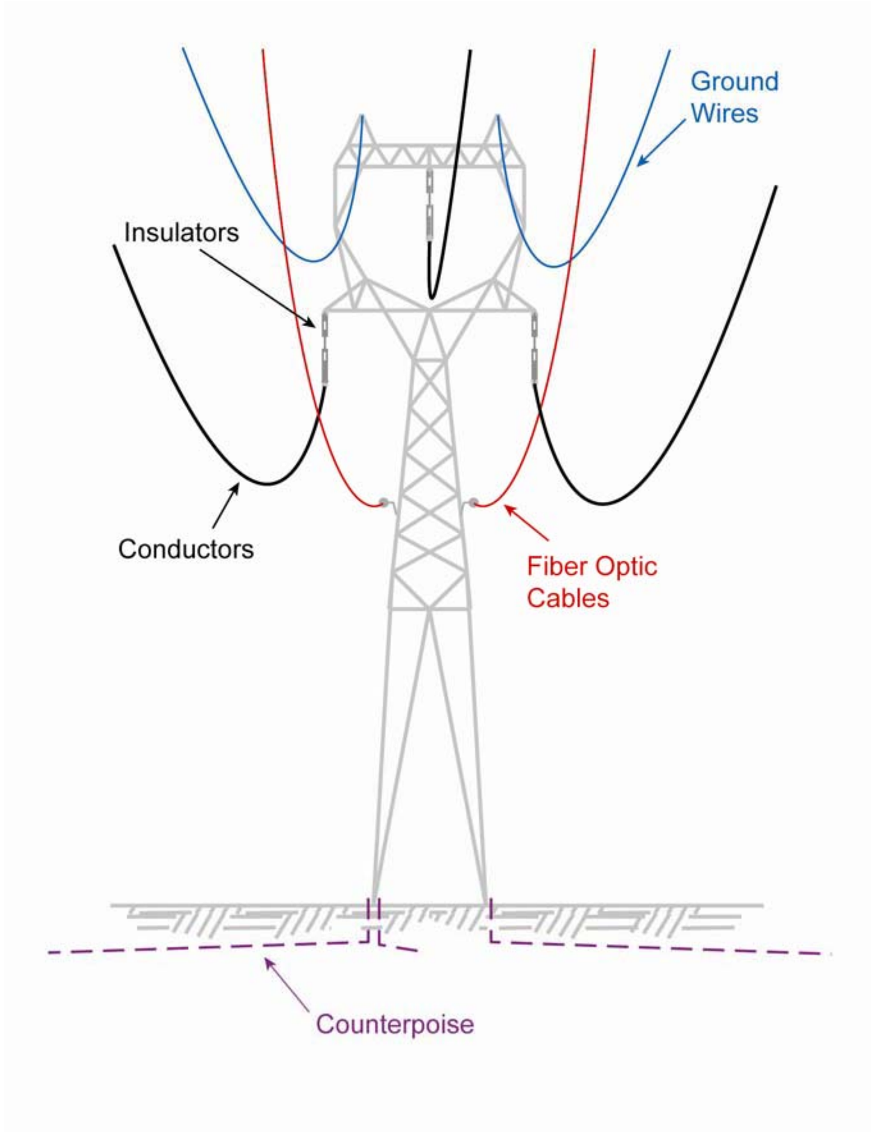
The conductor would need to be fitted together where one reel of conductor ends and a new reel begins. Conductor fittings could be made using hydraulic compression or implosive devices. Hydraulic compression uses a press that compresses the fittings on the conductor. With implosive fittings, an explosive device is set off with a sound like a gunshot, causing the fitting to collapse and tighten around the conductor to provide a solid connection. Nine conductors (three bundles each with three conductors) would need to be fitted once about every 1.5 to 2 miles. (See **Pulling and Tensioning Sites**, for a description of the area needed to pull and tighten conductors.)

For safety reasons, BPA has established minimum conductor heights above ground and other obstacles that meet or exceed National Electrical Safety Code clearance requirements. For the proposed 500-kV line, standard minimum clearance of the conductor above the ground is 29 feet. The clearance requirement over highways is 45.5 feet; other clearances (railroads, rivers, trees, etc.) are determined on a case-by-case basis. The proposed line would be designed to meet or exceed these requirements. (See Appendix A for information on safety around power lines.)

Overhead Ground Wire and Counterpoise

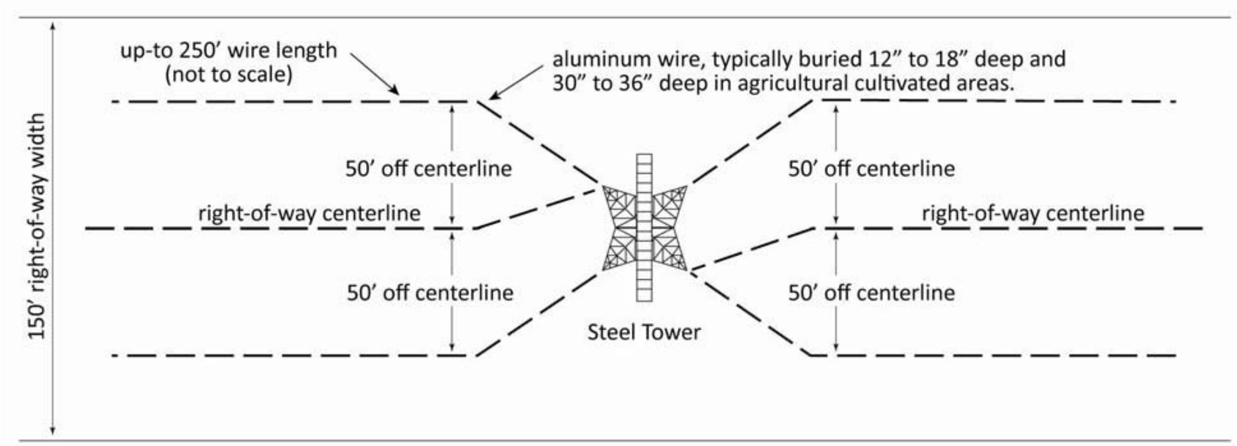
Two small wires (0.5-inch diameter), called overhead ground wires, would be attached to the top of the transmission towers (see Figure 2-3). Ground wires are used for lightning protection. When lightning strikes, the overhead ground wire takes the charge instead of the conductors. Between towers that cross the Columbia River, the fiber optic cable (see **Fiber Optic Cable**) that would be installed would also act as the overhead ground wires (the fiber optic cable is reinforced to be strong enough for the long span required to cross the river).

Figure 2-3. Components on a Transmission Tower



To take the lightning charge from the overhead ground wire and dissipate it into the earth, a series of wires called counterpoise would be buried in the ground at the base of the towers and within the transmission line right-of-way (see Figure 2-3 and Table 2-1). Counterpoise could be needed at every tower, depending on the soil types present. Up to six aluminum wires (3/8-inch in diameter) could be buried up to 250 feet from the tower (see Figure 2-4). The wire is usually buried 12-18 inches deep, except in cultivated areas where it would be buried about 30 inches deep or deeper if a farmer uses deeper plowing methods. Typically, one counterpoise wire would run down the center line of the right-of-way from each side of the tower. Two other wires would run at a 45-degree angle away from each side of the tower, then turn and run within the right-of-way at a distance of 50 feet off centerline (see Figure 2-4). Where there are obstructions, buried utilities, or environmentally sensitive areas, the counterpoise design would be changed to avoid these areas.

Figure 2-4. Typical Overhead View of Counterpoise



During construction, the counterpoise could be buried several ways. Installers could use backhoes, trenchers, vibrating plows, or occasionally hand dig trenches depending on the depth, soils, terrain and size of buried rock. With a backhoe the trench would be 12 or more inches wide. Removed soil and rocks would be piled to the side and placed back in the trench to cover the counterpoise. If a trencher is used, the trencher would open up a 4-6 inch trench and lift up the soil to the side. The soil would be pushed back into the trench after the counterpoise is installed. Large tractors use a vibrating plow to force a blade into the ground. The counterpoise would then run through a hole in the blade and trail out behind the blade at a specified depth. In areas where a tower would be built on solid rock, counterpoise would be placed in crevices where possible; otherwise counterpoise would not be used.

Fiber Optic Cable

Fiber optic cable also would be strung on the transmission towers (see Figure 2-3). Fiber optic cable would provide communication links for the transmission system. Fiber optics technology uses light pulses rather than radio or electrical signals to transmit messages. This communication system can gather information about the system (such as the line in service and the amount of power being carried, meter reading at interchange points, and status of equipment and alarms). Fiber optic cable also allows voice communications between power dispatchers and line maintenance crews and provides instantaneous commands that control power system operation.

The fiber optic cable would be less than 1 inch in diameter and would be mounted under and/or between the conductors (see Figure 2-3). Every 3-5 miles there would be a splice box/reeling location to string and then put tension on the fiber optic cable. The splice box would be installed in the ground between the tower legs, mounted on the towers, or placed on the ground next to the tower and covered with rock. Vault boxes would be installed at each substation site.

Between towers that cross the Columbia River, the fiber optic cable would also act as the overhead ground wires (see **Overhead Ground Wire and Counterpoise**). The fiber optic cable is reinforced to be strong enough for the long span required to cross the river.

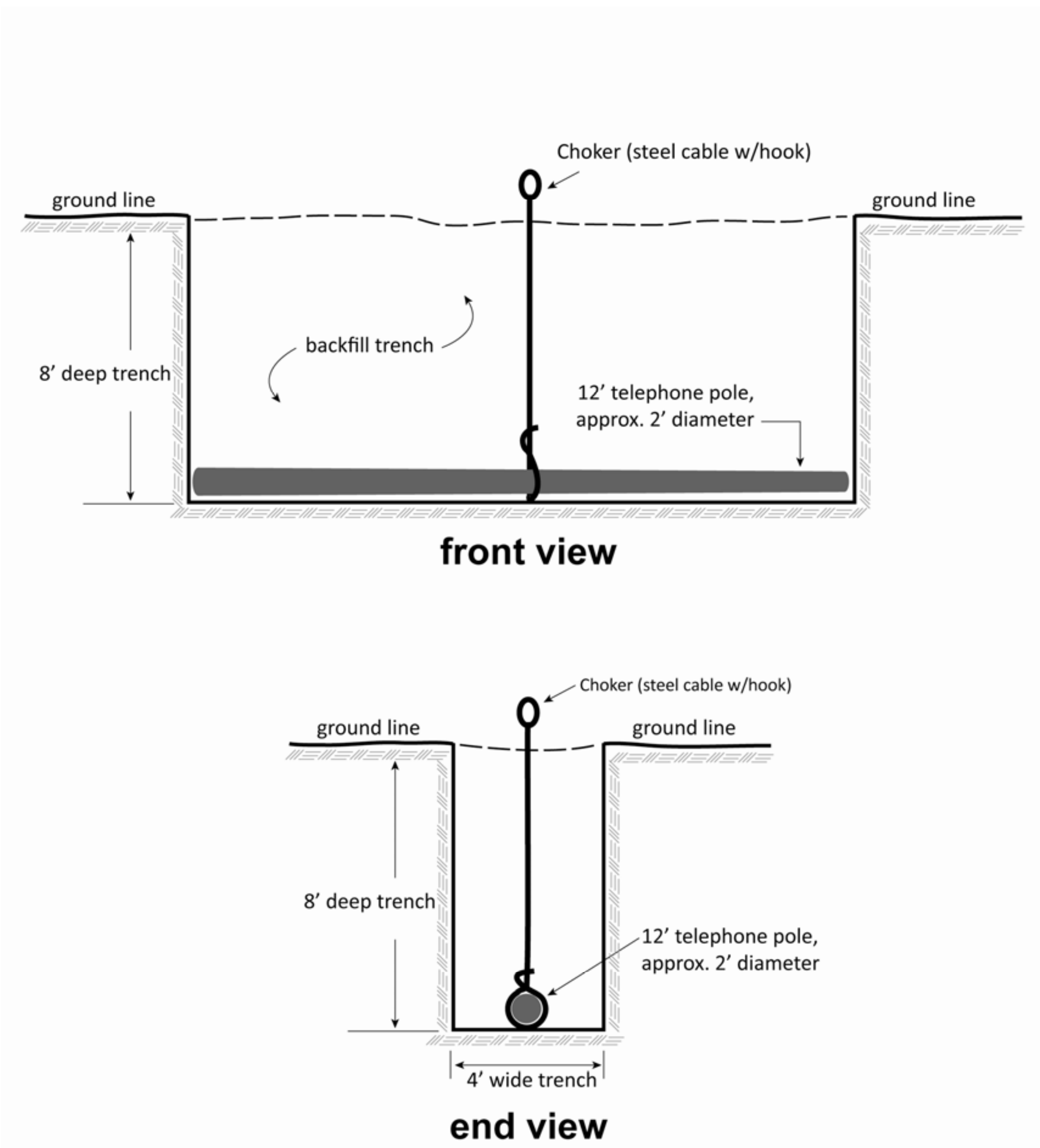
Pulling and Tensioning Sites

Pulling and tensioning sites are areas used for pulling and tightening the conductor and fiber optic cable to the correct tension once they are mounted on the transmission towers. As is typical for high-voltage transmission lines, pulling and tensioning sites for the proposed line would be needed about every

1.75 miles along the transmission line route. About 18 pulling and tensioning sites would be required for construction of the proposed project. Pulling sites would be within or next to the right-of-way for the transmission line. These sites would include a flat area to place a large flatbed trailer that holds the reels of conductor or a tensioning machine. Depending on conditions, the site could be graded, graveled with crushed rock that includes some fines, reseeded, or a combination of these activities. An area about 100 feet wide by 300 feet long, or about 0.75 acre would be disturbed at each site.

Pulling and tensioning of the proposed lines also would require "snubs," which are trenches about 8 feet deep by 4 feet wide by 12 feet long (see Figure 2-5). After the conductor is pulled through the towers and before it is strung under tension, it is tied off on poles buried in the snub. These trenches would be backfilled following construction.

Figure 2-5. Typical Snub Placement



The tension required to pull fiber optic cable is much less than the tension required to pull conductor and would involve lighter equipment to pull the cable (no snubs needed). The fiber optic cable pulling and tensioning sites would be about every 3 miles along the line and would disturb about a 0.25 acre area within or next to the right-of-way. The fiber optic cable pulling sites would be located with the conductor pulling sites where possible.

The appropriate locations for pulling sites are determined by the construction contractor using environmental and land use information provided by BPA. If the pulling sites are identified outside of the right-of-way, additional surveys for cultural resources and or flora and fauna could be required for those sites.

Staging Areas

One or two temporary staging areas would be needed along or near the proposed transmission line for construction crews to store materials, equipment and vehicles. Staging areas can be from 5-15 acres depending on the amount of materials and number of locations needed. The contractors hired to construct the transmission line would be responsible for determining appropriate staging area locations. Often the contractor rents empty parking lots or already developed sites for use as staging areas. Environmental review of staging areas would be conducted prior to approval for use if necessary.

2.3.3 Substations

Substations are vital hubs for transmission lines. They can connect different transmission lines together, isolate lines when necessary, regulate voltage on the system, and transform voltages.

For this project, the southern end of the proposed transmission line would connect to BPA's existing Big Eddy Substation and the northern end would connect to a new Knight Substation. The substations would require 500-kV bays with equipment to connect the proposed line to the system. The equipment includes the following:

- **Power circuit breakers.** A breaker is a switching device that can automatically interrupt power flow on a transmission line at the time of a fault, such as a lightning strike, tree limb falling on the line, or other unusual event. The breakers would be installed at the substation to redirect power as needed. Several types of breakers have been used in BPA substations. The breakers planned for this project, called gas breakers, are insulated by special nonconducting gas (sulfur hexafluoride). These breakers would contain no oil, except a small amount of hydraulic fluid.
- **Switches**. These devices are used to mechanically disconnect or isolate equipment. Switches are normally located on both sides of circuit breakers.
- **Bus Tubing and Pedestals.** These are ridged aluminum pipes that the power flows on within the substation.
- **Control House and Conduit.** The control house is typically a one-story building with communication equipment and switches necessary to turn equipment on and off. Some control houses are plumbed for bathroom facilities and have a work space for personnel. Underground conduit throughout the substation connects the yard equipment to the control house.

- **Substation Dead-end Towers.** These are the towers within the substation where incoming or outgoing transmission lines end. Substation dead-ends are typically the tallest structure within the substation.
- **Grounding Mat.** A wire mesh mat is laid about 18 inches below ground throughout the substation, extending outside the fence perimeter. Equipment is connected to the mat for grounding, as is required for the protection and safety of both equipment and personnel.
- **Substation Rock Surfacing**. A 3-inch layer of rock, selected for its insulating properties, is placed on the ground within the substation to protect operation and maintenance personnel from danger during substation electrical failures.
- **Substation fence**. A chain-link fence with barbed wire on top surrounds the substation for security and public safety. A 10-foot wide gravel buffer would be just outside the fence.
- **Stormwater Retention System**. Stormwater management involves careful measures to prevent sediment and other pollutants from entering surface or groundwater, treatment of runoff to reduce pollutants, and flow controls to reduce the impact of altered hydrology.

Because this project is not proposing to integrate lower voltage power from generation facilities, but is proposing increasing the capacity of BPA's 500-kV transmission system, no new transformers would be needed at Big Eddy Substation or Knight Substation. Transformers are the only oil-filled equipment within an electrical substation, and because no transformers are required, there would be no new potential sources of oil at either substation.

2.3.4 Access Roads

Access roads are the system of roads that BPA's construction and maintenance crew would use to get to the tower sites along the transmission line and to get to substations. Engineers design roads to be used by cranes, excavators, supply trucks, boom trucks, log trucks, and line trucks. BPA's road system consists of a mix of permits or access road easements across public and private land. Roads are built within the transmission line right-of-way as much as possible. For this project, the transmission line routes are usually within 2 miles of public roads. Access road approaches would be from these public roads. If existing access roads can be used, they would be upgraded as necessary. Some new access roads, both temporary and permanent, would be needed. Spur roads would be needed from the existing access roads to the new tower sites; spur roads would generally be within the right-of-way (see Appendix B).

Access roads would require a 14-foot wide travel surface (wider on curves), with about a 20-40 foot-wide total area disturbed (including drainage ditches). The disturbed area would be wider in steep terrain where cut-and-fill would be required. Typically, a 50-foot wide easement would be obtained from the landowner for new access roads. Maximum road grades would vary depending on the erosion potential of the soil: 6-8 percent on erodible soils, 10-15 percent for erosion-resistant soils.

Dirt roads in the project area become slippery and impassible when wet. Gravel would be placed on roads where needed for dust abatement, stability, load bearing, and to keep them passable during wet soil conditions. Where new roads cross streams or drainages, culverts would be needed. Drain dips or water bars may also be needed on steep slopes or where access roads cross drainages that carry seasonal runoff.

If towers are placed in agricultural fields, BPA would typically only build temporary access to the tower site to construct the line. Once construction is complete, the road would be removed and the soil would be restored for continued agricultural use. If a permanent road is necessary, BPA would work with the landowner to determine if it could be built in a location beneficial to the landowner. If a tower has to be accessed for maintenance or emergency situations and BPA has to put in a road that impacts crops, BPA would pay the landowner for any crop damage that occurs.

BPA, in coordination with landowners, places gates at the entrances to access roads to prevent public access to private lands and the transmission line right-of-way. There also would be gates in fences that separate animals or denote property lines. Gate locks would be coordinated with the landowners to ensure that both BPA and the landowner could unlock the gates.

2.3.5 Vegetation Clearing

When vegetation grows or falls close to a transmission line it can cause an electrical arc that can start a fire, cause an outage of the line, or injure or kill someone. Tall vegetation cannot be allowed to grow within the transmission line right-of-way. Tall trees that grow outside of the right-of-way that could fall into the line must also be removed. In deep valleys with sufficient clearance, trees may be left in place. Most of the vegetation along the transmission line routes is low-growing sagebrush or agricultural crops; both are compatible with transmission lines. There are some areas along the routes where tall-growing vegetation is present (see Section 3.3 Vegetation and Map 3-5).

2.3.6 Final Design and Construction

Prior to actual construction of the proposed transmission line and substation, final design work would be completed to determine the precise location of all project components. To determine exact tower locations along a transmission line right-of-way, BPA collects terrain data primarily using LiDAR, a remote sensing technology employing eye-safe laser pulses originating from a helicopter or airplane, augmented as necessary by other terrain data collection methods such as photogrammetry and survey crews working on the ground. High-resolution aerial imagery is also collected to aid in tower siting. Towers are positioned during final design using the terrain data and aerial imagery to provide adequate conductor clearances above ground and avoid obstacles while generally minimizing the frequency, height, and impact of the towers. This same data is used to locate access roads. Engineers also use environmental information, known utility locations, and information from discussions with landowners to help determine tower and access road locations.

Typically construction begins with right-of-way clearing. The right-of-way would be cleared of any vegetation that might hinder line safety or construction access. For this project, relatively little vegetation would be cleared because tall-growing species are only present in a few areas. Access roads then would be built or upgraded. Holes for tower footings would be dug with a trackhoe (drilling or blasting may also occur if rock is present) and footings would be put in place at each tower site. Towers would be either assembled at the tower site and lifted into place by a large crane (30- to 100-ton capacity) or assembled at a staging area and set in place by a large skycrane helicopter. The towers would then be bolted to the footings.

Next, the conductor would be strung from tower to tower through pulleys on the towers. A sock line (thick rope) would be placed in the pulleys and pulled through by a helicopter much smaller than the skycrane. A hard line (smaller wire than conductor) would be attached to the end of the sock line and pulled back to where the conductor reel is located. The hard line would be connected to a plate that holds the bundle of conductors (one for each phase), which would be pulled through the pulleys to the other end of the pull and secured by snubbing the conductors in the snub trenches. The fiber optic cable and ground wire would also be strung using a helicopter, with pulling sites on the ground to tighten the cable.

After the towers, conductors and fiber optic cable are installed, the construction contractor would remove construction equipment and debris and restore the disturbed areas. Soils used for agriculture in the temporary disturbance area that become compacted would be restored and reseeded after project construction to reestablish close to original conditions.

At the substation site, several construction activities would occur. The site would be excavated to bring the topography to grade. Once a layer of soil material is laid down, the ground mat, conduit for control cables, concrete foundations for all the high voltage equipment and structures would be installed.

After all the below grade work is completed, the above grade construction work would begin with the erection of the dead-end towers and aluminum pedestals to support the electrical bus. Then other support structures would be installed for the high voltage equipment. The high voltage equipment would be bolted on the support structures and connected to the electrical bus by a short length of conductor. Control cables would then be attached to the high voltage equipment and routed to the control house.

2.3.7 Construction Schedule and Work Crews

Construction of the project would take about 20 months. The transmission line and substation would be constructed by one or more construction crews. A typical transmission line construction crew for a 500-kV line consists of the following:

- 50-60 construction workers (70-100 at the peak of construction)
- 20 vehicles (pickups, vans)
- 3 bucket trucks
- 1 conductor reel machine
- 3 large excavators (bulldozers, backhoes)
- 1 line tensioner, 1 puller, 1 reel trailer
- 2 helicopters (small helicopter and skycrane; size dependent on lifting required)
- Large and mid-sized cranes
- Road construction equipment (dump trucks, rollers, graders, dozers, excavators)

A crew can typically construct about 10 miles of transmission line in about 4 months. Actual workforce numbers would vary over time, with about 100 workers as the largest number working on the project at one time.

If a decision is made to build the project, construction would likely begin in summer 2011 and the line would be energized and operating by February 2013. Work at the substations would start first, followed by construction of the line. For areas where the project would require work on existing transmission lines — such as at Knight Substation or for options that would require existing lines to be removed and rebuilt — construction would have to be scheduled for times when the existing lines are lightly used and electricity could be rerouted.

2.3.8 Maintenance

During the life of the project, BPA would perform routine, periodic maintenance, and emergency repairs on the transmission line. For lattice steel towers, maintenance usually involves replacing insulators.

BPA typically conducts routine inspection patrols of the 15,000-mile federal transmission system in the Pacific Northwest by helicopter. BPA has conducted routine inspection patrols for its existing transmission lines in the project vicinity by helicopter since 1950. Helicopter inspection of the new line would occur twice a year.

Patrols are essential to determine where line maintenance is needed and to ensure continued reliability of the transmission system. Helicopter teams look for damaged insulators, damaged support members, washed-out roads, hazardous vegetation, encroachments, and problems indicating that a repair may be needed. Aerial inspections typically are followed by annual ground inspections for each line. Maintenance vehicles would use access roads where established and maintenance workers would walk through agricultural fields when able to avoid damage to crops. If repairs are needed or in emergency situations, vehicles and equipment would need to drive through fields and could cause damage to crops, vegetation, and other property. BPA would compensate landowners for damages.

Vegetation also would be maintained along the line for safe operation and to allow access to the line. The project area would need little vegetation maintenance because most vegetation in the area is grass and other low-growing plants.

BPA's vegetation management would be guided by its Transmission System Vegetation Management Program EIS and Record of Decision (August 23, 2000) (BPA 2000a,b). BPA adopted an integrated vegetation management strategy for controlling vegetation along its transmission line rights-of-way. This strategy involves choosing the appropriate method for controlling the vegetation based on the type of vegetation and its density, the natural resources present at a particular site, landowner requests, regulations, and costs. BPA may use a number of different methods: manual (hand-pulling, clippers, chainsaws), mechanical (roller-choppers, brush-hogs), biological (insects or fungus for attacking noxious weeds), and herbicides. Since there is little tall-growing vegetation in the project area and the vegetation is slow growing, there would be little vegetation maintenance required along the proposed line. Any tree removal would likely be individual trees cut with a chainsaw.

Noxious weed control is also part of BPA's vegetation maintenance program. BPA works with the county weed boards and landowners on area-wide plans for noxious weed control. In the project area, BPA contracts with the Klickitat and Wasco county weed boards; the counties work with landowners to control noxious weeds along the rights-of-way. Prior to controlling vegetation, BPA would send notices to landowners and request information that might help in determining appropriate methods and mitigation measures (such as herbicide-free buffer zones around springs or wells).

2.3.9 Estimated Project Cost

The total estimated project cost ranges between $90-115 million depending on the routing alternative and tower option.

2.4 Proposed Action Alternatives

The proposed action alternatives consist of a combination of transmission line routes, substations, and fiber optic cable options. The following lists the project elements being considered (preferred project elements are noted).

Transmission Line Routes:

- West Alternative
- Middle Alternative
- East Alternative (preferred)

Substations:

- Improvements At Big Eddy Substation (common to all alternatives)
- New Knight Substation at
  - Site 1 (preferred) or
  - Site 2

Fiber Optic Cable:

- Loop Back Option or
- Wautoma Option (preferred)

2.4.1 Big Eddy Substation

All action alternatives begin at Big Eddy Substation. Big Eddy Substation would require a new 500-kV bay to connect the proposed line into the electrical system. All work would occur and all equipment would be installed within the existing electrical yard and control house. Installing new equipment would disturb about 1 acre of a previously disturbed area on the north side of the yard.

Existing BPA Transmission Lines in the Project Area

There are several existing transmission lines in the project area that may be referred to throughout this sction of the EIS. Some of these connect to Big Eddy Substation (see Map 2-1):

- McNary-Ross—a 345-kV lattice steel line that crosses the West and Middle alternatives and parallels a portion of the East Alternative
- Harvalum-Big Eddy—a 230-kV lattice steel line that parallels a portion of the Middle and East alternatives
- John Day-Big Eddy—a 500-kV lattice steel line that runs east from Big Eddy Substation
- DC Test Line—a lattice steel line that runs northeast from Big Eddy Substation for about 5 miles; no longer used
- Spearfish Tap—a 115-kV wood-pole line that parallels a portion of the West Alternative
- Chenoweth-Goldendale—a 115-kV wood-pole line used by Klickitat PUD that parallels a portion of the West and Middle alternatives and crosses the East Alternative
- Big Eddy-Spring Creek—a 230-kV lattice steel line that parallels a portion of the Middle Alternative and crosses the East Alternative
- Wautoma-Ostrander—a 500-kV lattice steel line that runs across the Knight Substation Sites
- North Bonneville-Midway—a 230-kV lattice steel line located parallel to the Wautoma-Ostrander line

2.4.2 West Alternative

From Big Eddy Substation, the West Alternative route extends north within mostly vacant BPA right-of-way to the Columbia River. After crossing the Columbia River, this route heads west and then north, paralleling BPA's existing Spearfish Tap 115-kV wood-pole transmission line (see box and Map 2-1). The route then angles northeast next to BPA's existing Chenoweth-Goldendale 115-kV wood-pole line for about 12 miles, to a point just south of the Little Klickitat River.

> **Line Mile References for Route Alternatives**
>
> References to specific areas on each route alternative refer to that specific alternative and the line mile of that alternative measured from Big Eddy Substation. Each alternative is distinguished by a letter - "W" for the West Alternative, "M" for the Middle Alternative, and "E" for the East Alternative. The line mile or range of line miles is given after the letter, for example, "W1" means West Alternative at line mile 1; M1 means Middle Alternative at line mile 1, etc. Longer segments are identified with a line mile range such as W1-5 (West Alternative, between line miles 1 and 5). Where alternatives share the same corridor, multiple letters are used, such as ME3-6 (Middle and East alternatives, between line miles 3 and 6).

At this point, the West Alternative turns east and continues to follow the Chenoweth-Goldendale line for about 4 miles. The route then separates from the existing line and heads straight north for about 4 miles to the connection with BPA's Wautoma-Ostrander transmission line at either proposed Knight Substation site. This alternative is about 27 miles long.

There are various right-of-way and tower combination options for the West Alternative. For the portion of line between Big Eddy Substation and the Columbia River (line mile W1-2 [see box]), BPA has an existing 125 foot-wide easement that presently does not have any transmission lines in it. If this existing right-of-way were used for the project, BPA would need an additional easement for 25 feet of right-of-way. The existing easement crosses over a shed that has been inadvertently built within the easement, and also is close to a barn; both structures would need to be removed. BPA is considering adjusting the line design to avoid removing these structures.

A 1.5-mile section of the West Alternative (line mile W4-5) would parallel the Spearfish Tap 115-kV line. The existing right-of-way along this line is 450-feet wide and would accommodate a proposed transmission line to the west without additional right-of-way.

BPA is also considering building the line as a double-circuit line for the first 5 miles from Big Eddy Substation. This would take the line across the Columbia River and up to BPA's Spearfish Tap line. The double-circuit line in this area would be available for a possible future line, eliminating the need for another Columbia River crossing if a future line were built in the area.

Where the West Alternative would follow the Chenoweth-Goldendale line (line miles W6-22), the proposed line could either be built parallel (adjacent) to the existing line in new 150 foot-wide right-of-way or the Chenoweth-Goldendale line could be removed and the proposed line could be built in the existing 100-foot wide right-of-way, with BPA needing to purchase an additional 50 feet of right-of-way.

Klickitat County Public Utility District (PUD) uses the Chenoweth-Goldendale line to serve its Goldendale Substation. If the line were to be removed, the operational impacts to the PUD would be considered.

Also being considered is the option of rebuilding the Chenoweth-Goldendale line as a double-circuit line to carry both the proposed Big Eddy-Knight line and the existing Chenoweth-Goldendale line.

In locations where the West Alternative does not parallel other lines, or where there is no existing easement, the line would require a new 150 foot-wide right-of-way.

With different tower type and right-of-way use possibilities, there are several combinations that create options for the West Alternative (see Table 2-2 and Figures 2-6 through 2-12).

Table 2-2. West Alternative Options—Tower Configurations by Line Mile

Option	Description
West Option 1	**Single-circuit towers** for the entire route (see Figure 2-6), including: • Use existing vacant right-of-way (W0-2) • Parallel to the existing Spearfish Tap line (W3.8-4.9) (see Figure 2-7) • Parallel to the existing Chenoweth-Goldendale (W5.7-22.5) (see Figure 2-8)
West Option 2	**Single-circuit towers** from Big Eddy Substation to intersection with Chenoweth-Goldendale line (W0-5.7) (see Figure 2-6), including: • Parallel to the existing Spearfish Tap line (W3.8-4.9) (see Figure 2-7) **Double-circuit towers** (Big Eddy-Knight and the Chenoweth-Goldendale line) (W5.7-22.5) with removal of the existing structures along this portion (see Figure 2-9) **Single-circuit towers** for the remainder of the route (W22.5 to Knight Substation) (see Figure 2-6)
West Option 3	**Single-circuit towers** for the entire route (see Figure 2-6), including: • Parallel to the existing Spearfish Tap line (W3.8-4.9) (see Figure 2-7) • Removal of the existing Chenoweth-Goldendale line along this portion (W5.7-22.5) and build Big Eddy-Knight line in its place (see Figure 2-10)
West Option 4	**Double-circuit towers** from Big Eddy Substation (Big Eddy-Knight and possible future line) to end of the Spearfish Tap (W0-4.9) (see Figure 2-11), including: • Parallel to the existing Spearfish Tap line along this portion (W3.8-4.9) (see Figure 2-12) **Single-circuit towers** for the remainder of the route (W4.9 to Knight Substation) (see Figure 2-6), including: • Parallel to the existing Chenoweth-Goldendale line (W5.7-22.5) (see Figure 2-8)
West Option 5	**Double-circuit towers** from Big Eddy Substation (Big Eddy-Knight and possible future line) to end of the Spearfish Tap (W0-4.9) (see Figure 2-11), including: • Parallel to the existing Spearfish Tap line along this portion (W3.8-4.9) (see Figure 2-12) **Single-circuit towers** from the Spearfish Tap to intersection with Chenoweth-Goldendale line (W4.9-5.7) (see Figure 2-6) **Double-circuit towers** (Big Eddy-Knight and the Chenoweth-Goldendale line (W5.7-22.5) with removal of existing Chenoweth-Goldendale structures along this portion (see Figure 2-9) **Single-circuit towers** for the remainder of the route (W22.5 to Knight Substation) (see Figure 2-6)
West Option 6	**Double-circuit towers** from Big Eddy Substation to end of the Spearfish Tap (W0-4.9) (see Figure 2-11), including: • Parallel to the existing Spearfish Tap line along this portion (W3.8-4.9) (see Figure 2-12) **Single-circuit towers** for the remainder of the route (W4.9 to Knight Substation) with removal of the existing Chenoweth-Goldendale line along this portion (W5.7-22.5) (see Figure 2-6)

The West Alternative's span across the Columbia River is about 4,167 feet long. The towers on either side of the river would have to be tall enough to keep the lowest part of the conductors a safe distance above the river (safety clearances are determined on a case-by-case basis). The height of the river crossing towers would depend on the terrain, the span, and whether single-circuit or double-circuit towers are used. On the Oregon side of the river, the towers would be about 365 feet tall if single-circuit towers are used and 433 feet tall if double-circuit towers are used. On the Washington side of the river, the towers would be about 401 feet tall for single circuit towers and about 438 feet tall for double-circuit towers.

Although the project area in general has few trees, the West Alternatives would cross over several groves. Based on preliminary estimates, about 93-130 trees would need to be removed for the West Alternative (see Section 3.3 Vegetation and Map 3-5).

About 40 miles of access roads would be needed for the West Alternative (see Table 2-3). Access roads would be a combination of new access roads, temporary roads (through cropland), improved existing BPA access roads (where the proposed alternative would parallel existing lines), and improved county roads (roads needing improvement because they are impassible when wet).

Table 2-3. Estimated Access Road Needs By Action Alternative

Road Needs	West Alternative	Middle Alternative	East Alternative
New Road (miles)	21	19	16
Temporary Road (miles)	3	3	5
Improve Existing Access Road (miles)	11	15	16
Improve County Road (miles)	5	0	0
Total Roads needed (miles)	**40**	**37**	**37**
Culverts	25	28	30
Potential Areas of Cut and Fill	None	Line Miles ME4-10, M10-14	Line Miles ME4-10, E10-15

There are three county roads that would need improvement as part of the access road system for the West Alternative. The county roads are Ahola Ridge Road (from Horseshoe Bend Road south to Finn Ridge Road), Finn Ridge Road (from Harms Road to Ahola Ridge Road), and Palomino Drive (from Horseshoe Bend Road north).

Roads for the West Alterative would require about 25 culverts where they would cross intermittent streams. The terrain along the West Alternative is not as steep as the Middle and East alternatives; access roads for the West Alternative would not likely require cut and fill into hillsides during construction.

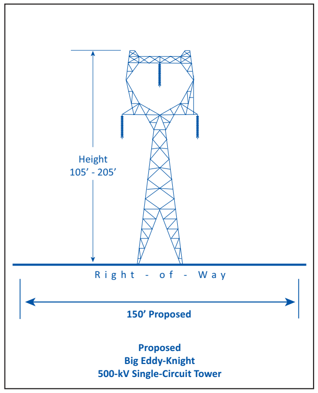


Figure 2-6. Proposed Single-Circuit Tower (West, Middle and East Alternatives)

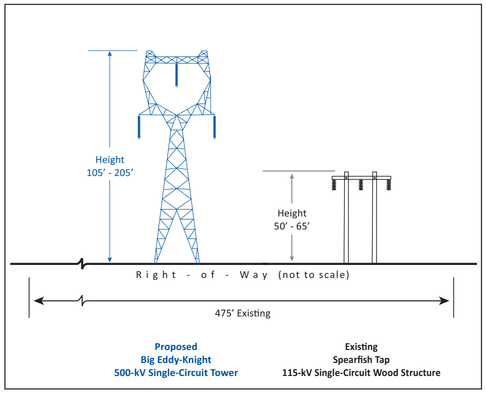


Figure 2-7. Proposed Single-Circuit Tower Parallel to the Spearfish Tap Line (West Alternative)

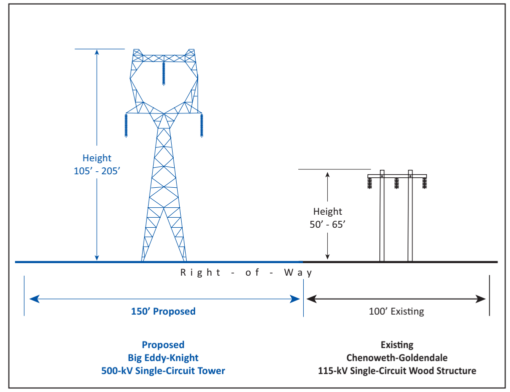


Figure 2-8. Proposed Single-Circuit Tower Parallel to the Chenoweth-Goldendale Line (West and Middle Alternatives)

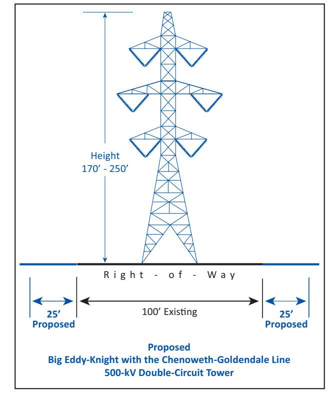


Figure 2-9. Proposed Double-Circuit Tower with the Chenoweth-Goldendale Line (West Alternative)

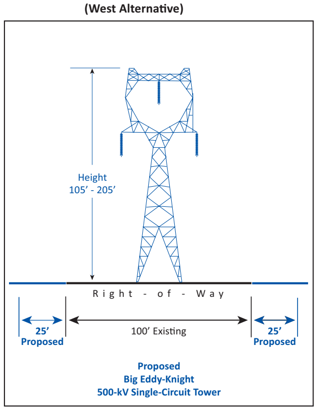


Figure 2-10. Proposed Single-Circuit Tower with the removal of the Chenoweth-Goldendale Line (West Alternative)

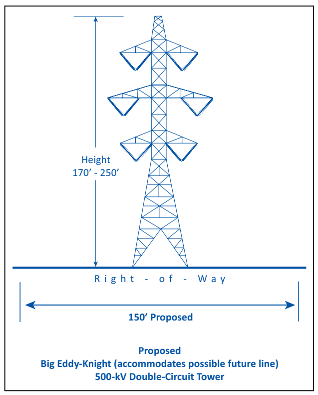


Figure 2-11. Proposed Double-Circuit Tower (West Alternative)

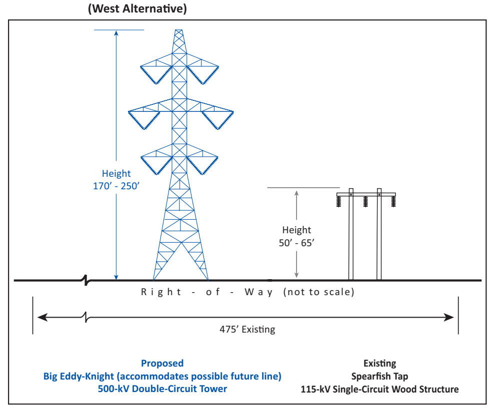


Figure 2-12. Proposed Double-Circuit Tower Parallel to the Spearfish Tap Line (West Alternative)

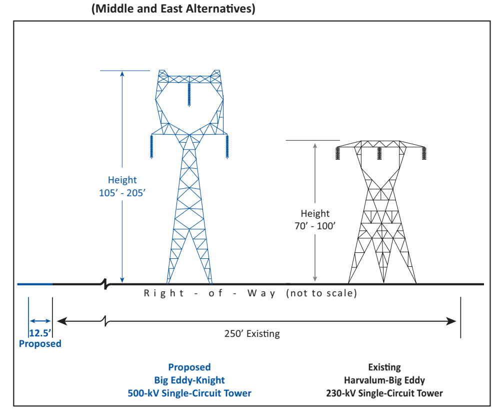


Figure 2-13. Proposed Single-Circuit Tower Parallel to the Harvalum-Big Eddy Line (Middle and East Alternatives)

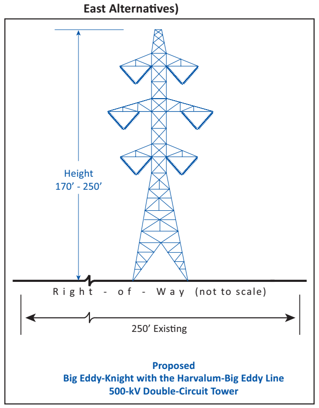


Figure 2-14. Proposed Double-Circuit Tower with the Harvalum-Big Eddy Line (Middle and East Alternatives)

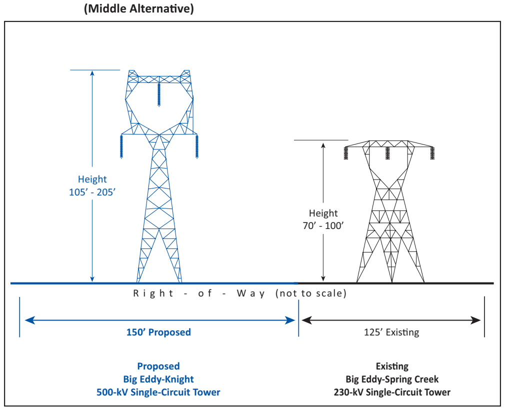


Figure 2-15. Proposed Single-Circuit Tower Parallel to the Big Eddy-Spring Creek Line (Middle Alternative)

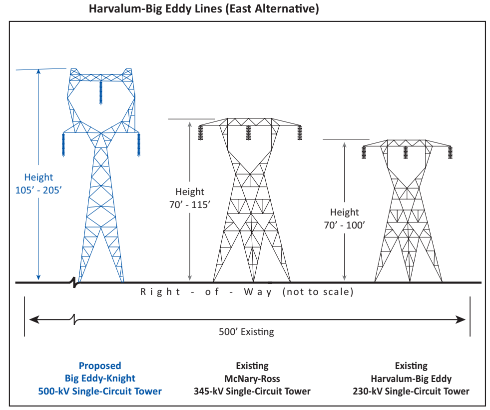


Figure 2-16. Proposed Single-Circuit Tower Parallel to the McNary-Ross and Harvalum-Big Eddy Lines (East Alternative)

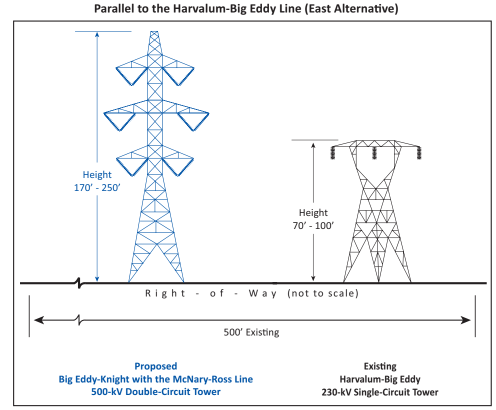


Figure 2-17. Proposed Double-Circuit Tower with the McNary-Ross Line Parallel to the Harvalum-Big Eddy Line (East Alternative)

2.4.3 Middle Alternative

Like the West Alternative, the Middle Alternative begins at BPA's existing Big Eddy Substation, with the same substation improvements as described for the West Alternative. From Big Eddy Substation, the Middle Alternative route extends east and slightly north in existing right-of-way next to BPA's existing Harvalum-Big Eddy 230-kV lattice steel transmission line for about 7 miles before crossing the Columbia River. The route crosses the river just west of the Harvalum-Big Eddy line near Wishram, Washington, and continues to parallel this existing line for about 1.5 miles before heading north in new right-of-way.

The Middle Alternative then heads generally north for about 15 miles to the Knight Substation sites, with two jogs east along the way – one for about 1.5 miles along BPA's existing Big Eddy-Spring Creek 230-kV lattice steel transmission line, and the other for about 2 miles partially along BPA's existing Chenoweth-Goldendale line. This alternative is about 27 miles long.

There are various right-of-way and tower combination options for the Middle Alternative. As the Middle Alternative exits Big Eddy Substation, it would cross BPA property that surrounds the substation until it meets up with the existing Harvalum-Big Eddy transmission line. The Harvalum-Big Eddy line has extra right-of-way and building the proposed line on the west side of it would only require an additional 12.5 feet of right-of-way. BPA is also considering removing the Harvalum-Big Eddy line through this section (line mile ME1-9) and rebuilding the line with double-circuit towers to carry both the existing and proposed line. No new right-of-way would be required for the double-circuit tower option. However, for the double-circuit option, BPA is also considering moving an about 1-mile long section of the line near ME7 to the west so the river crossing tower on the Oregon side would be west of the existing crossing by about 1,000 feet. Changing this section, which is within the boundary of the National Scenic Area, would abandon the existing Columbia River crossing for the Harvalum-Big Eddy Line and establish a new combined corridor (of equal width) for this exsting line and the proposed line. The termination point of the river crossing on the Washington side of the river would remain unchanged.

Where the Middle Alternative parallels the existing Big Eddy-Spring Creek and Chenoweth-Goldendale lines, the proposed line would be on the north side of the existing lines in new 150 foot-wide right-of-way.

In locations where the Middle Alternative does not parallel other lines, the line would require a new 150 foot-wide right-of-way.

With different tower type and right-of-way use possibilities, there are several combinations that create options for the Middle Alternative (see Table 2-4 and Figures 2-6, 2-8, and 2-13 to 2-15).

The Middle Alternative's span across the Columbia River is about 4,551 feet long. The towers on either side of the river would have to be tall enough to keep the lowest part of the conductors a safe distance above the river (safety clearances are determined on a case-by-case basis). The height of the river crossing towers would depend on the terrain, the span, and whether single-circuit or double-circuit towers are used. On the Oregon side of the river, the towers would be about 282 feet tall if single-circuit towers are used and 407 feet tall if double-circuit towers are used. On the Washington side of the river, the towers would be about 173 feet tall for single circuit towers and about 232 feet tall for double-circuit towers.

There are few trees along the Middle Alternative. Based on preliminary estimates, about 14-26 trees would require removal for this alternative (see Section 3.3 Vegetation and Map 3-5).

About 37 miles of access road would be needed for the Middle Alternative (see Table 2-3). The access roads would be a combination of new roads, temporary roads (through cropland), and improved existing BPA access roads (where the proposed alternative would parallel existing lines). No county roads would be improved for the Middle Alternative.

Table 2-4. Middle Alternative Options—Tower Configurations by Line Mile

Tower Option	Description
Middle Option 1	**Single-circuit towers** for the entire route (see Figure 2-6), including: • Parallel to the existing Harvalum-Big Eddy line (M0.4-9.2) (see Figure 2-13) • Parallel to the Chenoweth-Goldendale line (M20-22.5) (see Figure 2-8) • Parallel to the existing Big Eddy-Spring Creek line (M11-12.5) (see Figure 2-15)
Middle Option 2	**Single-circuit towers** from Big Eddy Substation within the National Scenic Area boundary (M0-0.8), outside the National Scenic Area to the boundary with the National Scenic Area (M0.8-6.5) (see Figure 2-6) **Double-circuit towers** within the National Scenic Area (Big Eddy-Knight and the Harvalum-Big Eddy) (M6.5-9.2) with removal of existing Harvalum-Big Eddy towers along this portion (see Figure 2-14) **Single-circuit towers** for the remainder of the route (M9.2 to Knight Substation) (see Figure 2-6), including: • Parallel to the existing Big Eddy-Spring Creek line (M11-12.5) (see Figure 2-15) • Parallel to the Chenoweth-Goldendale line (M20-22.5) (see Figure 2-8)
Middle Option 3	**Single-circuit towers** from Big Eddy Substation to the intersection with the Harvalum-Big Eddy line (M0-0.4) (see Figure 2-6) **Double-circuit towers** to end of overlap with the Harvalum-Big Eddy line (Big Eddy-Knight and the Harvalum-Big Eddy) (M0.4-9.2) with removal of existing Harvalum-Big Eddy towers along this portion (see Figure 2-14) **Single-circuit towers** for the remainder of the route (M9.2 to Knight Substation) (see Figure 2-6), including: • Parallel to the existing Big Eddy-Spring Creek line (M11-12.5) (see Figure 2-15) • Parallel to the Chenoweth-Goldendale line (M20-22.5) (see Figure 2-8)

About 28 culverts would be needed where access roads would cross intermittent streams. On either side of the Columbia River and where the Middle Alternative climbs over the Columbia Hills, the terrain is steep in areas and access road construction would likely require cut banks to keep road grades gentle enough for trucks and equipment to ascend (see Table 2-3 for line mile locations).

2.4.4 East Alternative (Preferred)

From Big Eddy Substation, the East Alternative route follows the same path as the Middle Alternative for about the first 9 miles to a point just north of Wishram, at which point the routes separate. The East Alternative continues east next to two existing BPA lines that parallel each other – BPA's Harvalum-Big Eddy 230-kV lattice steel line and BPA's McNary-Ross 345-kV lattice steel line – for an additional 5 miles before turning north in new right-of-way. The East Alternative then generally runs north for about 14 miles to the proposed Knight Substation sites. This alternative is about 28 miles long.

The East Alternative is BPA's Preferred Alternative.

There are various right-of-way and tower combination options for the East Alternative. Because the East Alternative follows the same route as the Middle Alternative for the first 9 miles, it would require the same amount of right-of-way and have the same tower options as the Middle Alternative (i.e., exit Big Eddy Substation on BPA land; be located to the west of the Harvalum-Big Eddy line with a new 12.5 foot wide right-of-way; and/or be built double-circuit with the Harvalum-Big Eddy line in existing right-of-way). As with the Middle Alternative, it would also include the possibility of moving an about 1-mile long section of the line near ME7 to the west so the river crossing tower on the Oregon side would be west of the existing crossing by about 1,000 feet. Changing this section, which is within the boundary of the National Scenic Area, would abandon the existing Columbia River crossing for the Harvalum-Big Eddy Line and establish a new combined corridor (of equal width) for this existing line and the proposed line. The termination point of the river crossing on the Washington side of the river would remain unchanged.

At Wishram where the East Alternative continues east and the McNary-Ross line joins the transmission corridor, the proposed line could be built as a single-circuit line running parallel on the north side of the existing lines. The existing corridor has extra right-of-way that would accommodate the proposed line; no additional right-of-way would be required. BPA is also considering removing the McNary-Ross line through this section (line mile E9-14) and rebuilding the line with double-circuit towers to carry both the existing and proposed line. As with the single-circuit option, no new right-of-way would be required for the double-circuit tower option in this section (E9-14).

With different tower type and right-of-way use possibilities, there are several combinations that create options for the East Alternative (see Table 2-5 and Figures 2-6, 2-13, 2-14, 2-16, and 2-17). East Alternative Option 3 is the preferred option.

Table 2-5. East Alternative Options—Tower Configurations by Line Mile

Tower Option	Description
East Option 1	**Single-circuit towers** for the entire route (see Figure 2-6), including: • Parallel to the existing Harvalum-Big Eddy line (E0.4-9.2) (see Figure 2-13) • Parallel to the existing Harvalum-Big Eddy line (E9.2-14) and McNary-Ross line (E9.2-14) (see Figure 2-16)
East Option 2	**Single-circuit towers** from Big Eddy Substation within the National Scenic Area boundary (E0-0.8), outside the National Scenic Area to the boundary with the National Scenic Area (E0.8-6.5) (see Figure 2-6) **Double-circuit towers** within the National Scenic Area (Big Eddy-Knight and the Harvalum-Big Eddy line) (E6.5-9.2) with the removal of existing Harvalum-Big Eddy towers along this portion (see Figure 2-14) **Double-circuit towers** within the National Scenic Area (Big Eddy-Knight and the McNary-Ross line) (E9.2-14) with removal of existing McNary-Ross towers along this portion. This portion also parallels the existing Harvalum-Big Eddy line (E9.2-14) (see Figure 2-17) **Single-circuit towers** for the remainder of this route (E14 to Knight Substation) (see Figure 2-6)
East Option 3 (Preferred)	**Single-circuit towers** from Big Eddy Substation to the intersection with the Harvalum-Big Eddy line (E0-0.4) (see Figure 2-6) **Double-circuit towers** to end of overlap with the Harvalum-Big Eddy line (Big Eddy-Knight and the Harvalum-Big Eddy) (E0.4-9.2) with removal of existing Harvalum-Big Eddy towers along this portion (see Figure 2-14) **Double-circuit towers** where the proposed line parallels the existing McNary-Ross line (Big Eddy-Knight and the McNary Ross line) (E9.2-14) with removal of existing McNary-Ross towers along this portion. This portion also parallels the existing Harvalum-Big Eddy line (E9.2-14) (see Figure 2-17) **Single-circuit towers** for the remainder of this route (E14 to Knight Substation) (see Figure 2-6)

The East Alternative would have the same river crossing towers as the Middle Alternative. The span across the Columbia River at this location is about 4,551 feet long. The towers on either side of the river would have to be tall enough to keep the lowest part of the conductors a safe distance above the river (safety clearances are determined on a case-by-case basis). The height of the river crossing towers would depend on the terrain, the span, and whether single-circuit or double-circuit towers are used. On the Oregon side of the river, the towers would be about 282 feet tall if single-circuit towers are used and 407 feet tall if double-circuit towers are used. On the Washington side of the river, the towers would be about 173 feet tall for single circuit towers and about 232 feet tall for double-circuit towers.

There are few trees along the East Alternative. Based on preliminary estimates, about 6-16 trees would be removed for this alternative (see Section 3.3 Vegetation and Map 3-5).

About 37 miles of access roads would be needed for the East Alternative (see Table 2-3). Access roads would be a combination of new roads, temporary roads (through cropland), and improved existing BPA access roads (where the proposed alternative would parallel existing lines). No county roads would be improved for the East Alternative.

About 30 culverts would be needed where access roads would cross intermittent streams. On either side of the Columbia River and where the East Alternative climbs over the Columbia Hills, the terrain is steep in areas and access road construction would likely require cut banks to keep road grades gentle enough for trucks and equipment to ascend (see Table 2-3 for line mile locations).

2.4.5 Knight Substation Options

Each of the action alternatives would connect to BPA's Wautoma-Ostrander transmission line at the proposed Knight Substation. Two site options have been identified for this proposed substation, and all three alternatives could use either option. The proposed substation sites are located in an area under the Wautoma-Ostrander line that is at the optimum electrical distance from BPA's Big Eddy, Wautoma and Ostrander substations. This location would provide the maximum electrical system performance for a connection to the Wautoma-Ostrander line and the proposed Big Eddy-Knight line. The new substation would redistribute the flow of electricity across a number of BPA's high-voltage transmission lines, provide additional capacity on those lines, and increase reliability of the transmission system.

Knight Substation would require about 30 acres and would be an enclosed 10-acre facility. As is typical when building new high-voltage substations, BPA would have additional land available for site design flexibility to accommodate potential future substation needs. The substation would be located under the transmission line corridor that contains BPA's Wautoma-Ostrander 500-kV and North Bonneville-Midway 230-kV lines. The substation would have 3 electrical bays: two for the existing lines to connect to and one for the Big Eddy-Knight line. (Please see Section 2.3 Project Components, for a description of equipment within a substation.) The electrical yard would have room for four additional bays for possible future lines. The station control house would be a 30-foot by 40-foot concrete block building that would stand about 15 feet tall. The substation would require excavation of about 250,000 cubic yards of soil.

The substation would include a stormwater retention system. The system could include a pond, which could occupy about 1 acre and have a volume of about 3 acre-feet.

Knight Substation Site 1 (Preferred)

Knight Substation Site 1 would be on private property about ½ mile west of Knight Road. The property has gentle rolling terrain and is currently being farmed, but is for sale. Because siting the substation on the property would likely sever it from the remaining ownership and agricultural use, 80 acres would likely be purchased (the parcel is 80 acres, but BPA presently owns 8 acres of it for the right-of-way of the existing lines crossing through it).

Construction at Substation Site 1 would require temporary road access, likely off Hill Road from the west, Butts Road from the south, or from Pine Forest Road from the north. These county roads may require upgrading. Permanent access would be required for operations after construction, likely from Knight Road. The Big Eddy-Knight line would approach the substation from the south across private property.

Knight Substation Site 2

Knight Substation Site 2 would be designed and built in the same manner as Site 1. Site 2 is next to Site 1 on a 544-acre parcel, owned by DNR, which abuts the west side of Knight Road.

The parcel is in the Conservation Reserve Program (CRP) and in dryland grain production. BPA would purchase a 30-acre portion of the parcel.

Site 2 would be accessed from the east off Knight Road. The proposed line would approach the substation from the south along DNR property.

2.4.6 Fiber Optic Cable Options

All three action alternatives would require installation of fiber optic cable for system communications. Two options have been identified for routing this cable: a Loop Back Option and a Wautoma Option. All three alternatives could use either fiber optic cable option.

Loop Back Option

The proposed transmission line would require a fiber optic cable for communications between substations (see **Fiber Optic Cable** in Section 2.3.2). The fiber optic cable needed for electrical system communications would be strung on the proposed transmission line towers from Big Eddy Substation north to Knight Substation. Fiber must make a complete loop with other fiber networks to function. For this option, the cable would be strung on the proposed new transmission towers, then another cable would be run south to Big Eddy Substation on the new towers to form a loop. The two cables would be separated by about 10 feet (attached on opposite sides of the tower). Cable installation would occur concurrently with construction of the new transmission line.

Wautoma Option (Preferred)

In this option only one fiber optic cable would be strung on the new towers from BPA's Big Eddy Substation north to Knight Substation. Instead of returning a second cable to Big Eddy Substation, however, the fiber optic cable would be strung from Knight Substation to Wautoma Substation on the existing transmission towers that support BPA's Wautoma-Ostrander transmission line. The cable would extend northeast for about 72 miles on this existing line to BPA's existing Wautoma Substation in northwest Benton County, Washington (see Map 1-1). Every 3 to 5 miles a splice box would be installed and a reeling site established to string and put tension on the cable. About 16 splice boxes would be placed on the transmission towers or in the ground adjacent to the towers. At each site, about 0.25 acre of ground in line with the conductors within the existing right-of-way would be temporarily disturbed by a reeling truck and tensioning equipment.

Equipment used along the route would consist primarily of standard utility equipment, such as bucket trucks, light duty trucks, cranes, four-wheel drive pickup trucks, line truck with pulling and tensioning reel, helicopter, and all-terrain vehicles. Use of helicopters and/or loud equipment would be minimized before 8 a.m. or after dusk to avoid disturbing landowners. All utility equipment would stay within the right-of-way and use existing access roads. There would be no staging areas.

Some work would also take place at local substations. Two concrete vault boxes (4 feet x 4 feet x 4 feet) would be installed outside the yard at Knight and Wautoma substations. Other fiber optic equipment needed as part of the communications network would also be installed within existing substation yards. Existing access roads would be used for construction.

The Wautoma Option would optimize the transmission communications system by creating a large communication loop that could be used by multiple substations.

2.5 No Action Alternative

Under the No Action Alternative, BPA would not build the proposed Big Eddy-Knight transmission line, Knight Substation, or install fiber optic cable. Without building these facilities, BPA would be unable to provide long-term firm transmission service for the service requests that the proposed line is intended to accommodate. However, BPA may be able to provide other forms of transmission service to some of these customers, such as non-firm transmission service (non-firm is not guaranteed to be available and is only available after commitments for firm service have been met).

2.6 Alternatives Considered but Eliminated from Detailed Study

BPA has considered a number of potential alternatives to the Proposed Action. These include alternatives developed by BPA based on its knowledge of and experience in transmission line design and possible environmental issues, as well as alternatives that either were suggested or responded to concerns raised during the scoping process for this EIS. For each potential alternative, BPA assessed whether the alternative was reasonable under NEPA and thus merited detailed evaluation in this EIS, or was unreasonable and could be eliminated from detailed study.

BPA considered several factors in making this assessment of potential alternatives. BPA considered whether the potential alternative would meet the identified need for the Proposed Action and achieve the project's purposes (see Section 1.3). In addition, BPA considered whether the alternative would be practical and feasible from a technical and economic standpoint and using common sense, consistent with CEQ guidance on assessing the reasonableness of alternatives. Finally, BPA considered whether an alternative would have obviously greater adverse environmental effects than the Proposed Action. The alternatives that did not meet these considerations and were eliminated from detailed study in this EIS are described in this section.

2.6.1 Non-Transmission Alternatives

BPA considered whether there could be a solution to the project need that would not require construction of a new transmission line. Some examples of non-transmission alternatives include: distributed generation (siting generation closer to the load so power does not have to be transmitted over the line in question), demand side management (reduces the load during peak demand times), and general conservation (reducing load by using more energy-efficient appliances). A Remedial Action Scheme (RAS) is another non-transmission alternative. Concerning distributed generation, demand side management, and general conservation, BPA's proposed action involves responding to existing requests for transmission service over a portion of its transmission system that has limited available transmission capacity (ATC). These three non-transmission alternatives would not address the specific need for additional capacity in the project area. Because they would not meet this identified need, these non-transmission alternatives were considered but eliminated from detailed study in this EIS.

RAS is a system of dropping generation from the system to prevent overloads. BPA uses RAS to prevent transmission planning reliability criteria violations (such as facility overloads and system instability) resulting from severe unplanned transmission line outages. RAS equipment requires local generators to automatically cut or "drop" their generation to protect the transmission system when the capacity of the system is reached and an unplanned outage occurs. Typical actions include tripping generators off-line and switching reactive power devices with high speed control systems. BPA has used the maximum possible RAS-initiated generation dropping to manage existing commitments on the transmission system in eastern Oregon west of the John Day Dam area. RAS currently allows BPA to provide safe and reliable system operation with the existing generators in this area.

To address the transmission service requests with RAS, BPA would have to determine all the generation associated with the transmission service requests. The requests for service are for firm (non-interruptible) transmission service. Therefore, placing them on a RAS would not fulfill the requests. Also, in order to maintain transmission system reliability, BPA must limit the total amount of generation that may be tripped by RAS for credible contingencies. Studies show dropping any additional generation beyond what has already been included to accommodate the additional firm transmission service requested will compromise the stability of the system. BPA's planning studies showed also that even with all of the proposed new generation included in the RAS to optimize transfer capability, BPA could not grant the 1,150 MW of additional firm transmission service. Therefore, this alternative was eliminated from further consideration.

2.6.2 Transmission Line Alternatives

Use the Existing Transmission System without Upgrades

This alternative attempts to meet the project need just by using the existing transmission system without upgrading any facilities. The transmission studies conducted by BPA have shown that adding 1,150 MW of the requested firm service to its existing firm commitments, without providing system upgrades, could result in violations of planning reliability standards. Providing this requested service would exceed the available transmission capacity of BPA's existing transmission lines in the area, which likely would result in thermal overloads, as well as voltage and transient stability criteria violations, and line outages. Given the interconnected nature of the regional transmission system, critical outages could cascade to other transmission lines owned by BPA or other utilities. The outages would most likely start with lines in the area (such as the John Day-Big Eddy line). However, other portions of the regional transmission system could also be affected through further cascading outages.

Because of the severe operational issues and risks in managing the existing transmission system without upgrades, this alternative would not meet the identified need and maintain system reliability. Therefore, this alternative was eliminated from further consideration.

Lower Voltage Line Upgrades or Additions

BPA also considered upgrading lower voltage transmission facilities to meet the need. There are no lower voltage facilities currently at risk of exceeding their operating limits if a major critical line went out, i.e., upgrading these lines would not provide the additional capacity needed to meet the need for the project. In addition, building many 230-kV lines or 115-kV lines in place of one 500-kV line would increase line losses and costs, and require additional new right-of-way and materials. Therefore, upgrading or adding lower voltage lines was eliminated from further consideration.

2.6.3 Undergrounding the Transmission Line

During the scoping process, some people suggested burying the new transmission line. Underground transmission cables are highly complex when compared to overhead transmission lines and lower-voltage distribution cables used to deliver power to individual homes. For a 500-kV line, three individual cables would have to be manufactured and installed at a cost about 10 times the cost of an overhead design.

Because costs are so high, BPA uses underground cable only in limited situations. Underground cables are considered where an overhead route is not possible, such as for long water crossings (e.g., in the San Juan Islands of Washington). In addition, underground transmission cables are used for relatively short distances in comparison to typical overhead transmission lines. BPA's longest underground transmission cable is a 69-kV submarine cable that is 9 miles long in the San Juan Islands.

In addition to significantly higher construction costs, underground transmission cables in terrestrial settings also result in much higher maintenance costs, and environmental impacts that are typically greater than impacts associated with an overhead line. Installation of underground cable would require the use of large excavators and other heavy equipment to dig a continuous cable trench a minimum of 10 feet wide and 6 feet deep to install the cables. All trees and brush would need to be cleared along this construction corridor. This construction activity would cause substantial surface and subsurface disturbance, soil erosion potential, potential impacts to cultural resources, plants and habitat (all of which can often be spanned with overhead lines) along the transmission line route. In areas where bedrock is near the surface, construction would also require blasting, which would result in noise and air quality impacts. In areas where the cables would cross water bodies such as the Columbia River, construction could require excavation in wetlands and riparian areas that could largely be avoided with an overhead transmission line. The cables that would be installed likely would be oil-filled, which would require above-ground termination and oil storage equipment at several locations along the line. This equipment would result in visual impacts.

Once the cables are installed, a permanent corridor approximately 150-feet wide would be required, with a continuous parallel access road along the route of the buried transmission line to allow necessary maintenance and repair of the cables. Repairs would require excavation along the affected reach. Because the cables would be underground, the cables would be more susceptible to damage and failure due to geological hazards such as seismic activity, landslides, and soil erosion. Failures also can result from aging of the cables, heat stress, and a variety of other external and internal causes. In addition, because the cables would be buried, it would be much more difficult to locate failed or damaged cables, and service likely would take weeks or months to restore compared to the hours or days it takes to restore service on an overhead line.

Underground cable remains a tool available for low-voltage distribution and for special high-voltage situations, but because of its high cost and environmental impacts, it is not considered a reasonable alternative to solve the high voltage transmission need identified in Chapter 1 and was eliminated from detailed evaluation.

2.6.4 Transmission Line Routing Options

Northern Portion of the Original West Alternative

When BPA proposed the Big Eddy-Knight project, the West Alternative continued north toward the Wautoma-Ostrander line rather than turning east with the Chenoweth-Goldendale line. When it reached the Wautoma-Ostrander line, the route turned east and paralleled the Wautoma-Ostrander for over a mile before reaching the original Substation Site A (which has also been eliminated) (see Map 2-1). The northernmost portion of the original West Alternative was eliminated because a section of the route heading to the original Substation Site A would have needed to be separated from the existing lines by 1,200 feet or more (see **Line separation** in Section 2.2) and would require the purchase of a new right-of-way with several homes that would need to be removed. The other proposed project routes would not have this requirement. Therefore, this portion of the original West Alternative was eliminated from detailed evaluation.

Blockhouse Routing Option

After BPA proposed the project and held public meetings, an existing 100 foot-wide vacant BPA easement was identified. BPA considered using this easement, in conjunction with the purchase of an additional 50-foot wide right-of-way, for the northern portion of the West Alternative. The easement is located from line mile W18 from the Chenoweth-Goldendale line directly north to the Wautoma-Ostrander line. This route was referred to as the Blockhouse Option. Three homes and Project Patch facilities (a retreat center for troubled youth and their families) have been inadvertently built within the easement. Because several homes and the retreat center would have required removal and the other alternatives would not have this requirement, this option was eliminated from detailed evaluation.

Link Routing Option

BPA also considered an additional route to link the West, Middle, and East alternatives that would have been located south of where the West Alternative turns to the east. This route was eliminated from detailed evaluation because BPA could use the existing right-of-way of the Chenoweth-Goldendale line and the Link Option did not provide any advantages not found in that option.

South Alternative

BPA considered a South Alternative line route that started at Big Eddy Substation and continued east in Oregon parallel to two of BPA’s existing John Day-Big Eddy lines. This route would have crossed the Deschutes River, and then turned north to cross the Columbia River into Washington near Maryhill Museum. Once in Washington, the route would have continued north to Knight Substation along the same route as the East Alternative.

Although the route would have paralleled existing lines in Oregon, the proposed line would have had to have been separated from the John Day- Big Eddy lines by at least 1,200 feet (see L**ine separation** in Section 2.2), requiring a new 150 foot-wide right-of-way and creating a new corridor for its entire length. The route also included a new, difficult Columbia River crossing. Although the route was suggested as one that could avoid crossing the National Scenic Area, it did not completely circumvent the area. The route crossed the Deschutes River at a state recreation area and at a location where the Deschutes River is designated as a Wild and Scenic River. At over 30 miles long, the route was 2-3 miles longer than the other routes. The route also required all new right-of-way.

The added length of the route would have negatively affected electrical performance and power distribution on the Wautoma-Ostrander transmission line. The additional length would have also increased the costs of the project. Because this longer line route could not meet the electric performance standards required for the project, and because this alternative has increased cost and no environmental advantages over alternatives already being considered, this South Alternative was eliminated from detailed evaluation.

2.6.5 Alternate Substation Site

BPA considered a substation site, called Substation Site A, at the northern end of the original West Alternative. This substation site did not perform electrically as well as the proposed substation sites (1 and 2) to the east (see Map 2-1). In addition, because the portion of the West Alternative that connected to that site has been eliminated and the Middle and East routes would be required to be separated from the Wautoma-Ostrander line by 1,200 feet (see **Line separation** in Section 2.2), Substation Site A was eliminated from detailed evaluation.

2.7 Comparison of Alternatives

BPA has evaluated the action alternatives and the No Action Alternative, and has compared the alternatives based on the purposes of and need for the proposed project, the affected environment, and environmental consequences. The results of the comparison are summarized in Tables 2-6 and 2-7. All action alternatives (West, Middle, and East) would meet the need for the project; the No Action Alternative would not. Mitigation measures that would apply to all the action alternatives are listed in Table 2-8.

Table 2-6. Comparison of Proposed Action Alternatives to Project Purposes

Purpose	West Alternative	Middle Alternative	East Alternative	Knight Substation Site 1	Knight Substation Site 2	Fiber Optic Cable Loop Back Option	Fiber Optic Cable Loop Wautoma Option	No Action Alternative
Optimize electrical capacity/performance of the proposed new line and substation	The length and design would provide optimal electrical capacity and performance.	Same as West Alternative	Same as West Alternative	This substation site is strategically placed to optimize electric system performance.	Same as Knight Substation Site 1	Would provide basic communication service for the project, but would not enhance overall transmission system communications.	Would optimize the transmission communications system by creating a large communication loop that could be used by multiple substations.	Leaving the system as is (not constructing the project) would limit BPA's ability to provide service for new transmission requests.
Maintain reliability of BPA's transmission system to BPA and industry standards	Would allow BPA to grant requests for transmission service while maintaining reliability of the electrical grid to BPA and industry standards. In addition, it would increase the ability to serve Portland during winter and increase system flexibility should there be an interruption in the operation of one of the area's other transmission lines.	Same as West Alternative	Same as West Alternative	Knight Substation would increase the reliability of the electrical grid by creating a new location where electricity can be diverted to alternate paths.	Same as Knight Substation Site 1	Would provide basic communication service for the project, but would not enhance overall transmission system communications.	Would optimize the transmission communications system by creating a large communication loop that could be used by multiple substations.	Would limit BPA's ability to provide service to new transmission request as the capacity of existing lines in the area cannot accommodate the requests without compromising reliability of the system. Also, additional benefits of proposed line (increased system flexibility and capacity to Portland in the winter) would not be gained.
Meet BPA's contractual and statutory obligations	While BPA has no express contractual or statutory obligation to build the proposed project, the project would help BPA further its statutory mandates and tariff provisions that direct BPA to construct additions to the transmission system to integrate and transmit electric power and maintain system stability and reliability, as appropriate.	Same as West Alternative	Same as West Alternative	Same as West Alternative	Same as West Alternative	Same as West Alternative	Same as West Alternative	By not constructing the line, BPA would not be acting in furtherance of its applicable statutory mandates or tariff provisions.
Minimize project costs where practical	Would be more expensive than the Middle Alternative for single-circuit options for entire route and the most expensive alternative for double-circuit in all appropriate locations. Tearing down the existing Chenoweth-Goldendale line and building in the existing right-of-way would be more expensive than building the line parallel to Chenoweth-Goldendale.	Would be the least expensive action alternative comparing both single-circuit options for entire route and double-circuit options where appropriate.	Would be the most expensive action alternative for single-circuit options for entire route. Would be more expensive than Middle Alternative and less expensive than West Alternative for double-circuit options where appropriate.	Likely more expensive than Substation Site 2 because BPA would have to purchase more acreage due to possible severance of property – but property is for sale	Likely less expensive than Substation Site 1 due to possible purchase of amount needed only.	Less expensive than Wautoma Option	More expensive than Loop-Back Option	No immediate costs would be involved if the line were not built.
Minimize impacts to the environment	The project has been designed to minimize impacts to the environment where feasible, and mitigation measures are identified to avoid or reduce these impacts. Please see Table 2-7 for a comparison of the environmental impacts of the alternatives.	Same as West Alternative	Same as West Alternative	Same as West Alternative	Same as West Alternative	Would have fewer impacts than the Wautoma Option as it would not disturb any areas that would be not already be disturbed through the construction of the Big Eddy-Knight line.	Would have greater impacts than the Loop-Back Option as, although the fiber would be on an existing line, areas would be disturbed for pulling and vaults along the Wautoma-Ostrander line.	If the line were not built there would be no environmental impacts due to construction or operation.
Minimize Future Impacts	Building the first 5 miles using double-circuit towers would accommodate a future line, eliminating the need for an additional river crossing in the future. Removing the Chenoweth-Goldendale line may require future line work to service Klickitat County PUD.	Building 9 miles of double-circuit towers to include the Harvalum-Big Eddy line would allow for a future upgrade of that portion of line without new towers.	Building 14 miles of double-circuit towers to include the Harvalum-Big Eddy and McNary-Ross lines would allow for a future upgrade of that portion of line without new towers.	N/A	N/A	Would provide service for Knight Substation.	Because this option would create a greater fiber loop and increase flexibility of the communication system; the need for future fiber optic cables in the area would be less.	Does not provide any future benefits to system

Table 2-7. Summary of Environmental Impacts by Alternative

Resource	West Alternative	Middle Alternative	East Alternative (Preferred)	Big Eddy Substation	Knight Substation Site 1 (Preferred)	Knight Substation Site 2	Fiber Optic Cable – Loop Back Option	Fiber Optic Cable Wautoma Option (Preferred)	No Action Alternative
Land Use and Recreation	***Moderate-to-high*** impact. It would impact the most (of the alternatives) park and conservation land (23-29 acres permanent impact). Would impact rangeland (78-95 acres), with some impacts to nonirrigated cropland (10-12 acres), and a small amount of irrigated cropland (0.5 acre) and orchard (0.2 acre). New right-of-way = 233-432 acres. Would follow existing BPA right-of-way for 16 of 27 miles. The longest amount of proposed line in the National Scenic Area, about 9.5 miles.	***Low-to-moderate*** impact. It would impact some park and conservation land (3 acres permanent impact); have the least impact on rangeland (73-74 acres), with the most impacts to nonirrigated cropland (24-25 acres), and a small amount of irrigated cropland (0.5 acre) and orchard (0.2 -.03 acre). New right-of-way = 284-309 acres. It would follow existing BPA right-of-way for 9 of 27 miles. The shortest amount of proposed line in the National Scenic Area, about 5.5 miles.	***Low-to-moderate*** impact. It would impact some park and conservation land (2 acres permanent impact). Would impact the most rangeland (81-83 acres), with some impacts to nonirrigated cropland (17-18 acres), and a small amount of irrigated cropland (0.8 acre) and orchard (0.2-.03 acre). New right-of-way = 258-269 acres. It would follow existing BPA right-of-way for 14 of 28 miles. Crosses the National Scenic Area for about 7.5 miles.	***No*** impact because all work would occur within the existing substation yard.	***Moderate*** impact. It would convert more than 70 acres of prime farmland to nonagricultural use and require a 0.75-mile access road.	***Moderate*** impact. It would convert 30 acres of prime farmland to nonagricultural use, with a shorter access road, but could make farming difficult on northern portion of the site.	Same overall impact as the selected action alternative. Incremental impacts from stringing the cable would be minimal.	***Low*** impact because little land would be disturbed.	***No*** impact.
Visual Resources	***High*** impact. It is the longest route in the National Scenic Area (9.5 miles) and would include a new Columbia River crossing. Although portions would parallel or replace an existing wood-pole transmission line, the new steel towers would be noticeably taller and more industrial-looking than the existing wood-pole line. It would be visible from the highest number of parks (9), scenic highways (3) and trails (4). It would run near (within 1,000 feet of) the fewest homes – 17-24 – but potentially interfere with expansive views for some current residents and those building homes in several new, large-lot subdivisions near the Little Klickitat River.	***Moderate-to-high*** impact. It would run the shortest distance through the National Scenic Area (5.5 miles) and would parallel or share an existing Columbia River transmission line crossing. Portions in the Gorge would be next to or replace an existing transmission line with much existing infrastructure (highways, railroad tracks and other development), but would be visible where it climbs in new right-of-way up the Columbia Hills. Visible from the fewest number of parks (3), scenic highways (2) and trails (1). It would run near the greatest number of homes – 42-46 – of which 25 are in the community of Wishram. Would also run near several new large-lot subdivisions, potentially interfering with expansive views.	***Moderate*** impact. While it would run for 7.3 miles through the National Scenic Area, and share some of the Middle Alternative's route here, it would parallel or replace an existing transmission line through this area. It would climb the Columbia Hills in new right-of-way through a field of taller wind turbines. It would be visible from a few parks (4), scenic highways (3) and trails (1) and would run by 39-42 homes, 25 of them in Wishram.	***No*** impact because all work would occur within the existing substation yard with existing infrastructure.	***Low-to-moderate*** impact because, although there are few sensitive viewers nearby, the substation would place a commercial building in an existing agricultural field somewhat visible to motorists on Knight Road.	***Moderate*** impact. Slightly greater impact than Site 1 because it is located closer to motorists on Knight Road and to a future housing development across the road.	Same overall impact as the selected action alternative.	***Low*** impact. Stringing of cable along the existing line would occur in a relatively unpopulated area and construction work would be brief at each work site. Once strung, the cable would blend in with existing lines on the towers.	***No*** impact.
Vegetation	***High*** impact because it could impact eight of nine special-status species found or potentially present along the line and two priority ecosystems. Also would be the only action alternative to impact high-quality grassland. It would predominantly impact disturbed shrub-steppe/ grassland, about the same amount as other action alternatives, and a small amount of high-quality shrub-steppe. It would require removal of the greatest number of trees, 93-130.	***Moderate*** impact. It could impact two special-status species found or potentially present along the line. It would predominantly impact disturbed shrub-steppe/grassland and a small amount of high-quality shrub-steppe. About 26 trees would be removed in upland areas. It would not cross any priority ecosystems.	***Low*** impact. It could impact one special- status species potentially present along the line. It would predominantly impact disturbed shrub-steppe/grassland, but no high-quality species. About 16 trees would be removed in upland areas. It would not cross any priority ecosystems.	***No*** impact because all work would occur within the existing substation yard.	***No*** impact on special-status species, priority ecosystems, any type of shrub-steppe/grassland or woodlands. Disturbs nonirrigated cropland only.	***No*** impact on special-status species, priority ecosystems, any type of shrub-steppe/grassland or woodlands. Disturbs nonirrigated cropland only.	Same overall impact as the selected action alternative.	***No-to-low*** impact because no special-status species, priority ecosystems, any type of shrub-steppe/grassland or woodlands would be disturbed.	***No*** impact.

Resource	West Alternative	Middle Alternative	East Alternative (Preferred)	Big Eddy Substation	Knight Substation Site 1 (Preferred)	Knight Substation Site 2	Fiber Optic Cable – Loop Back Option	Fiber Optic Cable Wautoma Option (Preferred)	No Action Alternative
Geology and Soils	***Low*** soil erosion and landslide impacts. Building the line and about 40 miles of access roads would disturb about 169-268 acres. With mitigation, resulting erosion rate would be similar to naturally occurring erosion rates for the area. Least disturbance within potential landslide areas – about 2.5 acres.	***Low-to-moderate*** soil erosion and landslide impacts. Building the line and about 37 miles of access roads would disturb about 159-179 acres. With mitigation, resulting erosion rate would be similar to naturally occurring rate. Disturbance within potential landslide areas – about 8-9 acres – would be more than the West Alternative, but much less than the East Alternative.	***Moderate-to-high*** soil erosion and landslide impacts because it would cross a greater amount of steep terrain. Building the line and about 37 miles of access roads would disturb about 169-212 acres. With mitigation, resulting erosion rate would be slightly higher than the naturally occurring rate. Disturbance within potential landslide areas – about 22-30 acres – is the greatest among the action alternatives.	***Low*** soil erosion impact. Amount of soil disturbed by substation and access road construction would be relatively small and the site is mostly flat. ***No*** landslide impact.	***Moderate*** soil impacts. Amount of soil disturbed by substation and access road construction would be relatively small and the site is mostly flat. ***No*** landslide impact.	***Moderate*** soil impacts; with mitigation, the soil loss rate would be about 0.5 ton of soil per year. The site is flatter than Site 1. ***No*** landslide impacts.	Same overall impact as the selected action alternative.	***No-to-low*** impact because limited digging and compaction would occur and mitigation would help alleviate these impacts.	***No*** impact.
Water Resources and Wetlands	***Low*** overall impact on waterways. Least disturbance (2 acres) within 50 feet of streams. Highest number of stream crossings by new and improved access roads (32); however, only intermittent streams, drainages and dry washes would be impacted. Lowest number (25) of new culverts required. No impact on floodplains. Only one riparian area potentially impacted along intermittent Threemile Creek where removing some shade trees could slightly affect water temperatures. ***High*** potential impact on wetlands. Between 1.7-3 acres of wetlands would be temporarily or permanently impacted, including three high-quality wetlands that would have small portions disturbed.	***Low*** overall impact on waterways. About 2.2 acres within 50 feet of streams would be disturbed. New and improved access roads would cross 20 intermittent streams or drainages; up to 28 new culverts could be installed. A small portion of Fifteenmile Creek's floodplain would be impacted by improvements to an existing access road. No riparian areas would be disturbed. ***Moderate-to-high*** impact on wetlands. Between 1.4-1.7 wetland acres would be impacted, including one high-quality wetland that would have a small portion disturbed.	***Low*** overall impact on waterways. About 2.7-2.9 acres of land within 50 feet of streams would be disturbed. New and improved access roads would cross 30 intermittent streams or drainages; up to 30 new culverts could be installed. A small portion of Fifteenmile Creek's floodplain would be impacted by improvements to an existing access road. No riparian areas would be disturbed. ***Low-to-moderate*** impact on wetlands, of which less than 1 acre would be disturbed. No high-quality wetlands have been identified along this alternative.	***No*** impact because there are no water resources present within the existing substation yard.	***No*** impact on waterways or wetlands.	***No*** impact on waterways or wetlands.	Same overall impact as the selected action alternative.	***No*** impact on waterways or wetlands, because all would be avoided (spanned).	***No*** impact.
Wildlife	***Moderate-to-high*** impact because it would disturb some high-quality habitat, including grasslands, shrub-steppe, woodlands, rock, cliff and wetlands, and some special-status species. Slight impacts would be likely on the Western gray squirrel; amphibians, turtles, and invertebrate species; the sage lizard; and some common species of birds and wildlife.	***Low-to-moderate*** impact because it would predominantly disturb common habitat abundant in the area. It would disturb a small amount of high-quality habitat (the fringe of one shrub-steppe area) and slightly impact woodlands and wetlands. There would be few potential impacts on special–status species (amphibians and certain turtles; bald eagle; white pelican; and mule and black-tailed deer).	***Low-to-moderate*** impact because it would predominantly disturb common habitat abundant in the area. It would not disturb high-quality habitats and would only slightly impact woodlands and wetlands. It would have the least potential impact on special–status species (bald and golden eagles; prairie and peregrine falcons; white pelican; amphibians and certain turtles; and mule and black-tailed deer).	***No*** impact because all work would occur within the existing substation yard.	***Low*** impact because substation construction would remove 10 acres of cropland from use, a small percentage of this widespread and relatively low-quality habitat. No special-status species, nests or burrows were found on site.	***Low*** impact because substation construction would remove 10 acres of cropland from use, a small percentage of this widespread and relatively low-quality habitat. No special-status species, nests or burrows were found on site.	Same overall impact as the selected action alternative.	***Low-to-moderate*** impact because it could cause temporary displacement in some areas. The higher impact would occur if construction took place during breeding seasons for migratory birds or the Western gray squirrel.	***No*** impact.

Resource	West Alternative	Middle Alternative	East Alternative (Preferred)	Big Eddy Substation	Knight Substation Site 1 (Preferred)	Knight Substation Site 2	Fiber Optic Cable – Loop Back Option	Fiber Optic Cable Wautoma Option (Preferred)	No Action Alternative
Fish	***No-to-low*** impact. Four fish-bearing streams would be crossed (same number as other action alternatives, although some would cross at different locations), but towers would be placed well away from the water's edge, no culverts would be installed, and no riparian trees would be removed. The Columbia and Little Klickitat rivers and Fifteenmile Creek have special-status fish species present where crossed, but construction work would not occur near these waterways. Culverts would be placed only in seasonal non-fish-bearing tributaries or dry washes.	***No-to-low*** impact. It would cross four fish-bearing streams, with no towers near streams, no culverts installed, and no riparian trees removed. There would be no impacts on special-status fish species where it crosses the Columbia and little Klickitat rivers and Fifteenmile Creek. An existing access road along Fifteenmile Creek would require upgrading; mitigation measures would ensure no sediment reaches the creek. Culverts would be placed only in seasonal non-fish-bearing tributaries or dry washes.	***No-to-low*** impact. It would cross four fish-bearing streams, with no towers near streams, no culverts installed, and no riparian trees removed. There would be no impacts on special-status fish species where it crosses the Columbia and little Klickitat rivers and Fifteenmile Creek. An existing access road along Fifteenmile Creek would require upgrading; mitigation measures would ensure no sediment reaches the creek. Culverts would be placed only in seasonal non-fish-bearing tributaries or dry washes.	***No*** impact because there are no fish-bearing waterways within or in the vicinity of the existing substation yard.	***No*** impact because no fish-bearing streams are in the vicinity.	***No*** impact because no fish-bearing streams are in the vicinity.	Same overall impact as the selected action alternative.	***No*** impact because all waterways and riparian areas would be avoided.	***No*** impact.
Cultural Resources	***Moderate*** impact. Would pass within 1 mile of 157 cultural resource sites, 11 of which are within the right-of-way. It would also cross through Homesteads of the Dalles Mountain Ranch Historic District and an area of the Columbia Hills that could contain unknown cultural resources. While surveys conducted before construction would help identify these, potential impacts on cultural resources are higher than the other action alternatives.	***Low*** impact. Would pass within 1 mile of 133 cultural resource sites, of which nine are within the right-of-way. It would also cross over an Oregon Trail segment (no longer visible) at two places. However, the most significant cultural site would be separated by a vertical distance that precludes disturbance.	***Low*** impact. Would pass within 1 mile of 123 cultural resource sites, of which 10 are within the right-of-way. It would also cross over an Oregon Trail segment (no longer visible) at two places. However, the most significant cultural site would be separated by a vertical distance that precludes disturbance.	***No*** impact because all work would occur within the existing substation yard; no sites are present.	***No-to-low*** impact because the likelihood of disturbing cultural resources on the site is minimal. There are no known cultural sites in the vicinity; limited archaeological testing on site found none.	***No-to-low*** impact because the likelihood of disturbing cultural resources on the site is minimal. There are no known cultural sites in the vicinity.	Same overall impact as the selected action alternative.	***Low*** impact because new ground disturbance would be minimal. (BPA is also surveying the area and consulting with Tribes.)	***No*** impact.
Socioeconomics	***Low*** impact on the local and regional economy. It would primarily impact agricultural land, removing a small portion from use and reducing revenues by a correspondingly small percentage. Landowners would be reimbursed for land required for new right-of-way or access roads. The state of Washington and Klickitat County would benefit from one-time tax gains from "use" taxes levied on transmission line materials. Impacts on property values would be variable and limited. There would be no impact on public services. For the West Alternative only: one tower option would permanently remove the Chenoweth-Goldendale line, which would have a ***moderate*** impact on the Klickitat County Public Utility District, which uses the line for backup service.	***Low*** impact, same as West Alternative.	***Low*** impact, same as West Alternative.	***No*** impact because all work would occur within the existing BPA owned substation yard.	***Low*** impact. While some of the overall 80-acre site would be removed from crop production, between 50-70 acres could be leased out for cultivation in the future. In addition, the landowner would be compensated if BPA buys the property. Loss in property taxes to Klickitat County would be minimal.	***Low*** impact. While about 30 acres of leased cropland would be removed from production, financial losses for the owner (Washington DNR) would be a small fraction of annual revenues. DNR would also be compensated if BPA buys the land. There would be no impacts on property taxes.	Same overall impact as the selected action alternative.	***No*** impact because no land would be taken out of production.	***No*** impact.

Resource	West Alternative	Middle Alternative	East Alternative (Preferred)	Big Eddy Substation	Knight Substation Site 1 (Preferred)	Knight Substation Site 2	Fiber Optic Cable – Loop Back Option	Fiber Optic Cable Wautoma Option (Preferred)	No Action Alternative
Transportation	***Low-to-moderate*** impact. Motorists could experience temporary delays during construction, although many Klickitat County roads in this area are lightly traveled. The project would require 21 miles of new access roads, 11 miles of existing access road upgrades, 5 miles of county road upgrades and 3 miles of temporary access roads. After construction, operations and maintenance traffic would be infrequent and minimal. The West Alternative would pass relatively close to two airports and have at least 11 towers exceeding 200 feet, considered an aviation hazard. The Federal Aviation Administration (FAA) would determine which towers require lighting/painting and which wires require marker balls.	***Low*** impact. Some motorists could experience temporary delays during construction. The project would require 19 miles of new access roads, 15 miles of existing access road upgrades, and 3 miles of temporary access roads. After construction, operations and maintenance traffic would be infrequent and minimal. At least five towers would exceed 200 feet and require FAA review for safety requirements.	***Low*** impact. Some motorists could experience temporary delays during construction. The project would require 16 miles of new access roads, 16 miles of existing access road upgrades, and 5 miles of temporary access roads. After construction, operations and maintenance traffic would be infrequent and minimal. At least eight towers would exceed 200 feet and require FAA review for safety requirements.	***No*** impact because construction and operations and maintenance vehicles would use existing roads to access the substation.	***Low*** impact. During construction, equipment would access the site by traveling on Knight Road to an adjacent county road -- likely Hill, Butts or Pine Forest road. A few local motorists may experience traffic delays. Permanent access would be from Knight Road, on which operations and maintenance traffic would be infrequent.	**Low** impact. During construction, equipment would access the site from Knight Road. A few local motorists may experience traffic delays. Permanent access would be from Knight Road, on which operations and maintenance traffic would be infrequent.	Same overall impact as the selected action alternative.	***No*** impact because the project would only require one crew and would use existing county roads and BPA access roads.	***No*** impact.
Noise	Temporary ***moderate-to-high*** construction noise impacts, which would affect a few residents or business owners at a time as crews complete line segments and move on. **Low** impacts from operations and maintenance of the line. Corona noise generated by the new conductors would be higher in foul weather and usually masked by ambient noise. Inspections by ground crews or helicopter would generate short-lived noise once or twice annually.	Temporary ***moderate-to-high*** construction noise impacts, same as West Alternative. **Low** impacts from operations and maintenance of the line, with the exception of one Wishram home that could be within 71 feet of the centerline (single-circuit option only) and may experience slightly higher noise impacts if corona is present on the line. Inspections by ground crews or helicopter would generate short-lived noise once or twice annually.	Temporary ***moderate-to-high*** construction noise impacts, same as West Alternative. **Low** impacts from operations and maintenance of the line, with the exception of one Wishram home that could be within 71 feet of the centerline (single-circuit option only) and may experience slightly higher noise impacts if corona is present on the line. Inspections by ground crews or helicopter would generate short-lived noise once or twice annually.	Temporary ***moderate*** construction noise impacts on a few nearby residents (***high***, if blasting is required). ***No*** noise impacts from operations and maintenance, because the substation's existing equipment and nearby transmission lines would remain the primary sources of environmental noise.	Temporary ***low-to-moderate*** construction noise impacts because there are no residences within 1,000 feet. ***No-to-low*** operations and maintenance noise impacts because the existing adjacent transmission line would remain the predominant source of environmental noise.	Same impacts as Site 1.	Same overall impact as the selected action alternative.	Temporary ***low*** construction noise impacts because of the few number of residents. ***No*** operations and maintenance noise impacts beyond those of the existing transmission line.	***No*** impact.
Public Health and Safety	***Low*** general safety impacts, because all safety standards would be followed during construction, operations and maintenance. Electric and magnetic field (EMF) impacts would be similar for each action alternative. Construction standards and grounding requirements would minimize potential nuisance shocks from electric fields near the right-of-way. Magnetic field levels at houses in the area would remain comparable to ambient levels.	***Low*** general safety impacts, same as the West Alternative. EMF impacts would be the same as the West Alternative, with one exception: if a single-circuit option were used, the Middle alternative would run within 71 feet of one home, potentially boosting magnetic fields there slightly over ambient levels, for a potentially higher impact on that one home.	***Low*** general safety impacts, same as the West Alternative. EMF impacts would be the same as the West Alternative, with one exception: if a single-circuit option were used, the East alternative would run within 71 feet of one home, potentially boosting magnetic fields there slightly over ambient levels, for a potentially higher impact on that one home.	***No*** general safety or EMF impacts beyond those already posed by the existing substation. Addition of the new 500-kV line would not incrementally increase EMF.	***Low*** general safety impacts, because all safety standards would be followed during construction, operations and maintenance. ***No*** EMF impact. EMF levels at the perimeter of the substation yard would reflect fields generated by the new 500-kV line; within several hundred feet, these fields would dissipate to ambient levels.	Same impacts as Site 1.	Same overall impact as the selected action alternative.	***Low*** general safety impacts, because all safety standards would be followed during cable stringing, operations and maintenance. ***No*** EMF impacts.	***No*** impact.

Resource	West Alternative	Middle Alternative	East Alternative (Preferred)	Big Eddy Substation	Knight Substation Site 1 (Preferred)	Knight Substation Site 2	Fiber Optic Cable – Loop Back Option	Fiber Optic Cable Wautoma Option (Preferred)	No Action Alternative
Air Quality	***No-to-low*** impact. Construction would generate temporary increases in windblown dust and exhaust emissions, but the amount would be small and comparable to that typically created by agricultural equipment in the area.	***No-to-low*** impact, same as West Alternative.	***No-to-low*** impact, same as West Alternative.	***No-to-low*** impact. Construction within the yard would generate temporary increases in windblown dust and exhaust emissions, but the amount would be small.	***No-to-low*** impact, same as action alternatives.	***No-to-low*** impact, same as action alternatives.	Same overall impact as the selected action alternative.	***No*** impact.	***No*** impact.
Greenhouse Gases	***Low*** impact. Removal or disturbance of trees, vegetation and soil, and exhaust from construction equipment and maintenance vehicles would incrementally increase carbon dioxide, methane and nitrous oxide emissions, but by a relatively small amount.	***Low*** impact, same as West Alternative.	***Low*** impact, same as West Alternative.	***Low*** impact. No trees or vegetation would be disturbed, because work would occur within the graveled substation yard. Emissions from construction vehicles would be minimal.	***Low*** impact, same as action alternatives.	***Low*** impact, same as action alternatives.	Same overall impact as the selected action alternative.	**No** measurable impact.	***No*** impact.

Table 2-8. Proposed Mitigation Measures for the Action Alternatives

Resource	Proposed Mitigation Measures
Land Use and Recreation	• Provide a schedule of construction activities to all landowners that could be affected by construction. • Limit construction to daylight hours, minimizing disturbance to those residents who work during the day. • Compensate landowners for any new land rights required for right-of-way or access road easements. • Compensate landowners for any damage to property during construction. • Compensate landowners for reconfiguration of irrigation systems due to placement of towers or access roads. • Restore compacted cropland soils to pre-construction conditions. • Work with landowners to determine mitigation measures needed to maintain CRP conservation status, if needed. • Follow applicable goals and objectives of the National Scenic Area Management Plan with guidance from the USFS and CRGC in the National Scenic Area. • Reseed disturbed areas (see mitigation measures in Vegetation). • Implement measures to reduce the possible spread of noxious weeds (see mitigation measures in Vegetation). • Implement measures to control dust (see mitigation measures in Geology and Soils) • Implement measures to control construction noise (see mitigation measures in Noise). • Minimize or eliminate public access to project facilities through postings and installation of gates and barriers at appropriate access points, and at the landowner's request.
Visual Resources	• Site all construction staging and storage areas away from locations that would be clearly visible from sensitive scenic areas, trails and scenic highways as much as practical. • Implement construction site maintenance and clean-up. Keep construction areas free of debris. • Provide regular maintenance of access roads and gates within and leading to the corridor. • Reseed disturbed areas (see mitigation measures for Vegetation). • Implement measures to reduce the possible spread of noxious weeds (see mitigation measures in Vegetation). • Implement measures to control erosion and dust (see mitigation measures in Geology and Soils, and Air Quality). • Implement measures to control construction noise (see mitigation measures in Noise).
Vegetation	• Locate towers and roads outside of priority ecosystems, high-quality vegetation communities, and areas of special-status plants as much as possible. Avoid these areas during construction (staging areas, pulling sites, etc.). • Avoid tree removal to the extent possible. • Cut or crush vegetation rather than blade in areas that would remain vegetated to maximize the ability of native plants to resprout. • Work with the appropriate state agency to mitigate impacts to federal species of concern or state-listed species if impacts are unavoidable.

Table 2-8. Proposed Mitigation Measures for the Action Alternatives

Resource	Proposed Mitigation Measures
	• Seed all disturbed areas to prevent colonization by weeds and facilitate reestablishment of the preconstruction plant community. Use approved (local Farm Service Agency) native seed mixtures in high quality vegetation communities and a combination of native and non-native seed in disturbed vegetation communities. Include the dominant native species from the impacted community in the seed mix. • Conduct invasive weed surveys prior to and following construction to determine potential weed spread and appropriate corrective actions. • Collaborate with the Klickitat County Weed Board or Wasco County Weed Department and landowners to determine and carry out the best control measures deemed locally effective. • Use certified weed-free mulch, if mulch is used for erosion control. • Pressure or steam wash vehicles and other equipment that have been in weed-infested areas at established wash stations upon leaving the infested areas to prevent spreading weeds to uninfected areas during construction. • Equip all vehicles with basic fire-fighting equipment, including extinguishers and shovels to prevent fires that could encourage weed growth.
Geology and Soils	• Minimize the project ground disturbance footprint, particularly in sensitive areas (i.e., steep slopes and landslides areas). • Prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) for construction activities to lessen soil erosion and improve water quality of stormwater runoff. • For the SWPPP, use management practices contained in the Storm Water Management Manual for Eastern Washington (e.g., use silt fences, straw bales, interceptor trenches, or other perimeter sediment management devices; place them prior to the onset of the rainy season and monitor and maintain them as necessary throughout construction). • Prepare a Fugitive Dust Control Plan to control dust. • Water or use palliatives on exposed soil surfaces in areas disturbed during construction. • Water, use palliatives, or cover construction materials if they are a source of blowing dust. • Gravel access road surfaces in areas of sustained wind and potential dust erosion. • Ensure construction vehicles travel at low speeds on access roads and at construction sites to minimize dust. • Limit the amount of time soils are left exposed. • Reseed disturbed areas (see mitigation measures in Vegetation). • Conduct additional site-specific evaluations in areas of potential landslides to determine degree of recent activity, likelihood of activation or reactivation, potential setbacks, and site-specific stability as appropriate. • Design roads to limit water accumulation and erosion; install appropriate access road drainage (ditches, water bars, cross drainage, or roadside berms) to control and disperse runoff.
Water Resources and Wetlands	• Minimize the project ground disturbance footprint, particularly in sensitive areas such as stream crossings and wetlands, and stream and wetland buffers. • Develop and implement a Spill Prevention, Control and Countermeasure Plan to minimize the potential for spills of hazardous material, including provisions for storage of hazardous materials and refueling of construction equipment outside of riparian zones, spill containment and recovery plan, and notification and activation protocols. • Prepare and implement a SWPPP (see mitigation measures in Geology and Soils) to improve water quality of stormwater runoff.

Table 2-8. Proposed Mitigation Measures for the Action Alternatives

Resource	Proposed Mitigation Measures
	• Prepare to manage dewatering, including proper disposal of drilling fluids and mud away from wetlands or surface waters. • Prepare for management of excess concrete. • Remove and dispose of sediment properly, away from wetlands or surface waters. • Install culverts for access roads in the dry season or during low-flow conditions if possible to minimize sediment delivery to streams. • Limit tracking of soil onto paved roads by gravelling road approaches, washing vehicle wheels, and cleaning mud and dirt from paved roads to reduce sediment delivery to roadside ditches and nearby streams. • Avoid use of heavy equipment and vegetation removal in wetlands and wetland buffer zones to avoid soil compaction, destruction of live plants, and potential alteration of surface water patterns. Use track equipment or matting, if appropriate. • Avoid placing staging areas in wetlands or stream buffers. • Avoid placing new access roads through wetland complexes around the Columbia River, Fifteenmile Creek, Little Klickitat River, Spring Creek, Swale Creek, and Blockhouse Creek to minimize the potential for altering surface water patterns and isolating connected wetlands. • Use high-visibility fencing around wetland buffer zones to avoid inadvertent activity (e.g., parking and driving) in wetlands or buffers or streams. • Reseed disturbed areas (see mitigation measures in Vegetation).

Wildlife	• Minimize the project ground disturbance footprint, particularly in special-status areas such as priority ecosystems, which can include riparian areas, wetlands, and grassland/shrub-steppe.
	• Avoid tree removal to the extent possible.
	• In locations where nests for special-status species have been identified, determine construction schedules through consultation with WDFW or Oregon Department of Fish and Wildlife to avoid breeding season disturbance. The following mitigation schedules will be considered:
	  ➢ Peregrine falcon—avoid construction activities within 0.25 mile of any active nests during the breeding season (March 15 through August 31).
	  ➢ Prairie falcon and golden eagle—avoid construction activities within 0.25 mile of active nests during the breeding season (February 15 through July 15).
	  ➢ Western gray squirrel—avoid construction activities within 400 feet of all nest trees during the breeding season (March 1 through August 31). Avoid blasting within 0.25 mile of nest trees during this same period. Protect all western gray squirrel nests and nest trees. Maintain a 50-foot no-cut buffer around each nest tree.
	• Install bird diverters on overhead ground wires in high risk areas (over river and stream crossings and near wetlands).
	• Prepare and implement a SWPPP and a Spill Prevention and Contingency Plan (see mitigation measures for Geology and Soils and Water Resources and Wetlands) to protect wetland habitats.
	• Reseed disturbed areas (see mitigation measures for Vegetation).
	• Prepare for fire control (see mitigation measures for Vegetation) to protect habitats.

Fish	• Minimize the project ground disturbance footprint, reseed disturbed areas, and install culverts during the dry season (see mitigation measures for Vegetation and Water Resources and Wetlands) to limit sedimentation affecting fish habitat.

Table 2-8. Proposed Mitigation Measures for the Action Alternatives

Resource	Proposed Mitigation Measures
	• Prepare and implement a SWPPP and a Spill Prevention and Contingency Plan (see mitigation measures for Geology and Soils and Water Resources and Wetlands) to protect and fish habitats. • Avoid blasting within 200 feet of fish-bearing streams.
Cultural Resources	• Locate transmission line towers and access roads to avoid cultural resources, where possible. • Use existing access roads where possible to limit possibility of new disturbances. • Consult with the Washington DAHP or Oregon State Historic Preservation Office (SHPO), as applicable, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation, state agencies (if sites found on state lands), and the USFS (if sites found on USFS land or within the National Scenic Area) regarding NRHP eligibility of cultural resources. • Develop an Inadvertent Discovery Plan that details crew member responsibilities for reporting in the event of a discovery during construction. This plan should include directives to stop work immediately and notify local law enforcement officials (if appropriate), appropriate BPA personnel, Tribes, USFS (if appropriate) and the Washington DAHP or Oregon SHPO if cultural resources are discovered. • Ensure cultural resource monitors are present during construction in the area of known cultural resources to monitor sites during excavation and to prevent unauthorized collection of cultural materials. • Prepare a mitigation plan to protect sites if final placement of project elements results in unavoidable adverse impacts to a significant cultural resource.
Socioeconomics	• Compensate landowners at market value for any new land rights for right-of-way or access road easements. • Compensate landowners for damage to property or crops during construction or operation and maintenance activities. • Compensate landowners for irrigation systems that must be reconfigured to accommodate new transmission infrastructure. • Consult with the NRCS and the Farm Service Agency to mitigate impacts to CRP land to maintain existing CRP status of lands and federal payments to landowners, where practicable. • Prepare for fire management (see mitigation measures in Vegetation).
Transportation	• Coordinate with Klickitat County roads department for upgrades of county roads. • Coordinate routing and scheduling of construction traffic with state and county road staff, Columbia River operators, and railroad operators. • Employ traffic control flaggers and post signs warning of construction activity and merging traffic, when necessary for short interruptions of traffic. • Conduct regular maintenance on access roads and gates within and leading to the corridor. • Prepare and implement a SWPPP (see mitigation measures in Geology and Soils) to prevent sediments from being transported onto adjacent roadways. • Limit tracking of soil onto paved roads (see mitigation measures in Geology and Soils). • Design roads to limit erosion (see mitigation measures in Geology and Soils). • Restore public roadways to preconstruction conditions upon completion of project construction activities.

Table 2-8. Proposed Mitigation Measures for the Action Alternatives

Resource	Proposed Mitigation Measures
	• Coordinate with the WSDOT Aviation Division and comply with FAA regulations for marking or lighting (including painting and/or lighting towers and installing marker balls on overhead ground wires in specific locations). • Consult with the owner of Piper Canyon Airport to ensure aircraft safety at Piper Canyon Airport.
Noise	• Ensure standard sound-control devices, including mufflers, are on all construction equipment and vehicles. • Limit construction activities to daytime hours. • Notify landowners located along the corridor prior to construction activities, including blasting.
Public Health and Safety	• Notify landowners located along the corridor prior to construction activities, including blasting. • If blasting is required, take appropriate safety measures and follow all state and local codes and regulations. Lock up or remove all explosives from work sites at the end of the workday. • Hold crew safety meetings at the start of each construction workday to review potential safety issues. • Prepare and implement a Spill Prevention, Control and Countermeasure Plan (see mitigation measures in Water Resources and Wetlands) to manage hazardous materials and respond to emergency situations. • Prepare and maintain an on-site safety plan in compliance with state requirements. • Prepare for fire control (see mitigation measures in Vegetation). • Fuel all highway-authorized vehicles off-site to minimize the risk of fire. Fueling of construction equipment that is transported to the site via truck and is not highway authorized will be done in accordance with regulated construction practices and state and local laws. Helicopters will be fueled and housed at local airfields or at staging areas. • Secure the site at the end of each workday to protect equipment and the general public. • Ensure that BPA contractors flying helicopters prioritize public safety during flights. For example, establish flight paths to avoid populated areas or schools (Helicopter Association International 1993). • Implement appropriate airport safety measures (see mitigation measures in Land Use and Recreation). • Clear vegetation according to BPA standards to avoid contact with transmission lines. • Report possible hazardous materials, toxic substances, or petroleum products discovered along the transmission line route that would pose an immediate threat to human health or the environment, including large dump sites, drums of unknown substances, suspicious odors, stained soil, etc.). • Adhere to appropriate specifications for grounding fences and other objects on and near existing and proposed rights-of-way. • Construct and operate the new transmission line according to the NESC. • Restore reception quality if radio or television interference occurs as a result of constructing the transmission line so that reception is as good as or better than before the interference.
Air Quality	• Prepare and implement a SWPPP (see mitigation measures in Geology and Soils) to limit erosion and dust generation. • Control windblown dust (see mitigation measures in Geology and Soils).

Table 2-8. Proposed Mitigation Measures for the Action Alternatives

Resource	Proposed Mitigation Measures
	• Reseed disturbed areas (see mitigation measures in Vegetation) to prevent dust from erosion. • Shut down idling construction equipment, if feasible. • Ensure all vehicles are in compliance with applicable federal and state air quality regulations for tailpipe emissions. Certification that vehicles meet applicable regulations will be provided by contractors to BPA in writing. • Maintain and certify in writing that all construction equipment is in proper working condition according to manufacturer's specifications. • Obtain rock and concrete from sources with appropriate environmental permits.
Greenhouse Gases	• Implement vehicle idling and equipment emissions measures (see mitigation measures in Air Quality). • Encourage carpooling and the use of shuttle vans among construction workers to minimize construction-related traffic and associated emissions. • Locate all staging areas as close to construction sites as practicable to minimize driving distances between staging areas and construction sites. • Locate staging areas in previously disturbed or graveled areas to minimize soil and vegetation disturbance where practicable. • Use the proper size of equipment for the job. • Use alternative fuels for generators at construction sites such as propane or solar, or use electrical power where practicable. • Reduce electricity use in the construction office by using compact fluorescent bulbs, and powering off computers every night. • Submit a plan for approval to recycle or salvage non-hazardous construction and demolition debris. • Submit a plan for approval to dispose of wood poles locally where practicable. • Use locally sourced rock for road construction.

Chapter 3
Affected Environment, Environmental Impacts, and Mitigation Measures

Overview

This chapter describes the existing environmental resources that could be affected by the project and the potential impacts that the project alternatives would have on those resources.

The transmission line routing alternatives, substation site options and fiber optic cable options define the project area. The affected environment and potential impacts were determined through research and field observations along the proposed transmission line routes and at the substation sites by environmental specialists, and from information provided in agency and public comments. Field surveys were conducted along the transmission line alternatives and Knight Substation sites in August 2009 and spring 2010. For each resource, potential mitigation measures to reduce or avoid impact are also identified. The resources that could be affected by the project include the following:

- Land Use and Recreation
- Visual Resources
- Vegetation
- Geology and Soils
- Water Resources and Wetlands
- Wildlife
- Fish
- Cultural Resources
- Socioeconomics
- Transportation
- Noise
- Public Health and Safety
- Air Quality
- Greenhouse Gases

In each of the resource sections in this chapter, the impacts associated with work needed at Big Eddy Substation, construction of the proposed transmission line, access roads, the fiber optic cable Loop Back Option, and Knight Substation are described. Because the Wautoma Option for the fiber optic cable would be in an area separate from the proposed transmission line, this option is discussed in a separate section (see Section 3.15 Fiber Optic Cable Options). This chapter concludes with EIS sections required by applicable NEPA regulations and guidance.

Determining Impacts

To determine the impacts of the proposed action alternatives, the area that would be permanently removed from use for tower and road bed footprints and the area of temporary disturbance during construction were calculated.

The tower footprint that would be removed permanently from use for single-circuit towers would be about 0.13 acre; the footprint for double-circuit towers would be about 0.17 acre. New road bed impact acreage was estimated based on an average road width of about 30 feet wide (smaller on straight runs, larger at turns and for steep grades). The same 30-foot width was used for upgrading existing roads, even though the road bed exists and upgrades would only involve grading, widening, and gravel. Upgrading existing roads would obviously not have as great an impact as cutting and blading-in new roads, but since the extent of improvements in specific locations is unknown at this point in project planning, the "worst case" amount of impact disturbance in acres is provided.

Temporary impacts would occur in construction areas surrounding new towers, including counterpoise, pulling and tensioning sites, and staging areas. The area of temporary impact at each tower site would about be about 0.5 acre for single-circuit towers and about 0.8 acre for double-circuit towers. Where an existing line would be removed, wood pole removal would disturb about 0.1 acre and lattice steel tower removal would disturb about 0.43 acre. The estimated 18 conductor tensioning sites that would be required for any of the alternatives would impact a total of about 14 acres.

The various options for each alternative use a combination of single-circuit and double-circuit towers (see Chapter 2). The impacted acreages in the resource sections are provided as ranges, representing the use of the different tower options. Because the single-circuit towers have a smaller footprint than double-circuit towers, options with the greatest use of single-circuit towers impact the least acreage, and options with the greatest use of double-circuit towers impact the most acreage; all other options fall between these two amounts. For options that include tower removal, those impact acreages are included as temporary impacts. Road locations would be the same for all options of a given alternative, so no ranges are provided for roads.

Some of the options for each alternative remove existing lines and build in the alignment of that line. Although the options that involve line removal show greater acreage amounts impacted because they include the removal disturbance and may involve double-circuit towers, overall impacts would tend to be less since tower footprints could be combined and right-of-way use would be less.

At the end of the description of impacts for each alternative there is a brief discussion of which option has the least or most potential impacts.

3.1 Land Use and Recreation

This section describes the land ownership and land use, including recreation, in and near the proposed project, and how the project alternatives could affect these resources.

3.1.1 Affected Environment

The proposed project is in Wasco County, Oregon, and Klickitat County, Washington. Some of the proposed project is in the National Scenic Area. Land potentially affected by the proposed project is predominately rural and privately owned, with some publicly owned and tribal lands (see Map 3-1 and Table 3-1).

BPA owns land around Big Eddy Substation and all alternatives cross BPA land as they exit the substation. The Middle and East alternatives cross two different USFS parcels in Washington. The Middle Alternative crosses a USFS parcel that does not have an existing BPA right-of-way. The East Alternative crosses a parcel with an existing BPA right-of-way.

The Middle and East alternatives cross tribal trust land: Warm Springs tribal land in Oregon, and Yakama tribal land in Washington. The tribal trust land is managed by the Bureau of Indian Affairs. The tribal trust lands crossed have existing BPA right-of-way, except for a Yakama parcel where the Middle Alternative climbs over the Columbia Hills.

The West Alternative crosses the most state-owned land: land managed by Washington Parks and Recreation (Parks) (Columbia Hills State Park), two DNR parcels (Columbia Hills Natural Area Preserve and agricultural leased land), and a parcel managed by the Washington Department of Fish and Wildlife (WDFW). BPA has an existing 100-foot wide right-of-way occupied by BPA's Chenoweth-Goldendale wood-pole line across these parcels. The West Alternative also crosses a DNR parcel leased for agriculture as the alternative heads toward Substation Site 2.

The Middle Alternative only crosses state land on the same DNR parcel crossed by the West Alternative as it heads to Substation Site 2.

The East Alternative crosses a DNR parcel used for wind production, and the DNR parcel crossed by the other alternatives as it heads to Substation Site 2.

Substation Site 2 is on DNR property that is leased for agriculture.

Line Mile References for Route Alternatives

References to specific areas on each route alternative refer to that specific alternative and the line mile of that alternative measured from Big Eddy Substation. Each alternative is distinguished by a letter - "W" for the West Alternative, "M" for the Middle Alternative, and "E" for the East Alternative. The line mile or range of line miles is given after the letter, for example, "W1" means West Alternative at line mile 1; M1 means Middle Alternative at line mile 1, etc. Longer segments are identified with a line mile range such as W1-5 (West Alternative, between line miles 1 and 5). Where alternatives share the same corridor, multiple letters are used, such as ME3-6 (Middle and East alternatives, between line miles 3 and 6).

Table 3-1. Public and Tribal Lands in the Project Area

Public Entity	Landowner/ Land Manager	Land Use	Location
Federal	BPA	Big Eddy Substation	W0, ME0
	USFS	Conservation and Dispersed Recreation	ME10–11
Tribal	Warm Springs and Yakama Tribes, Tribal Members	Tribal Trust Land: Agricultural	W3–4, ME3–4, ME8, M9–10, and E9–13
State	State of Washington, Parks and Recreation	Recreation and Conservation (Columbia Hills State Park)	W7–8
	State of Washington, DNR	Recreation and Conservation (Columbia Hills Natural Area Preserve)	W8.5–10.5
	State of Washington, DNR	Washington State Trust Lands – Leased Agriculture and Dispersed Recreation	W16–17, WM26, E28, Substation Site 2
	State of Washington, DNR	Washington State Trust Lands – Wind Power Production	E15
	State of Washington, WDFW	Conservation	W11

Columbia River Gorge National Scenic Area

The National Scenic Area was designated to protect and enhance the scenic, natural, cultural, and recreation resources of the Columbia River Gorge, while encouraging new growth to occur in existing urban areas (USFS 2010). As such, it has its own management plan that guides development and designates land uses in the National Scenic Area (CRGC and USFS 2007). In the National Scenic Area the West Alternative crosses land that is designated as urban area, large-scale agriculture, and special agriculture; the Middle and East alternatives cross two urban areas, large-scale agriculture, and tribal lands (listed as Bureau of Indian Affairs [BIA] lands). More information on the National Scenic Area and consideration of consistency with land use designations is provided in Chapters 5 and 7.

Agriculture

Farming is a dominant land use in Klickitat and Wasco counties. All route alternatives cross Prime Farmland and Farmland of Statewide Importance (NRCS 2009c), and both substation sites are on Prime Farmland. These classifications identify land most suitable for producing “food, feed, fiber, forage, and oilseed crops” as determined by the Natural Resources Conservation Service (NRCS) (Prime Farmland), and the states (Farmland of Statewide Importance) (NRCS 2007), and are based primarily on soil type.

Most land in the project area is rangeland. Livestock includes primarily cattle and sheep. The greatest concentrations of rangeland are found where the route alternatives cross the Columbia Hills, where the West Alternative runs northeast, and along the Little Klickitat River. (See Map 3-2 for the general land cover types in the area; see Map 3-3 for the land uses found along the project alternatives during field surveys.)

Cropland is found interspersed with rangeland along the alternatives in Oregon, where the route alternatives each cross through the Centerville Valley, and where they combine in one route to head to the substation sites. Cropland and rangeland are frequently intermingled, resulting in irregularly shaped fields. Most cropland is dryland wheat and barley, with wheat being the most common crop. Both substation sites are used for non-irrigated crops.

Irrigated cropland and pasture occur infrequently; two irrigated alfalfa fields were identified during surveys near line miles WM22 and E23 (see Map 3-3).

There are several small cherry orchards in Oregon crossed by the alternatives (line miles W0.5 and ME0.5) and a vineyard in Washington near Highway 14 crossed by the West Alternative (line mile W4.5).

Some agricultural land has been removed from production through the Conservation Reserve Program (CRP). Under this program, farmers receive annual rental payments to remove highly erodible or other sensitive land from production, and subsequently reestablish and maintain natural communities for a certain number of years (NRCS 2010). In Oregon, three landowners have property in CRP crossed by the Middle and East alternatives. In Washington, about 25 landowners with property crossed by the alternatives also have property in CRP (more specific information pertaining to CRP land crossed by the proposed alternatives in Washington was unavailable).

Residential

There are four population centers in the area: The Dalles, Oregon, and Goldendale, Wishram, and Centerville, Washington. Outside these population centers, low density residential development is generally associated with farms. Houses are located in Oregon near line miles W0.5, ME0.5, ME3.0, ME7, and in Washington near line miles ME9, W12-13, W17-18.5, W19.5, WM20-20.5, M13, M17, E22-23, and WME27 (see Appendix B for a map showing locations of houses within 800 feet of the route alternatives). There are also at least four subdivisions plotted with 20-acre residential lots near the Little Klickitat River along the Middle and West alternatives, and west of Knight Substation Site 2. There are few homes developed on these lots. (See Chapter 5 for information about county zoning.)

Industrial

Industrial facilities include The Dalles Dam, the Klickitat County Port District, and the Dallesport area of Klickitat County.

The eastern portion of the Columbia River Gorge is home to many wind power generation facilities. Klickitat County has designated much of the county as an Energy Overlay Zone. One wind project—Windy Flats—is located in the project area on the Columbia Hills north of the National Scenic Area boundary. The East Alternative crosses through Windy Flats where it is on DNR land at line mile E15 (see Map 3-3), and a potential expansion area for the project is located in the vicinity of the West and Middle alternatives.

Conservation and Recreation

Along the route alternatives, various lands are used to protect and conserve native habitats and rare species. The Columbia River and Columbia River Gorge are also host to a number of recreational activities including hiking, windsurfing, biking, kiteboarding, camping, fishing, boating, photography, picnicking, and wildlife viewing, with facilities managed by municipalities, counties, regional government, states, and the federal government.

Columbia Hills Natural Area Preserve. The West Alterative crosses the DNR-managed Columbia Hills Natural Area Preserve from about line miles W8.5–10.5. The preserve is dedicated, under the Washington Natural Area Preserves Act, to the preservation of high quality and rare natural areas, as well as threatened and endangered species as part of the Washington Natural Heritage Program (WNHP) (WNHP 2007, 2009b) (see Map 3-3). It covers about 3,600 acres north of Columbia Hills State Park and is the largest natural area preserve in Washington. The preserve contains lands that "represent the finest natural, undisturbed ecosystems in state ownership," and was established to "protect the highest quality examples of native ecosystems and rare plant and animal species" in the state of Washington (WNHP 2010). While preservation is its primary mission, the preserve is also used for research, education, and recreation. Recreation in the preserve consists primarily of hiking, wildflower viewing, and wildlife observation along The Dalles Mountain Road (WNHP 2009a).

USFS Land. The USFS has two parcels along the Middle and East alternatives (line miles M10 and E10). These parcels are managed for natural resource values and are open to the public for hiking, hunting, etc.

WDFW Lands. WDFW manages property that is used for conservation of plants and animals and is open to the public for recreation along the West Alternative at line mile W11.

Eckton Ranch. A private landowner donated permanent conservation easements on Eckton Ranch to the Columbia Land Trust, a nonprofit nature conservancy. The West Alternative crosses Eckton Ranch at line mile W18. The purpose of the conservation easements is to promote the long-term conservation of natural resources in the Little Klickitat River watershed while maintaining agricultural and rural residential uses (McEwen 2009).

Parks. Columbia Hills State Park, crossed by the West Alternative at about line miles W6.5–8.5, covers about 3,300 acres and has about 7,500 feet of Columbia River shoreline (Washington State Parks 2009). The park includes Horsethief Lake (a national historic site) and Dalles Mountain Ranch. The West Alternative crosses the Dalles Mountain Ranch portion of the park, which is managed for its natural, historic, and cultural resources, and used by the public for hiking and education. This recreation area is characterized by natural settings and scenic views. The proposed right-of-way would pass within about 0.3 mile of the ranch. In addition, the right-of-way would pass next to a parking area on the north end of the park.

The West Alternative would pass through portions of the park designated as Resource Recreation (the most common designation), and Natural Area (Washington State Parks and Recreation Commission 2003). Resource Recreation is a mid-intensity classification intended to allow recreational opportunities of a higher intensity, while still protecting the integrity of the natural landscape. The Natural Area designation is applied to areas identified as supporting rare or sensitive native plants or important wildlife habitat, and is intended to emphasize protection and enhancement of the natural environment through increased management efforts.

The following parks are in the vicinity of the project, but are not crossed by the project alternatives (see Map 3-1):

- Spearfish and Little Spearfish Lake, both about 0.5 mile southwest of the West Alternative in the southwest portion of the project area, provide shore-based and small-boat fishing opportunities. Access to the lakes is provided through Spearfish Park, managed by the Army Corps of Engineers (Corps). The park contains a boat ramp and picnic area.
- Seufert Park is the home of The Dalles Dam Visitor Center on the Oregon side of the Columbia River about 1.5 miles southwest of the West Alternative. The park is operated by the Corps.

- Hess Park is a small day-use park on the Washington side of the Columbia River off U.S. Highway (U.S.) 197 about 1.5 miles southwest of the West Alternative near the Klickitat Port District complex adjacent to The Dalles Dam.
- Celilo Park is a popular local launch location for windsurfers and kiteboarders about 1 mile east of the Middle and East alternatives.
- Riverfront Park (about 3 miles west of Big Eddy Substation), Avery Recreation Area (about 3 miles west of the Middle and East alternatives), Sorosis Park (about 3 miles west of Big Eddy Substation), Thompson Park (about 2 miles west of Big Eddy Substation), Deschutes River State Park (about 2.5 miles south of the Middle and East alternatives), and Goldendale Observatory State Park (about 2.5 miles east of all three route alternatives) are parks 2 or more miles from the nearest alternative.

Trails. The Klickitat Trail was established by the National Rails-to-Trails Conservancy and follows the historical route of the first railroad connecting Lyle and Goldendale (see Map 3-3). The West Alternative crosses the trail at line mile W11. The trail is now jointly managed by Washington State Parks, the USFS, and the Klickitat Trail Conservancy. The 31-mile trail offers scenic views and opportunities for hiking, mountain biking, bird-watching, and fishing (Klickitat Trail Conservancy 2009). It follows parts of both the Klickitat River and Swale Creek Canyon through the southwestern portion of the project area.

The Lewis and Clark National Historic Trail, managed by the National Park Service (NPS), follows the course of the Lewis and Clark Expedition along the Columbia River. Although there is no physical evidence of the expedition, historical markers can be found at Celilo Park, the Maryhill Museum of Art, and Columbia Hills State Park. Both State Route (SR)-14 in Washington and Interstate (I)-84 in Oregon are part of the Lewis and Clark National Historic Trail driving route (NPS 2009). All three transmission line alternatives cross SR-14 and I-84.

The Oregon National Historic Trail, which follows the historic Oregon Trail, passes south of the project from Biggs Junction to The Dalles. The trail passes through The Dalles to the south of Big Eddy Substation. Nearby trail sites include the Deschutes River Crossing at the Deschutes River State Park and the wagon ruts near Biggs Junction near the intersection of US-97 and I-84 (NPS 2006).

Private and Informal Recreation. Opportunities for informal recreational activities are plentiful. The Columbia River, the Little Klickitat River and Swale Creek in Washington, Fifteenmile Creek in Oregon, and other smaller waterways in both states provide opportunities for boating, swimming, and fishing. DNR lands that are leased for agricultural use are also available for dispersed recreation. Areas that could be used for wildlife observation, hiking, biking, hunting, and other outdoor activities also occur throughout the area on private lands.

Two private facilities open to the public occur in the southeastern portion of the project area along SR-14 just south of the East Alternative near line mile E14. The Maryhill Winery operates an onsite tasting room, hosts outdoor concerts, and is available for weddings and other social events (Maryhill Winery 2009). The Maryhill Museum of Art and its 6,000-acre property are listed on the National Register of Historic Places, and as official sites on the Lewis and Clark National Historic Trail (Maryhill Museum of Art 2009). The property includes several outdoor art installations, a series of gardens, a replica of Stonehenge, and the Klickitat County War Memorial.

Scenic Byways. The following national scenic byways occur in the project vicinity:

- SR-14 in Washington is designated both as the Columbia River Gorge Scenic Byway within the National Scenic Area (also designated as a National Forest Scenic Byway and All-American Road), and the Lewis and Clark Trail Highway from about Maryhill to west of the project area (National Scenic Byways Program 2009a). SR-14 is crossed by all three alternatives.

- U.S. Highway (US)-30 in Oregon is designated as the Historic Columbia River Highway. None of the action alternatives cross over the Historic Columbia River Highway, which ends about 2 miles west of Big Eddy Substation.
- US-97 in Oregon is designated as the Journey through Time Scenic Byway (also designated as the Yakama Scenic Byway in Washington). None of the alternatives cross over US-97, which is about 3 miles east of the East Alternative.

3.1.2 Environmental Consequences

General impacts that would occur for all route alternatives are discussed in this section, followed by impacts unique to each alternative.

Common Impacts

Impacts on land use would include limitations of use within the right-of-way, removal of land from use due to tower footprints, roads, and Knight Substation, disruption of use due to the presence of the line through properties, and disturbance during maintenance and construction activities.

Use limitation within the right-of-way would include keeping the right-of-way clear of all structures, fire hazards, tall-growing vegetation and any other use that may interfere with the safe operation or maintenance of the line. Buildings or swimming pools could not be constructed with the right-of-way.

Most crops less than 10 feet high could be grown safely under the transmission line. However, orchards, Christmas trees, tall-growing landscape or natural vegetation, and crops supported by structures (e.g., trellises) would not be allowed within the right-of-way. Existing orchards, vineyards, and slow-growing trees may be allowed to remain if the line could be designed to accommodate them. Trees outside of the right-of-way that have the potential to fall or grow close enough to the conductors to cause an electrical arc would also be removed.

Many uses would not be restricted, but certain precautions would need to be taken, for example, no object should be raised higher than 14 feet above the ground within the right-of-way (i.e., when moving irrigation pipes, they should be kept low and parallel to the ground); ground elevation should not be altered (such as piling of dirt within the right-of-way); irrigation spray should not create a continuous stream onto the conductors or towers; fences should be grounded; and installing underground pipes or cables through the right-of-way needs to be coordinated with BPA so that they do not interfere with transmission line grounding systems. Vehicles and large equipment that do not extend more than 14 feet high, such as harvesting combines, cranes, derricks and booms could be operated safely under the line where it passes over roads, driveways, parking lots, cultivated fields or grazing lands. See Section 3.12 for safety issues and Appendix A for details about living and working safely around high-voltage power lines.

Rangeland tends to be compatible with transmission lines, because animals would be able to graze within the right-of-way. Although tower footprints and road beds would occupy land and remove that area of vegetation from grazing, livestock could still maneuver around the towers and roads to access their range. As with most land uses, disturbance during construction and vegetation removal could introduce or spread noxious weeds. Noxious weed infestations would impact rangeland quality and potentially harm sheep and cattle. (See Section 3.3 Vegetation for more discussion about noxious weeds and their presence along the alternatives.)

As part of the access road system, existing gates would be used or new gates would be installed at property boundaries. During construction and line maintenance, workers would need to take care to ensure that gates are closed and not let livestock escape. (Please see Section 3.10 Transportation for a discussion about potential increased trespass.)

Growing crops also would be generally compatible with the transmission line, but with more restrictions than rangeland. Crops would be allowed within the right-of-way, but as with rangeland the tower footprints and road beds would remove acreage from production. Working with the landowner, BPA would try to locate access roads along fences, using temporary construction access across fields to the tower locations. Temporary roads would be removed after construction and the land could be cultivated.

Towers would create an obstacle to till and work around, and if irrigation is used, it may need to be modified such that pipes may maneuver between the towers. Crop dusting would also be more difficult and dangerous with a transmission line crossing the field. Since the area around towers would not be tilled, these areas could become infested with noxious weeds, creating a seed source for contaminating the field in which the tower is located.

Depending on the time of year construction would occur in a particular area, crops could be damaged within the temporary construction footprint. Heavy machinery, materials on the ground, trenches for counterpoise, etc. would damage crops and compact soils, causing a temporary loss of soil productivity. The damage would depend on the type of crop (vineyards, orchards, annuals), the season (during summer growing season, harvest, or dormant winter), and if the land was in use or fallow. Compensation would be given for crop loss during construction (see Section 3.9 Socioeconomics).

During construction, livestock grazing, farming, and crop dusting in the area would have to be temporarily restricted to avoid conflicts between livestock or farm equipment and construction equipment.

CRP lands could potentially be impacted by locating a transmission line across those properties. Change in status would affect payments landowners would receive. However, the FSA Handbook Agricultural Resource Conservation Program for State and County Offices (USDA 2008) allows for CRP lands to be crossed by public utilities provided the county committee approves the use and the use is certified to have a minimum effect (vegetative cover is restored and impacts on erosion, wildlife and wildlife habitat, water, and air quality are kept to a minimum). In the unlikely event that the use was not approved, BPA would compensate for the affected acreage. Since BPA would work with landowners to provide information and mitigation measures to maintain CRP status, or provide compensation if the usage was not allowed, there would be ***no-to-low*** impacts on CRP lands for all route alternatives.

Residents that would be near the transmission lines would be limited from placing houses or outbuildings and from planting vegetation (that could grow above 10-feet tall at maturity) within the 150-foot right-of-way. The transmission line would also potentially create other possible issues for residents, such as impacts to views from homes, or concerns about property values and electric and magnetic field exposure (please see Sections 3.2 Visual Resources, 3.9 Socioeconomics, and 3.12 Public Health and Safety for more detailed discussions on these topics).

During construction activities residents would be disturbed by noise, dust, and traffic (please see Sections 3.10 Transportation, 3.12 Public Health and Safety, and 3.13 Air Quality for more detailed discussions on these topics).

Impacts of the project on recreation would occur if tower or road placement changed the recreational function by limiting the use or requiring the removal of facilities such as picnic areas, boat ramps, trails, access, etc. However, most impacts to recreation would be experiential; visual intrusions to the scenic character of the area (see Section 3.2 Visual Resources). These experiential impacts would occur at specific recreational sites and for general dispersed or informal recreational uses. Temporary construction activity could delay access to sites or impact a person's experience through noise, dust, and traffic.

Conservation uses would be impacted if the alternatives affected protected species or habitats.

Maintenance of the transmission line would disrupt land use through noise, truck traffic, and potential crop damage. Twice each year helicopter flyovers would cause temporary noise that could disturb grazing animals and people living, working or recreating along the transmission line. Annual ground inspections of the line may be noticeable to landowners as crews drive on access roads and walk to towers. In fields, where temporary roads would be removed and converted back to agricultural use after construction, maintenance personnel would walk to access the line, with little impact to the crop. If repairs would be required (e.g., insulators changed), then trucks would have to drive through fields to get equipment to the towers. The landowner or lessee would be compensated for crop damage. Equipment noise during repairs may be noticeable. Vegetation management activities would also require personnel to drive along the access roads or walk the right-of-way to determine vegetation clearing needs. Cutting trees with chainsaws and removing debris would cause noise and dust.

Overall, maintenance impacts for the alternatives would be ***low*** because the activities would not change land use; would be short term and limited to noise, dust and a small amount of vehicle traffic; there are few if any areas along the alternatives that would require tree removal on a regular basis; and BPA would compensate for crop damage.

BPA access roads could potentially create an avenue for unauthorized access onto properties. At the request of landowners, BPA would place gates at the entrance of access roads to prevent public access onto properties and the project corridor. There is the potential that even with gates, unauthorized access and use of the right-of-way and adjacent properties could occur. Washington DNR, which manages various state lands that would be crossed by all the alternatives, has raised concerns about potential impacts to state lands from this unauthorized access and use. Because transmission line corridors are linear facilities that typically can be accessed fairly easily by the general public, DNR is concerned that the project could contribute to unauthorized use and damage to state lands and public resources on these lands. DNR also is concerned that gates by themselves are not sufficient to prevent unauthorized access and use to its lands where the project and associated roads would be present.

In general, potential impacts from unauthorized public access and use include increased soil erosion, fire danger, introduction of noxious weeds, and illegal dumping, as well as disturbance of vegetation, wildlife and their habitat, and cultural resources. Increased soil erosion could occur from unauthorized uses such as off-road vehicles and other unmanaged recreational activities accessing areas and disturbing the soils that are present, which can lead to erosion of these soils from rainfall and other events. Over time, unauthorized uses of gravel or dirt roads in the vicinity of the project corridor also could lead to accelerated deterioration of these roads through disturbance and erosion. Increased fire danger can result from activities by unauthorized users on or near the project from a variety of means, such as campfires, lit cigarettes, and vehicle exhaust systems coming into contact with vegetation. Potential impacts from soil erosion and increased fire danger are discussed in Sections 3.4 Geology and Soils, and 3.12 Public Health and Safety.

The potential introduction of noxious weeds from unauthorized public access and use can primarily occur from unauthorized vehicles inadvertently transporting and spreading seeds of noxious weeds into the project corridor and adjacent lands. Soil disturbance from these vehicles increases the potential for the introduced noxious weeds to become established in these disturbed areas. Impacts associated with the introduction of noxious weeds are discussed in Section 3.3 Vegetation.

Unauthorized access and use also can potentially disturb vegetation, wildlife and their habitat, and cultural resources. Vegetation and wildlife habitat can be disturbed by unauthorized vehicles driving over and crushing or uprooting plants, as well as by any vegetation clearance associated with an unauthorized use. Wildlife can be disturbed or displaced by the presence of and noise from unauthorized uses, and these uses can increase stress, disruption of normal foraging and reproductive habits, abandonment of unique habitat features, and energy expenditure of wildlife species in the area. Cultural resources can be disturbed by the damaging of known or previously undiscovered cultural resource sites or the unauthorized collection of artifacts or other cultural resources. Potential impacts associated with disturbance of vegetation, wildlife and their habitat, and cultural resources are discussed in Sections 3.3 Vegetation, 3.6 Wildlife, and 3.8 Cultural Resources.

To address DNR's concerns about unauthorized access to its lands as a result of the project, BPA would continue to work with DNR concerning possible avenues for controlling or minimizing the potential for unauthorized public access and use on state lands. Because BPA would use mitigation measures to decrease the potential for unauthorized public access and use and occurrences of this type of activity would generally be infrequent, impacts from unauthorized public access and use would be ***low***.

Because the work at Big Eddy Substation would be limited and within the existing fenced electrical yard, there would be no change in land use (use would continue to be electrical/industrial use). During construction, activities would create short-term noise and some increased traffic from workers and equipment delivery that could disturb local residents or other landowners. However, the existing substation yard is somewhat isolated on a hill about a quarter mile from the nearest residence. No recreation areas would be affected by work at Big Eddy Substation because none are close enough to see or be within earshot of construction activities. Overall, there would be ***no*** land use impacts for work at Big Eddy Substation because land uses would not change and construction disturbance would be isolated and temporary.

West Alternative

The West Alternative would follow existing BPA right-of-way for about 16 of its 27 miles. Between 233 and 432 acres of new right-of-way easement would need to be acquired: 233 acres for options that remove the existing Chenoweth-Goldendale line and use the existing 100-foot easement (West Options 2, 3, 4 and 5), and 432 acres if the proposed line were to be built parallel to the existing line (Option 1). The options that would use the existing right-of-way would require the least amount of new easement of all the route alternatives, whereas building the line parallel would require the greatest amount of new right-of-way of all the route alternatives (see Table 3-2). Easements would also be acquired for new access roads (see Table 3-3).

As with all the action alternatives, the right-of-way for the West Alternative would occupy more acres of private land than any other land use category. The West Alternative also would occupy the most acreage of state-owned land; about 31-106 acres of state land would need to be acquired for the transmission line right-of-way, depending on the line option and whether the route would go to Substation Site 1 or 2. Since the West Alternative would not cross tribal trust land, no right-of-way would be required across tribal land with this alternative. The only right-of-way across federal land under the West Alternative would be located on the BPA-owned land that surrounds Big Eddy Substation.

Table 3-2. Approximate Transmission Line Lengths and New Right-of-Way by Land Ownership and Action Alternative

	West Alternative		Middle Alternative		East Alternative	
Landowner	Miles of Line	New Right-of-Way (acres)	Miles of Line	New Right-of-Way (acres)	Miles of Line	New Right-of-Way (acres)
Private[1]	**20 (+1)**	**187–325 (+14)**	**24 (+1)**	**251–275 (+14)**	**24 (+1)**	**233–244 (+14)**
Federal	**0.4**	**1**	**1.0**	**9.7**	**0.8**	**0.7**
BPA	0.4	1	0.5	0.7	0.5	0.7
USFS	0	0	0.5	9.0	0.3	<0.1
Tribal	**0**	**0**	**1.1**	**9.0–9.8**	**1.6**	**0.8–1.3**
Warm Springs	0	0	0.6	0–0.8	0.6	0.8
Yakama	0	0	0.5	9	1.0	0-0.5
State[1]	**5.1 (+1)**	**31–92 (+14)**	**0 (+1)**	**0 (+14)**	**0.5 (+1)**	**9 (+14)**
Parks	1.8	11–33	0	0	0	0
DNR[1]	3 (+1)	18–54 **(+14)**	0 (+1)	0 **(+14)**	0.5 (+1)	9 **(+14)**
WDFW	0.3	2–5	0	0	0	0
Total	**27**	**233–432**	**27**	**270–309**	**28**	**244–269**
National Scenic Area	**9.5**	**72-119**	**5.5**	**40-43**	**7.5**	**1-5**

Note: An additional 1 mile of line and 14 acres of right-of-way would be needed for the last portion of the route going into the Knight Substation Site for all three route alternatives, which would be added to the private lands category for Site 1 and State DNR lands category for Site 2. Substation site acreages are not included (see Knight Substation Options in this section).

Table 3-3. Permanent Access Road Miles by Land Ownership and Action Alternative

	West Alternative			Middle Alternative			East Alternative		
Landowner	New	Upgrade Existing	Total	New	Upgrade Existing	Total	New	Upgrade Existing	Total
Private	**17**	**11**	**28**	**17**	**15**	**32**	**13**	**14**	**27**
Federal	**1**	**<0.1**	**1**	**3**	**<0.1**	**3**	**1.8**	**0.4**	**2.2**
BPA	1	<0.1	1	2	<0.1	2	1.7	<0.1	1.7
USFS	0	0	0	1	<0.1	1	0.1	0.4	0.5
Tribal	**0**	**0**	**0**	**0.9**	**0.8**	**1.7**	**1.3**	**2.7**	**4**
Warm Springs	0	0	0	0.4	0.5	0.9	0.4	0.5	0.9
Yakama	0	0	0	0.5	0.3	0.8	0.9	2.2	3.1
State	**4**	**5**	**9**	**0.7**	**0.1**	**0.8**	**0.8**	**0.1**	**0.9**
Parks	1	2	3	0	0	0	0	0	0
DNR	3	3	6	0.7	0.1	0.8	0.8	0.1	0.9
WDFW	<0.1	0	0	0	0	0	0	0	0

The West Alternative would have the longest amount of proposed line in the National Scenic Area; about 9.5 miles of line, which would require about 72-119 acres of new right-of-way. See Chapter 7, National Scenic Area Standards, for amounts of impact on the land uses within the National Scenic Area, and a discussion of project consistency with National Scenic Area land use designations crossed by the West Alternative.

Agriculture

The West Alternative would impact lands classified as farmlands of statewide importance and prime farmland. The tower and road footprints would remove about 38-51 acres of farmlands of statewide importance in Klickitat County, which is about 0.04 percent of land in this classification in the county, and about 4 acres in Wasco County, which is less than 0.001 percent of land in this classification in the county. Impacts to prime farmland would be about 12 acres in Klickitat County, which is less than 0.01 percent of land in this classification in the county, and about 1 acre in Wasco County, which is less than 0.3 percent of land in this classification in the county.

About 78–95 acres of rangeland would be removed from use due to tower footings and access roads (see Table 3-4), and an additional 33–84 acres of rangeland would be temporarily disrupted during tower construction.

Table 3-4. Impacts on Land Use by the West Alternative

	Permanent Impacts				Temporary Impacts		
	Towers[1] (acres)	New Roads (acres)	Upgraded Existing Roads (acres)	Total Permanent Impacts per Land Use (acres)[1]	Towers[1,2] (acres)	Temporary Roads (acres)	Total Temporary Impacts per Land Use (acres)[1]
Irrigated Cropland	0.1–0.2	0.3	0	**0.5**	0	0	**0**
Nonirrigated Cropland	2–4	8	0.3	**10–12**	7–12	9	**16–21**
Orchards/ Vineyards	0	0.2	<0.1	**0.2**	0	0	**0**
Rangeland	11–28	52	15	**78–95**	33–84	0	**33–84**
Conservation/Recreation	3–9	11	9	**23–29**	9–27	0	**9–27**
Totals by Type of Impact	**16–41**	**29**	**35**	**112–137**	**48–122**	**9**	**57–131**
National Scenic Area	6–14	23	23	**52–60**	17–41	1	**18–42**

[1] Impacts are presented as ranges from all possible tower options. Double-circuit options would have the greatest impacts from towers.
[2] The “Temporary Tower Impacts” column provides the total of the temporary tower construction impacts and removal of existing towers when applicable).

About 10–12 acres of nonirrigated cropland would be permanently taken out of production by tower footings and access roads, with an additional 16-21 acres temporarily impacted during construction. For options in which the proposed line would parallel the existing Chenoweth-Goldendale line, the towers would not be next to each other because the span length of the proposed line would be longer than that of the wood-pole line. Towers would be staggered, which would create more obstacles to farm around. For options in which the wood-pole line would be removed, existing farming conditions could actually be improved because, although the footprint of the proposed tower would be larger than the existing wood-pole line, the proposed line may be able to span fields more easily.

The small amount of irrigated cropland found along the West Alternative at line mile W21.5 would potentially be impacted by about 0.3 acre of new access road. Irrigation would likely be able to continue under the right-of-way without reconfiguration as the existing Chenoweth-Goldendale line already crosses the area.

Other agricultural impacted would include an orchard near line mile W1 and a vineyard between line miles W4 and W5. About 5 poplar windbreak trees would have to be removed where the line would cross over the orchard. The gap in trees could affect the orchard through increased exposure, but would not be on a side that sustains heavy winds. The vineyard could be impacted by about 0.2 acre of access road, but no plants would be removed.

Residences

The West Alternative would pass within 800 feet of 17–24 houses (see Appendix B). There are no houses within the proposed right-of-way, so none would need to be removed or relocated. However, in Oregon at line mile W0.5 a large outbuilding within the existing easement could potentially need to be relocated depending on whether the existing easement could be adjusted. About four houses would be within 300 feet of the new line, which could mean that the right-of-way would pass through parts of the property used for residential purposes. Some of these houses have the existing Chenoweth-Goldendale line encumbering the properties. About line mile WM25.5, a house within 330 feet of the proposed line would likely have residential uses impacted (no buildings, tall trees, etc.) by a new 150-foot wide right-of-way. Impacts to these properties would be less for the options that would use the existing right-of-way with a 50-foot wide addition (Options 2, 3, 5), than for the options that would parallel the existing Chenoweth-Goldendale line (Options 1 and 4) that would require an additional 150-wide right-of-way.

The West Alternative would also cross 17 of the 20-acre parcels being sold as residential lots along the Little Klickitat River from about line miles W17.5–21.5 (see parcel divisions on Map 3-1). These properties are presently encumbered by the existing Chenoweth-Goldendale line and the amount of additional encumbrance would depend on the option – less for Options 2, 3, and 5 and greater for Options 1 and 4.

During construction, noise and dust could impact residents in the area to some extent, with greater impacts the closer a home is to the proposed tower or road work.

Conservation and Recreation Lands

The West Alternative would impact the most parks, preserves, and conservation lands of the route alternatives. About 23–29 acres of land managed for conservation or recreation would be converted to tower footings and access roads (Table 3-4) and another 9–27 acres would be temporarily disrupted due to construction.

The West Alternative would require the installation of about 10 towers and 2 miles of line in Columbia Hills State Park and in the adjacent Columbia Hills Natural Area Preserve. In addition, new roads would be required and existing BPA roads that access the existing Chenoweth-Goldendale line through these areas would be upgraded (widened, bladed, graveled). The towers and roads would be located such that they would not impact the function of either the park or preserve; facilities would not be affected and recreational activities would not be restricted. However, because the proposed line would add an industrial, human-made element to the area, there would be experiential impacts to recreationists (see Section 3-2 Visual Resources). In addition, the proposed line would impact areas within both the park and preserve that support sensitive native plants and wildlife habitat and are managed for protection and enhancement of these natural environments. Towers and roads would remove some sensitive plant species designated for protection (see Section 3-3 Vegetation and Section 3-6 Wildlife for more information).

About 0.25 mile of the West Alternative would cross a corner of the Eckton Ranch conservation property near line mile W18. At least one tower and some access road work would be required on the property. Tower options 1 and 4 (alignment parallel to the existing line) would remove about 10 ponderosa pine trees in this location, whereas Options 2, 3, and 5 would not remove any trees. No sensitive plant species or habitat would be affected on this property and agricultural uses would be able to continue, though with some additional obstacles (especially for Options 2, 3, or 5).

The WDFW land crossed by the West Alternative at line mile W11 would likely have one tower and about 0.25 mile of right-of-way on the property. Although the proposed line would encroach on the conservation use of this area, the one special-status species found in this area would not be impacted (see Section 3-3 Vegetation).

Although the West Alternative would cross the Klickitat Trail at Swale Creek (near line mile W11) and parallel the trail (within about 500 feet) for about 0.3 mile, the trail would remain unaltered. However, the proposed line would create experiential impacts to hikers and bikers along this short segment of trial, degrading their experience of the natural environment.

There would be no functional impacts to informal recreational uses (biking, swimming, hunting, etc.) along the West Alternative, but the recreational experience of those participating in these activities in the vicinity likely would be affected by the presence of the proposed new line.

The quiet and scenic landscape of the recreational areas crossed would be disturbed by construction activities, but facilities would still be accessible.

In summary, the West Alternative would remove acreage from range and crop land, but use could continue; slightly impact an orchard and not substantially impact a vineyard; restrict residential use in the right-of-way, but not remove any homes; and impact conservation efforts of the Columbia Hills State Park and the Columbia Hills Natural Area Preserve by permanently removing sensitive species designated for conservation. Although all land uses would be impacted, most are abundant in the surrounding area. Because the Columbia Hills State Park and the Columbia Hills Natural Area Preserve are designated to protect established resources specific to that area, impacts would be great. Therefore, overall impacts of the West Alternative on land use would be ***moderate-to-high.***

Although still a moderate-to-high impact, the option that would remove the existing wood-pole line and use single-circuit towers in the existing alignment (West Option 3), would have the least impact of the tower options because it would have a smaller tower footprint, require the least amount of additional right-of-way, lessen the number of towers to navigate around during farming activities, and allow returned use of fields and grazing where the wood-pole structures are currently located. The options that would parallel the existing Chenoweth-Goldendale line (West Options 1 and 4) would have the greatest impact because they would require the greatest amount of new right-of-way and would create staggered towers across agricultural fields. The amount of impacts of West Options 2, 5, and 6 would be between these options.

Middle Alternative

The Middle Alternative would follow existing BPA right-of-way for about 9 of its 27 miles. Between 284 and 309 acres of new right-of-way easement would be acquired (see Table 3-2); 284 acres for the option that would rebuild the existing Harvalum-Big Eddy line with double-circuit towers (Option 3), 309 acres for the option that would parallel that line (Option 1). Acreage for Option 2 (which is a mix of the single and double-circuit towers along the existing lines) falls between these two acreages. Even if the line paralleled the Harvalum-Big Eddy line, there is vacant adjacent easement and only 12.5 feet of additional right-of-way width would be required. The remainder of the Middle Alternative would require a new 150-foot wide right-of-way. Easements would also be acquired for new access roads (see Table 3-3).

As with all the action alternatives, the right-of-way for the Middle Alternative would occupy more acres of private land than any other land use category. The Middle Alternative would not occupy any state-owned land if the route goes to Substation Site 1; if the Middle Alternative goes to Substation Site 2, the transmission line right-of-way would occupy 14 acres of easement across state land. About 0.6 miles of the Middle Alternative would cross Warm Springs Tribal trust land; about 12.5 feet of additional right-of-way (0.8 acres) would be occupied for options that parallel the existing line in this area (Options 1 and 2). In Washington, about 0.5 miles of Yakama Tribal trust land would be crossed where there is no existing line, requiring about 9 acres of new right-of-way. Federal land that would be crossed includes BPA-owned land surrounding Big Eddy Substation and about 0.5 miles of USFS land. There is no existing line across this USFS land, so about 9 acres of right-of-way would be obtained.

The Middle Alternative would have the shortest amount of proposed line in the National Scenic Area; about 5.5 miles of line would require about 40-43 acres for new right-of-way. See Chapter 7, National Scenic Area Standards for acreages of impact on the land uses within the National Scenic Area and a discussion of project consistency with National Scenic Area land use designations crossed by the Middle Alternative.

Agriculture

The Middle Alternative would impact lands classified as farmlands of statewide importance and prime farmland. The tower and roads footprints would remove about 23 acres of farmlands of statewide importance in Klickitat County, which is less than 0.005 percent of land in this classification in the county, and about 8 acres in Wasco County, which is less than 0.002 percent of the land in this classification in the county. Impacts to prime farmland would be about 15 acres in Klickitat County, which is about 0.01 percent of land in this classification in the county, and about 3 acres in Wasco County, which is about 0.8 percent of land in this classification in the county.

About 73–74 acres of rangeland would be removed from use for tower footings and access roads, and an additional 31–47 acres of rangeland would be temporarily disrupted during project construction (see Table 3-5).

The Middle Alternative would impact the most cropland of all the route alternatives. About 24–25 acres of nonirrigated cropland would be permanently taken out of production by tower footings and access roads, and another 25–27 acres of nonirrigated cropland would be temporarily disrupted during project construction. The small amount of irrigated cropland found along the Middle Alternative at line mile WE21.5 (the same irrigated land that the West Alternative would impact), would potentially be impacted by about 0.5 acre of new access road. Irrigation would likely be able to continue under the right-of-way without reconfiguration because the Chenoweth-Goldendale line already crosses the area.

The orchards crossed by the Middle Alternative near Big Eddy Substation would have a portion of a tower and some road within the vicinity, but no orchard trees would be removed because the line would be designed to span the orchard.

Table 3-5. Impacts on Land Use by the Middle Alternative

	Permanent Impacts				Temporary Impacts		
	Towers[1] (acres)	New Roads (acres)	Upgraded Existing Roads (acres)	Total Permanent Impacts per Land Use (acres)[1]	Towers[1,2] (acres)	Temporary Roads (acres)	Total Temporary Impacts per Land Use (acres)[1]
Irrigated Cropland	0.1–0.2	0.3	0	**0.5**	0.4–0.6	0	**0.4–0.6**
Nonirrigated Cropland	4–5	16	5	**24–25**	13–16	12	**25–27**
Orchards/ Vineyards	0.1–0.2	0.1	0	**0.2–0.3**	0.4–0.5	0	0.4–0.5
Rangeland	11–12	42	21	**73–74**	31–47	0	31–47
Conservation/ Recreation Lands	0.3	2.3	0	**3**	0.8	0	**0.8**
Total by Type of Impact	**16–18**	**60**	**25**	**101–103**	**46–64**	**13**	**58–76**
National Scenic Area	3–4	14	6	**23–24**	10–15	1	**11–16**

[1] Impacts are presented as ranges from all possible tower options. Double-circuit options would have the greatest impacts from towers.

[2] The "Temporary Tower Impacts" column provides the total of the temporary tower construction impacts and removal of existing towers (when applicable).

Residences

The Middle Alternative would pass within 800 feet of 42-46 houses (see Appendix B); most are either in Oregon or in Wishram, Washington. There are no houses within the proposed right-of-way, so none would be removed. About three–five houses would be within 300 feet of the new line, which could mean that the line would pass through parts of the property used for residential purposes. All but one of these houses has the existing Harvalum-Big Eddy line encumbering the properties, so no additional right-of-way restrictions would be imposed for the option that would rebuild the existing line as double-circuit (Middle Option 3) within the existing right-of-way. For options that would parallel all or portions of the existing Harvalum-Big Eddy line (Middle Options 1 and 2), an additional 12.5-foot width of new right-of-way would impose new land use restrictions to these properties. At about line mile WM25.5, a house within 330 feet of the proposed line would likely have residential uses impacted (no buildings, tall trees, etc.) by a new 150-foot wide right-of-way.

The Middle Alternative would also cross five 20-acre parcels being sold as residential lots along the Little Klickitat River from about line miles M20.5–21.5. These properties are presently encumbered by the existing Chenoweth-Goldendale line and the amount of additional encumbrance would depend on the option – less for Options 2, 3, and 5 and greater for Options 1 and 4.

During construction, noise and dust could impact residents in the area to some extent, with greater impacts the closer a home is to the proposed tower or road work.

Conservation and Recreation Lands

About 3 acres of USFS land managed for conservation and dispersed recreation would be impacted by a tower and new access road along the Middle Alternative, with an additional 0.8 acre of temporary impacts from tower construction. No special-status species, priority ecosystems, wetlands, or streams would be impacted on this property, so impacts to conservation efforts would be minimal. No recreation facilities would be affected. Dispersed recreation on this property, or elsewhere along the Middle Alternative (including uses on the Columbia River or areas near the Little Klickitat River) would not be impacted functionally, but those participating in those activities may be affected by the presence of the line.

In summary, because the Middle Alternative would remove acreage from range and crop land, but use could continue; would have little impact to residential use because the line would mostly pass homes in existing right-of-way and no structures would be removed; and would have minimal effects on conservation efforts on USFS land, the overall impacts of the Middle Alternative on land use would be ***low-to-moderate.***

Impacts of Middle Option 3 (removing the existing Harvalum-Big Eddy line and including it on double-circuit towers with the proposed line) would have a larger initial disturbance impact than the other two options, but would affect fewer acres by combining existing facilities and requiring less new right-of-way. Though still a low-to-moderate impact, Middle Option 1 would have the most impact of the three options because it would place an additional footprint adjacent to existing lines and require a slightly larger right-of-way. Impacts from Middle Option 2 would fall between Options 1 and 3.

East Alternative

The East Alternative would follow existing BPA right-of-way for about 14 of its 28 miles. Between 258-269 acres of new right-of-way easement would be acquired (see Table 3-2): 258 acres for the option that would rebuild the existing Harvalum-Big Eddy and McNary-Ross lines with double-circuit towers (Option 3), and 2 acres for the option that would parallel that line (Option 1). Acreage for Option 2 (which is a mix of the single and double-circuit towers along existing lines) falls between the two acreages given. Even if the line paralleled the two existing lines, there is vacant easement adjacent to the existing lines, only 12.5 feet of additional right-of-way would be needed along the Harvalum-Big Eddy line, and no new right-of-way would be needed along the McNary-Ross line. The remainder of the East Alternative would require a new 150-foot wide right-of-way. Easements would also be acquired for new access roads (see Table 3-3).

As with all the action alternatives, the right-of-way for the East Alternative would occupy more acres of private land than any other land use category. The East Alternative occupy between 9 and 23 acres of state-owned land depending on whether the route would go to Substation Site 1 or 2. As with the Middle Alternative, the East Alternative would cross about 0.6 miles of Warm Springs Tribal trust land and about 12.5 feet of additional right-of-way (0.8 acres) would be required for options that parallel the existing line in this area (Options 1 and 2). In Washington, about 1 mile of Yakama Tribal trust land would be crossed where there is no existing line, requiring about 0.5 acres of new right-of-way for Options 1 and 2, and no new right-of-way for Option 3. Federal land that would be crossed includes BPA-owned land surrounding Big Eddy Substation and about 0.3 miles of USFS land. No new right-of-way would be obtained across this USFS land because the existing corridor could accommodate either a new parallel single-circuit line or a rebuild of the existing line to double-circuit.

The East Alternative crosses the National Scenic Area for 7.5 miles and would require the least amount of new right-of-way within the National Scenic Area (1-5 acres). See Chapter 7, National Scenic Area Standards for acreages of impact on the land uses within the National Scenic Area and a discussion of project consistency with National Scenic Area land use designations crossed by the East Alternative.

Agriculture

The East Alternative would impact lands classified as farmlands of statewide importance and prime farmland. The tower and roads footprints would remove about 25 acres of farmlands of statewide importance in Klickitat County, which is about 0.005 percent of land in this classification in the county, and about 8 acres in Wasco County, which is less than 0.002 percent of the land in this classification in the county. Impacts to prime farmland would be about 9 acres in Klickitat County, which is about 0.007 percent of land in this classification in the county, and about 3 acres in Wasco County, which is about 0.8 percent of land in this classification in the county.

Table 3-6. Impacts on Land Use by the East Alternative

	Permanent Impacts				Temporary Impacts		
	Towers[1] (acres)	New Roads (acres)	Upgraded Existing Roads (acres)	Total Permanent Impacts per Land Use (acres)[1]	Towers[1,2] (acres)	Temporary Roads (acres)	Total Temporary Impacts per Land Use (acres)[1]
Irrigated Cropland	0.1	0.4	0.3	**0.8**	0.4	0	**0.4**
Nonirrigated Cropland	5–6	12	0.5	**17–18**	15–21	18	**33–39**
Orchards/ Vineyards	0.1–0.2	0.1	0	**0.2–0.3**	0.4–1.2	0	**0.4–1.2**
Rangeland	11–13	39	31	**81–83**	33–67	0	**33–67**
Conservation/ Recreation Lands	0.1–0.2	0.5	1	**2**	0.4–1.3	0	**0.4–1.3**
Total by Type of Impact	**17–19**	**52**	**33**	**102–104**	**49–91**	**18**	**67–108**
National Scenic Area	4–7	12	20	**36–39**	13–43	1	**14–44**

[1] Impacts are presented as ranges from all possible tower options. Double-circuit options would have the greatest impacts from towers.
[2] The "Temporary Tower Impacts" column provides the total of the temporary tower construction impacts and removal of existing towers (when applicable).

About 81–83 acres of rangeland would be removed from use due to tower footings and access roads, and an additional 33–67acres of rangeland would be temporarily disturbed during project construction (see Table 3-6).

The East Alternative would impact about 17–18 acres of nonirrigated cropland for tower footings and access roads, and another 33–39 acres would be temporarily disturbed during project construction. The small amount of irrigated cropland found along the East Alternative at line mile E23 would potentially be impacted by about 0.8 acre of towers and access roads and an additional 0.4 acre would be temporarily disturbed. Irrigation equipment may need reconfiguration to continue to operate under the line.

As with the Middle Alternative, the orchards crossed by the East Alternative near Big Eddy Substation would have a portion of a tower and some road within the vicinity, but no orchard trees would be removed because the line would be designed to span the orchard.

Residences

The East Alternative would pass within 800 feet of 39–42 houses (see Appendix B). As with the Middle Alternative, most of these houses are either in Oregon or in Wishram, Washington. There are no houses within the proposed right-of-way, so none would be removed. About three–five houses would be within 300 feet of the new line, which could mean that the line would pass through parts of the property used for residential purposes. All but one of these houses has the existing Harvalum-Big Eddy line encumbering the properties, so no additional right-of-way restrictions would be imposed for the option that would rebuild the existing line as double-circuit (East Option 3) within the existing right-of-way. For options that would parallel all or portions of the existing Harvalum-Big Eddy line (East Options 1 and 2), an additional 12.5-foot wide right-of-way would impose new land use restrictions on these properties. At about line mile E27, a house within 330 feet of the proposed line would likely have residential uses impacted (no buildings, tall trees, etc.) by a new 150-foot wide right-of-way.

During construction, noise and dust could impact residents in the area to some extent, with greater impacts the closer a home is to the proposed tower or road work.

Conservation and Recreation Lands

The East Alternative would impact about 2 acres of USFS conservation land due to tower and access road work, with an additional 0.4–1.3 acres of temporary impacts from tower construction. The impacts would be on land already encumbered by the existing right-of-way and would not affect any special-status species or ecosystems. No recreational facilities would be affected. Dispersed recreation on this property, or elsewhere along the East Alternative (including uses on the Columbia River or areas near the Little Klickitat River) would not be impacted functionally, but those participating in those activities may be affected by the presence of the line.

The East Alternative would pass within about 0.25 mile of the Maryhill Winery and the Maryhill Museum of Art on the opposite side of SR-14 (near line mile E13), but would not cross either property and would have no permanent impact on their use. Temporary impacts would include those caused by construction activities, which would be perceptible to outdoor visitors for a short period.

Industrial

The East Alternative would cross through about 0.5 mile of the Windy Flats wind energy project where it is on DNR property. The East Alternative is located so as to avoid impacts to wind turbines. The proposed line would not preclude future wind development near the line as long as structures, including blades, would not cross into the 150-foot right-of-way. Coordination with BPA would be necessary for potential underground work within the right-of-way.

In summary, because the East Alternative would remove acreage from range and cropland, but these uses could continue; there would be little impact to residential use because the line would mostly pass homes in existing right-of-way and no structures would be removed; there would be minimal impacts on conservation efforts on USFS land, and wind facilities would not be affected, impacts of the East Alternative on land use would be ***low-to-moderate.***

Knight Substation Options

Although BPA needs 30 acres for Knight Substation, at Site 1, BPA would likely purchase 72 acres (about 30 percent) of a 245-acre private agricultural property. This would create an 80-acre parcel that would be owned by BPA, as 8 acres are already owned by BPA where its existing transmission lines cross the property. The extra land would be purchased to avoid land-locking the current landowner.

Site 1 would remove 72 acres of nonirrigated cropland from grain production, impacting land that is classified as prime farmland. BPA may lease out the unused land for agricultural use. Possible roads needed to access Site 1 would be about 0.75 miles long, would further impact agricultural lands, and may dissect some fields or cut-off corners of fields from use. If the access road runs from Knight Road, it would impact DNR land leased for agricultural use.

Temporary construction impacts would include noise and dust during the 20 months it is expected to take for substation construction. However, Site 1 is surrounded by farmland, with no houses in the vicinity, so disturbance would be limited to drivers passing on Knight Road about 0.5 mile to the east. Overall, because Site 1 would convert more than 70 acres of prime farmland to a nonagricultural use and new roads would create further impacts, impacts of Site 1 would be ***moderate.***

For Site 2, BPA would likely purchase 30 acres (6 percent) of 544 acres of State Trust Land. Site 2 would remove the 30 acres from nonirrigated grain fields, presently fallow, impacting prime farmland. Dispersed recreation that may occur on this property would be eliminated from the 30-acre area the substation would occupy. The road to Substation Site 2 would be about 0.25 mile long and come directly from Knight Road to the site. A substation at Site 1 may cut off the top portion of the DNR land from practical use.

Site 2 is surrounded by farmland, although it is closer to Knight Road than Site 1, with no homes in the vicinity. On the east side of Knight Road, there are 20-acre parcels being sold as residential; in the unlikely event that homes were built prior to a proposed substation at Site 2, construction activities would disturb residents for the 20-month construction period. Drivers on Knight Road would also be slightly impacted by construction activities. Overall, impacts of using Site 2 would be ***moderate,*** as, although 30 acres of prime farmland would be converted to a nonagricultural use, and a relatively short 0.25 road would be required, it is possible that the property north of the substation would be difficult to continue farming and dispersed recreation would be slightly limited.

Fiber Optic Cable Options

For the Loop Back Option, no impacts on land use and recreation would occur other than those already described for each action alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential land use and recreation impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.1.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on land use and recreation.

- Provide a schedule of construction activities to all landowners that could be affected by construction.
- Limit construction to daylight hours, minimizing disturbance to those residents who work during the day.
- Compensate landowners for any new land rights required for right-of-way or access road easements.
- Compensate landowners for any damage to property during construction.

- Compensate landowners for reconfiguration of irrigation systems due to placement of towers or access roads.
- Restore compacted cropland soils to pre-construction conditions.
- Work with landowners to determine mitigation measures needed to maintain CRP conservation status, if needed.
- Follow applicable goals and objectives of the National Scenic Area Management Plan with guidance from the USFS and CRGC in the National Scenic Area.
- Reseed disturbed areas (see mitigation measures in Section 3.3 Vegetation).
- Implement measures to reduce the possible spread of noxious weeds (see mitigation measures in Section 3.3 Vegetation).
- Implement measures to control dust (see mitigation measures in Section 3.4 Geology and Soils)
- Implement measures to control construction noise (see mitigation measures in Section 3.11 Noise).
- Minimize or eliminate public access to project facilities through postings and installation of gates and barriers at appropriate access points, and at the landowner's request.

3.1.4 Unavoidable Impacts Remaining after Mitigation

Under any of the action alternatives, portions of a new transmission line would be introduced to areas where such infrastructure does not currently exist. Existing land uses in these locations would be altered by the placement of transmission towers, access roads, and right-of-way restrictions. Construction of Knight Substation would permanently reduce the agricultural capacity of the property on which it would be located.

3.1.5 No Action Alternative

The No Action Alternative would have ***no*** impact on land use because no new transmission lines, towers, and substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.2 Visual Resources

This section describes the scenic resources within the project area and how the project alternatives could affect these resources.

3.2.1 Affected Environment

The scenic resources in the area are high quality and include the Columbia River and National Scenic Area, recreational areas and trails, historic and scenic highways, the rural pastoral landscape in the Klickitat County plateau, and views of Mount Hood and Mount Adams. The action alternatives all begin within the National Scenic Area in Oregon (see Map 3-2). The purpose of the National Scenic Area is to protect and enhance the scenic, cultural, recreational and natural resources of the Gorge while allowing compatible growth to occur in existing urban areas (USFS 2010). For that reason, development through this area is of concern to those that oversee its protection, including the CRGC and USFS.

After exiting Big Eddy Substation, each alternative travels through the National Scenic Area and then crosses the Columbia River, either near The Dalles (West Alternative) or about 6 miles to the east (Middle and East alternatives). Each alternative travels through the National Scenic Area for several more miles, climbing up and over the Columbia Hills ridgeline in Washington. The hills are marked by sculpted terrain, rock outcrops, grasses, and shrubs. Descending down the north side of the Columbia Hills, the alternatives cross a gently rolling agricultural plateau for several miles before crossing the Little Klickitat River and some forested ravines – at different points, depending on the alternative.

After crossing the Little Klickitat River, the alternatives continue north to the Knight Substation area, where the terrain becomes more variable. Just north and east of the substation sites the forested foothills of the Simcoe Mountains begin. Terrain and trees limit or block views of the project from areas farther north.

Where the alternatives traverse the Klickitat County plateau, views can be expansive and include Mount Adams to the northwest and Mount Hood to the south.

Observers of this environment include local residents and business owners, recreationists using area parks and trails, and motorists, including those traveling on the area's scenic highways. There are many parks, trails and highways in or near the project area with extensive, high-quality viewsheds (observable near and distant scenery from a specific location). (See Table 3-7 for a list of parks, trails, and highways, listed from south to north.)

Likewise, some local residents and business owners have expansive views of either the National Scenic Area, the rolling Klickitat County plateau and/or nearby peaks. Throughout the area, many residents live on large, rural properties. Some county residents live in rural unincorporated communities such as Celilo and Biggs in Oregon, and Wishram and Centerville in Washington. A few also live or own land in one of several existing and future large-lot residential subdivisions, such as River Crest, near the Little Klickitat River in Washington. Urban areas near the project are The Dalles, Oregon and Goldendale, Washington.

Table 3-7. Parks,[1] Highways and Trails in or near the Project Area

Name	Location
Oregon Recreation Areas	
Sorosis State Park	Off E. Scenic Drive in The Dalles, west of Big Eddy Substation.
Thompson State Park	North of US-30 in The Dalles, west of Big Eddy Substation.
Riverfront State Park	Along the Columbia River in The Dalles, west of Big Eddy Substation.
Seufert County State Park	Southeast of The Dalles Dam, west of Big Eddy Substation.
Celilo State Park	Along the Columbia River, east of The Dalles and Big Eddy Substation and west of Celilo Village.
Deschutes River State Park	Off of Oregon SR-206, east of Celilo Village.
Washington Recreation Areas	
Spearfish Lake/Little Spearfish Lake	Just north of the Columbia River northeast of The Dalles.
Hess Park	Northwest of The Dalles Dam, off Highway 197.
Columbia Hills State Park	Off Washington SR-14, east of Spearfish Lake. Includes Horsethief Lake and the south portion of Dalles Mountain Ranch.
Columbia Hills Natural Area Preserve	The northernmost part of the Dalles Mountain Ranch (see above).
Avery Recreation Area	Off Washington SR-14 east of Columbia Hills State Park and about 2 ½ miles west of Wishram.
Goldendale Observatory State Park	Off US-97 on a hilltop north of Goldendale.
Scenic Highways	
I-84[2]	Runs east-west along the Oregon side of the Columbia River, in the southern part of the project area.
Historic Columbia River Highway (US-30)[2]	Runs east-west on the Oregon side of the river, roughly parallel with I-84.
Columbia River Gorge Scenic Byway; Lewis and Clark Trail Highway (SR-14)[2]	Runs east-west along the Washington side of the Columbia River.
Yakama Scenic Byway; Journey Through Time Scenic Byway (US-97)	Runs north-south outside the project area to the east.
Trails[3]	
Riverfront Trail	A multi-use trail that begins at the Columbia Gorge Discovery Center in The Dalles and ends at The Dalles Dam. It lies west of the project area.
Historic Lewis and Clark Trail	The Columbia River and surrounding gorge, through which the Lewis and Clark Expedition traveled to reach the Pacific Ocean.
Historic Oregon Trail	Follows much the same route as the Historic Columbia River Highway (see above).
Klickitat Trail	A multi-use trail that runs through Swale Creek Canyon to Uecker Road west of Centerville.

[1] For descriptions of parks, see Section 3.1 Land Use and Recreation.
[2] National Scenic Area Scenic Travel Corridor.
[3] This does not include undocumented trails that may be throughout the area.

3.2.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative. The evaluation of visual impacts is generally based on methods and protocol developed by the Federal Highway Administration, in combination with elements of other visual resource assessment methods, including those of the USFS and the Bureau of Land Management. (See Appendix C for more information about impact methodology.) Please see Chapter 7 for more discussion about the proposed project's consistency with National Scenic Area guidelines for visual resources.

Common Impacts

Potential visual impacts include temporary visual changes during construction and the overall permanent visual changes caused by the presence of the towers, conductors, access roads, and substation work. Visual quality and viewer sensitivity are combined to determine visual impacts.

Construction activities would create temporary changes in scenery by introducing helicopters, trucks and heavy equipment such as cranes and bulldozers to the area. Construction activities would occur over a 20-month period, during daylight hours. Construction crews would be working in localized areas of the transmission line right-of-way and at the substations, and would be visible primarily to nearby viewers or those with a direct line-of-sight. Installation of towers by skycrane helicopter and stringing of the conductor by helicopter would be visible from a greater distance. The one or two temporary staging areas that would be needed along or near the line to store materials, equipment and vehicles would be visible to those in the immediate vicinity. The staging areas would likely be an existing developed site or parking lot ranging from 5–15 acres, so no new areas would be developed. Construction activities would have a ***low-to-moderate*** temporary visual impact for any of the action alternatives depending on the location.

The permanent presence of lattice steel 500-kV towers would create an obvious human made or industrial element to the viewscape. Where the proposed line would parallel other transmission lines, the proposed line would not be out of context. Where the line would create a new corridor, the introduction of the line would degrade the natural visual quality of the area, although transmission lines are typical in rural landscapes. Because there are few trees in the project area, foreground views of the towers would be apparent because they could not be screened by vegetation (for example, there are no trees along road sides to block views of towers crossing over a road), but in the distance the towers could blend in as there would be no clear-cut right-of-way swath to highlight the corridor from a distance.

Because lattice steel towers have space between the members through which the background can be seen, the towers would blend in with the landscape from a distance with a backdrop of hills or vegetation. Weather conditions, such as fog and rain further obscure the ability to see the towers from a distance. The towers would be more obvious on tops of hills or ridges where they would break the skyline. The galvanized steel towers would appear shiny for 2–4 years before they dull with the weather and the transmission line conductors would be treated to reduce the shininess of the metal. Both the proposed single and double-circuit towers would be larger than the existing transmission line structures along the project. In general, new towers would range from 50–140 feet taller than existing BPA wood poles or lattice steel towers in the area. In most cases, the use of taller double-circuit towers would include removing existing poles and towers, and would reduce the number of towers, sense of clutter, and the width of a given corridor, but would add bigger, more obvious structures.

Where any alternative would run near the Columbia Gorge Regional Airport in Dallesport and where towers or conductors would exceed height restrictions, the FAA would require a review to determine whether towers should be marked with lights and/or red and white paint, and whether conductor spans should have marker balls. The lights would be white during the day and red at night; some steady-burning and some flashing. Where towers and wires require marking, their addition to the landscape would be more pronounced, both during the day and at night.

Defining "Sensitive Viewers"

The importance of a visual resource depends primarily on the sensitivity of the viewer, the distance of the resource from the viewer, the diversity of landscape elements and the context in which they are being viewed. Recreationists are generally highly sensitive to their surroundings, which can include both near and distant scenery, depending on landscape, elevation and vistas. Motorists can have variable sensitivity, partly because they must pay attention to the road and partly because they are moving through the resource area (vs. being stationary). However, motorists along scenic highways and National Scenic Area scenic travel corridors may have higher sensitivity to their surroundings because of their expectations.

Similarly, residents can be variably sensitive, depending on the quality of views from their properties. Rural residents, for example, may have longer viewsheds, i.e., more opportunities for scenic views over fields or valleys, than those in more urban areas. At the same time these residents often plant vegetation around the perimeters of their homes to provide privacy, shade and windbreaks.

Most viewers of the action alternatives would be in sparsely populated rural areas. There are only a few pockets of more urban populations. Neighborhoods close to the cores of these cities and towns would have limited or no views of the alternatives because of other buildings, fences and landscaping; dwellers on city outskirts or higher slopes may have some views of the alternatives. In general, views of the alternatives depend on the viewer's position in the landscape, and terrain, vegetation, or existing infrastructure that can obscure views.

Residents and business owners within 800 feet of an alternative or who have expansive views of areas an alternative would cross would be the most sensitive viewers, because of their extended viewing of the project area and the value they may place on views from their homes and businesses.

Access roads would also create a visual impact both in the foreground and in the distance, with new roads producing a more evident visual change than the upgrade of existing roads. Upgrading existing roads (widening, blading, and/or gravel) would brighten the road, and would make them more visible from a distance than they may be currently. Because temporary roads would be removed from crop lands after construction, they would not create a permanent visual impact. Unlike transmission lines, which form straight lines and angles, access roads can curve and follow terrain. In flat areas, roads are not seen as well from a distance, but on steep slopes, especially where cut and fill is needed, roads would likely appear more obvious unless uneven terrain allows them to be hidden on the hillside. (See Appendix B for a map showing preliminary road and tower locations along the action alternatives.)

Project-related work at Big Eddy Substation would have ***no*** impact on visual resources, because the new equipment required would be within the existing substation yard and the area already has an industrial look.

For all action alternatives, the visual impact of maintenance activities would be limited to people seeing helicopters, trucks, and maintenance workers along rights-of-way. Maintenance activities would have ***no-to-low*** temporary impacts on views, but would have a greater affect on recreationists seeking natural landscapes away from human activity.

The visual impacts of each action alternative are discussed next. To assess these impacts, each alternative was considered in three sections: the southern section, where the transmission line would run from Big Eddy Substation and cross up and over the Columbia Hills (through the National Scenic Area); the middle section, where the line would cross the arid Washington plateau and reach the Little Klickitat River; and the northern section, where the line would run from the Little Klickitat River to the Knight Substation sites.

West Alternative

Columbia Gorge and National Scenic Area Impacts

For its first 9.6 miles, as the West Alternative travels from Big Eddy Substation, over the Columbia River and through the National Scenic Area, the line would be visible from portions of eight parks and preserves, three scenic highways/corridors and some residences in The Dalles. (See Table 3-8 and Map 3-2.)

Because the proposed line would run near the Columbia Gorge Regional Airport, several towers between line miles W0-6.5 could require lighting and possibly painting. Marker balls would be placed on the line that spans the Columbia River between line miles W2-3. Marker balls may also be placed on the line that spans Fifteenmile Creek. This would heighten visibility of the towers and lines during the day and at night.

Several houses near Fifteenmile Creek in Oregon would have views of at least one tower and marker balls (if needed) where the line would span the creek. (See Appendix B for a map that shows house locations within about 800 feet of the proposed lines.) Also in this area, several poplar trees used as windbreak trees for an orchard would be removed, which would be noticeable to a few residents and travelers on Eightmile Road. (See Section 3.3 Vegetation, for a discussion about vegetation and a list of areas where trees would be removed.)

Views of the line from Sorosis, Thompson, Riverfront, and Seufert parks in Oregon and Hess Park in Washington would be distant and obscured by other human-made features as these parks are west of the project with existing views of The Dalles Dam and US 197. Views would be intermittent from Spearfish and Little Spearfish lakes because the terrain would block direct line-of-sight of the line. The West Alternative would not be visible from Tom McCall Preserve (Rowena Plateau), a popular scenic site west of the project area between Hood River and The Dalles, Oregon, because topography and vegetation would obscure the view or towers would be so distant they would blend in.

From The Dalles, viewers would not likely see the proposed towers leaving the Big Eddy Substation area. Although two towers would break the skyline, there are many towers in this developed urban area and the towers would be distant, so views would not be noticeably altered. Although the West Alternative would cross the Columbia River where there are presently no transmission lines, the location is difficult to see from The Dalles and SR-14 due to curves in the river, terrain, or distance. Motorists on I-84 would likely see towers on the Washington side of the Columbia River as they look north, but they would not see towers on the Oregon side because they would be on a bluff above the interstate highway.

Where the West Alternative would run parallel to the Spearfish Tap 115-kV wood pole line (line mile W3.5–5), and then parallel to or replace the Chenoweth-Goldendale 115-kV wood pole line (line miles W6–22), the West Alternative's new steel towers would be noticeably taller and more industrial-looking than these existing rustic wooden structures, particularly to motorists or bicyclists travelling on SR-14 (the Columbia River Gorge Scenic Byway and Lewis and Clark Trail Highway), and to recreationists at the Dalles Mountain Ranch portion of the Columbia Hills State Park and in the Columbia Hills Natural

Table 3-8. Scenic and Populated Areas Impacted by Action Alternative[1]

	Name	West Alternative	Middle Alternative	East Alternative
OR Recreation Areas	Sorosis State Park	X		
	Thompson State Park	X		
	Riverfront State Park	X		
	Seufert County State Park	X		
	Celilo State Park		X	X
	Deschutes River State Park			X
WA Recreation Areas	Spearfish Lake/Little Spearfish Lake	X		
	Hess Park	X		
	Columbia Hills State Park	X		
	Columbia Hills Natural Area Preserve	X		
	Avery Recreation Area		X	X
	Goldendale Observatory State Park	x	X	X
Historic Highways	I-84[2]	X	X	X
	Historic Columbia River Highway (US-30)	X		
	Columbia River Gorge Scenic Byway; Lewis and Clark Trail Highway (SR-14)[2]	X	X	X
	Yakama Scenic Byway; Journey Through Time Scenic Byway (US-97)			X
Trails	Riverfront Trail	X		
	Historic Lewis and Clark Trail	X	X	X
	Historic Oregon Trail	X		
	Klickitat Trail	X		
Populated Areas	The Dalles	X		
	Celilo		X	X
	Biggs			X
	Wishram		X[3]	X[3]
	Centerville		X	X
	Goldendale	X[3]	X[3]	X[3]
	Total Houses/Businesses within 800 feet[4]	17–24	42–46[5]	39–42[5]

[1] An "X" means some viewers at these locations may see towers if not obscured by vegetation, terrain or distance.
[2] Views from rest areas are unaffected; the closest one on I-84 is 11 miles west of The Dalles; on SR-14 it is about 3 miles west of Lyle.
[3] Close and direct views of towers for nearest residents.
[4] Lower numbers are for double-circuit configuration; higher numbers for single-circuit.
[5] These numbers include 25 homes in Wishram.

Area Preserve. Travelers would see the line as they approached where it crosses SR-14; views of the towers would appear larger as viewers got closer until they passed underneath the line (see Figure 3-1 for existing views and simulations of the proposed towers in the view; see Map 3-4 for photo locations). View duration for motorists would be less than 1 minute given speed, terrain and curves in the road. From SR-14, two towers of the West Alternative would break the skyline to the south towards the Columbia River and four towers would break the skyline to the north as they ascend the Columbia Hills (see Appendix C for skyline assessments from SR-14). These towers would be more noticeable from a distance than those towers that would have hills in the background behind them.

Expansive views of the Columbia Gorge from these areas would be marred in the foreground by the steel towers (see Figures 3-2 and 3-3). The removal of the existing wood-pole line would help lessen the visual impact slightly if it were replaced with the single-circuit tower. The larger, more complicated double-circuit towers would have an overall greater visual impact than the single-circuit towers, even if use of double-circuit towers allowed for the removal of the wood-pole line. The double-circuit towers would also be more visible from a distance where they climb over the Columbia Hills.

A relatively small number of trees would be removed in several isolated areas in this portion of the line. Tree removal would be noticed by people hiking in the area, but not by the general public.

Most of the access roads along this portion of the West Alternative are existing roads accessing the wood-pole line in the area. These roads would require upgrades that would make them more visible than they are presently. New roads would be needed as short spurs from the main access road to tower sites, and between line miles W1 and W4 where there are no existing transmission lines and no access road system. These areas are difficult to see from public areas.

Central Klickitat Plateau Impacts

At line mile W11, the alternative would cross the Klickitat Trail (see Figure 3-4), where the steel transmission towers would again be more visible than existing infrastructure to trail users and motorists on nearby Harms Road and the Centerville Highway. Hikers along the Klickitat Trail would see the line at the trail head and as they head west, but not after passing under the corridor.

From here, the West Alternative would continue to follow the Chenoweth-Goldendale line north and east 8 miles across sparsely populated, rolling agricultural fields. Several homes scattered between line miles W12-13 and W17-18 would have fore and middle ground views of the line. One home is surrounded by pine trees; about 10 trees would be removed if the wood pole line was removed and the single or double-circuit line was built in its place. This tree removal would be noticeable from the local road (Harms Road), but would not change views from the home itself.

At line mile W18, where the West Alternative turns east following the existing Chenoweth-Goldendale line along the area of the Little Klickitat River, the line may interrupt views of several residents scattered to the north of the line, and potential residents where 20-acre “view lots” are for sale to the south of the line. This area has Mount Adams and Mount Hood vistas. However, because the terrain is varied and it is more heavily vegetated along the river than other areas of the project, views of the line would be location specific. If BPA and the owners of Piper Canyon Airport (line miles W19-20) determined that nearby towers should be marked for safety, lighting and/or marker balls would also make the line more visible to residents. Trees (ponderosa pines) would be removed in upland areas along the line in this area, which may be visible to those living in the vicinity. (See Section 3.3 Vegetation for woodland areas along the alternatives that would require tree removal.) Combined with the installation of new steel towers, this would be a noticeable change of scenery for some nearby existing and future residential viewers (see Figure 3-5).

North Klickitat Plateau Impacts

At line mile W23, the West Alternative crosses SR-142 and heads north to the Knight Substation area at line mile W27. Along this stretch, it passes just west of Goldendale and parallels Knight Road, which is about 0.5 mile to the east. Though sparsely populated, views from these areas can be expansive and include Mount Adams to the northwest and the Columbia Hills and Mount Hood to the south. For local residents with such views, portions of towers could be visible in front of one or more landmarks (see Figures 3-6 and 3-7). One house is located within 800 feet of the proposed line along this stretch, and would have foreground views of the towers. Because of the distance from the Goldendale Airport and the size of the towers, the FAA has determined towers in this area would not require marking. The Goldendale Observatory State Park would potentially have views of the line through this area, but the line would be about 3 miles to the west of the observatory so views would be distant.

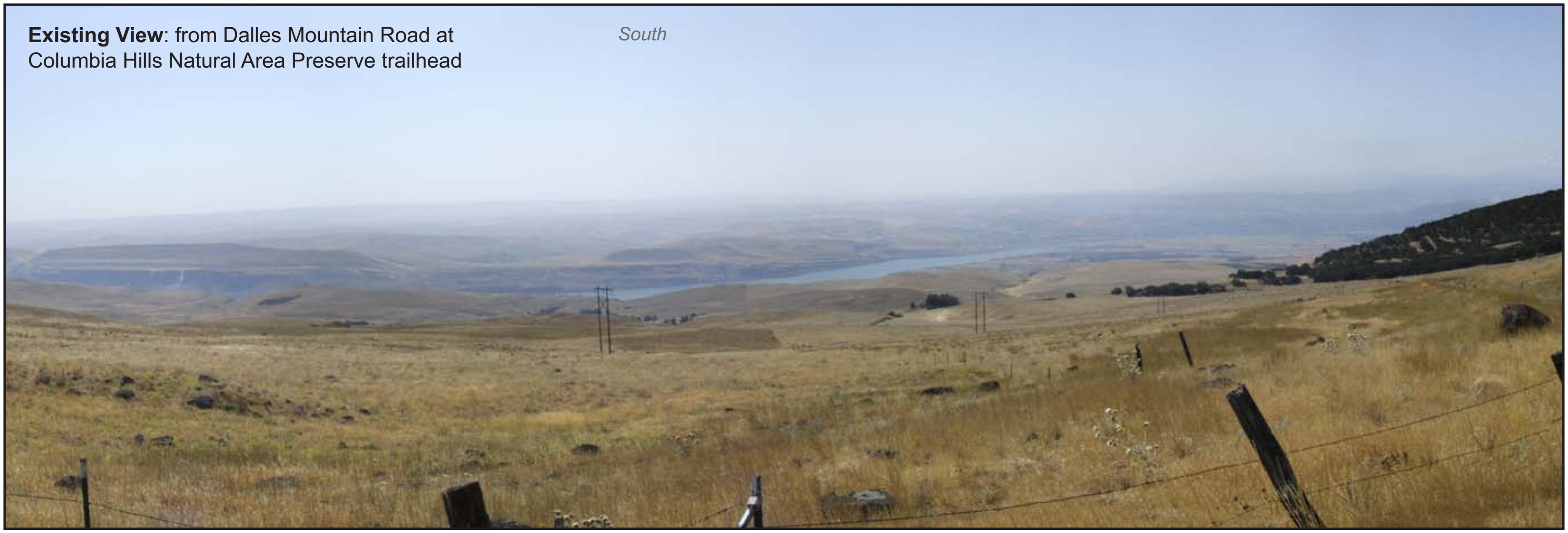
Overall, the West Alternative would have ***high*** impacts to visual resources, because it would create direct foreground views of the line across Columbia Hills State Park, the Columbia Hills Natural Area Preserve, near a portion of the Little Klickitat Trail, near several homes in the Central Klickitat Plateau area, and would be seen intermittently in views of Mount Adams from roads and houses near the Little Klickitat River (with some tree removal) and heading to the Knight Substation sites.

For the West Alternative, options that use double-circuit towers (West Options 2, 4, 5, and 6) would have higher visual impacts than the single-circuit options (West Options 1 and 3) because the larger double-circuit towers would be more noticeable and would not replace an existing line for the first 5 miles, and the towers would replace the smaller Chenoweth-Goldendale wood-pole line from line miles W6-22.

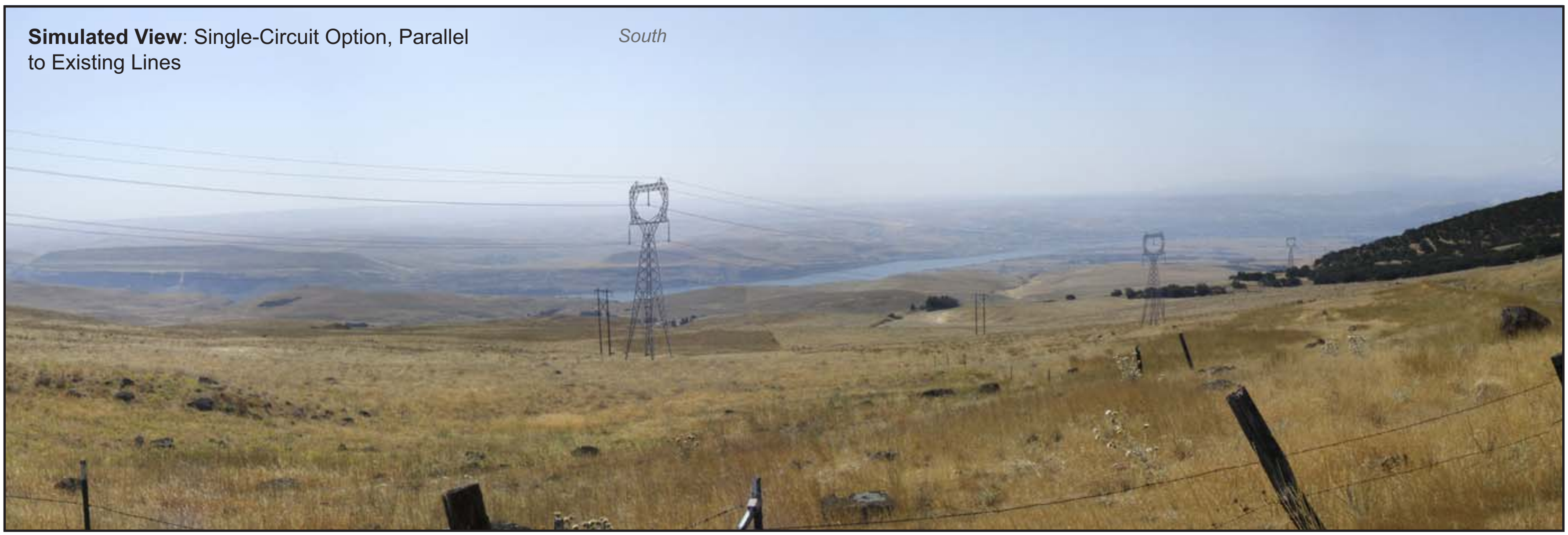
Figure 3-1. Photo Location 1. West Alternative Crossing of SR14 (from SR-14 near Dalles Mountain Road, Looking west, 0.2 mile east of line crossing)

Photo Location 1, continued. West Alternative Crossing of SR14 (from SR-14 near Dalles Mountain Road, Looking west, 0.2 mile east of line crossing)

Figure 3-2. Photo Location 2. West Alternative in Columbia Hills State Park (from Dalles Mountain Road, Looking South)

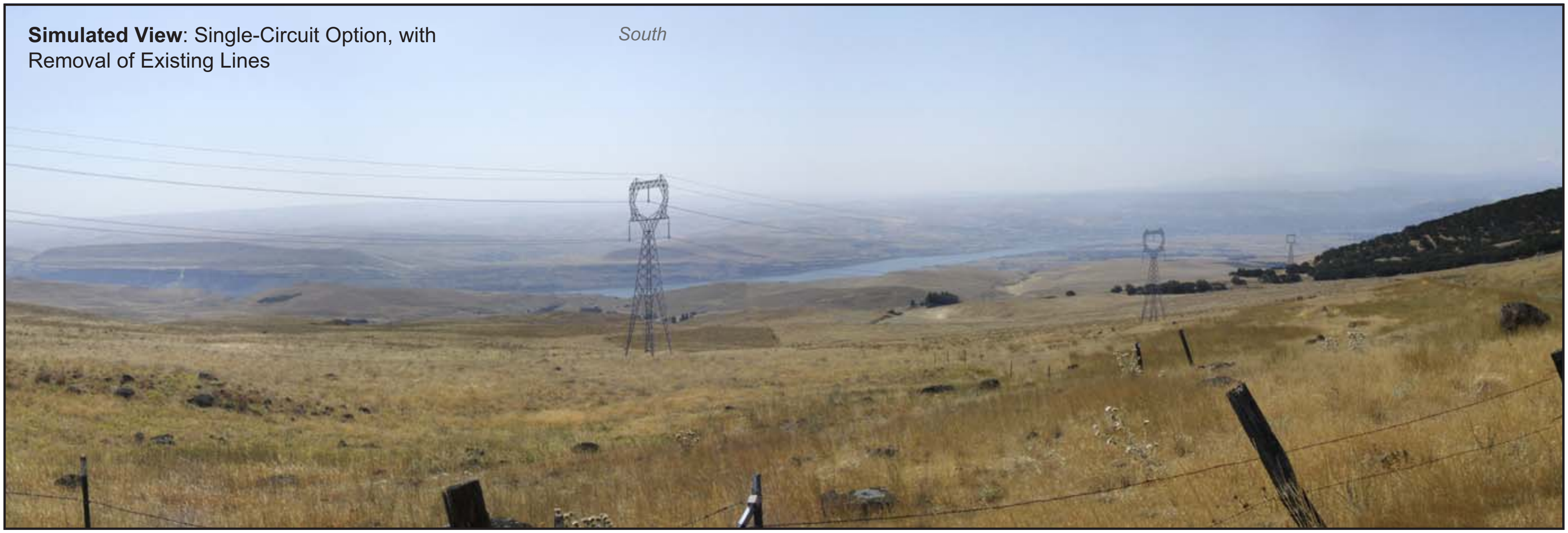


Existing View: from Dalles Mountain Road at Columbia Hills Natural Area Preserve trailhead



Simulated View: Single-Circuit Option, Parallel to Existing Lines

Photo Location 2, continued. West Alternative in Columbia Hills State Park (from Dalles Mountain Road, Looking South)



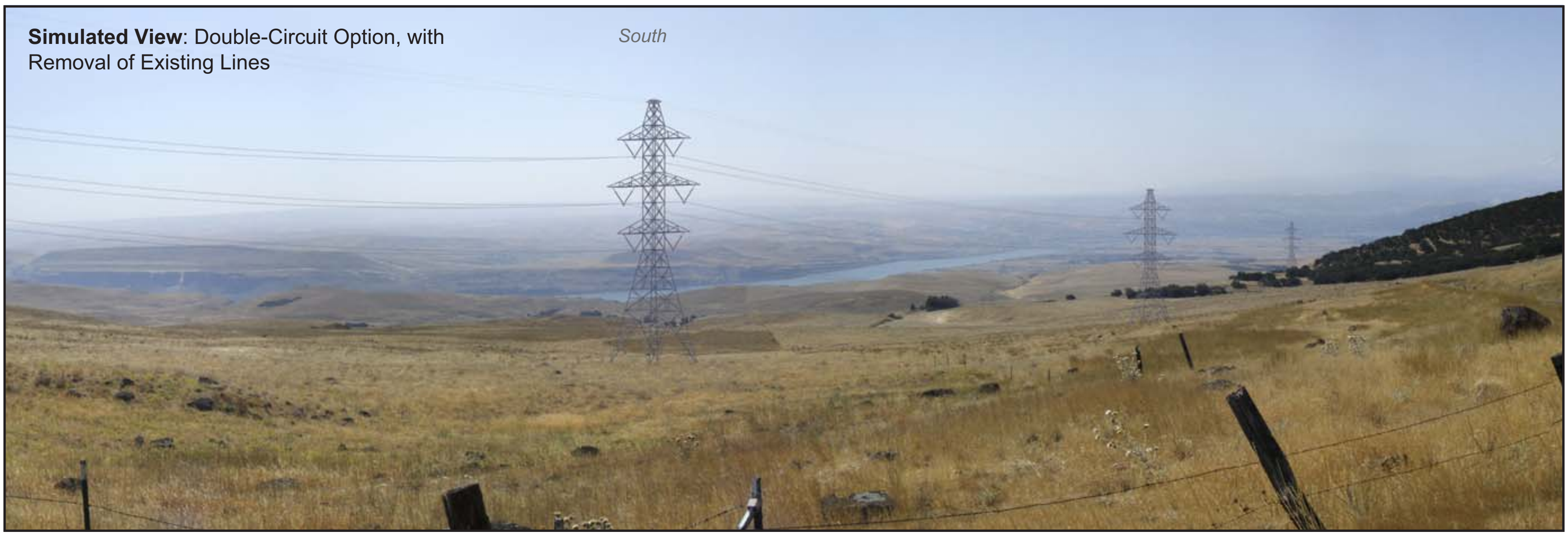


Figure 3-3. Photo Location 3. West Alternative in Columbia Hills State Park (from Dalles Mountain Road, Looking East)

Photo Location 3, continued. West Alternative in Columbia Hills State Park (from Dalles Mountain Road, Looking East)

Simulated View: Single-Circuit Option, with Removal of Existing Lines

Simulated View: Double-Circuit Option, with Removal of Existing Lines

Figure 3-4. Photo Location 4. West Alternative at Klickitat Trailhead (Looking West)

Existing View: from the Klickitat Trail beside Swale Creek, just west of Harms Road

Simulated View: Single-Circuit Option, Parallel to Existing Lines

Photo Location 4, continued. West Alternative at Klickitat Trailhead (Looking West)

Simulated View: Single-Circuit Option, with Removal of Existing Lines

Simulated View: Double-Circuit Option, with Removal of Existing Lines

Figure 3-5. Photo Location 5. West or Middle Alternative near Little Klickitat River (from Esteb Road, Looking Northwest toward Mt. Adams)

Existing View: from Esteb Road 0.66 mile north of Horseshoe Bend Road

Simulated View: Single-Circuit Option

Figure 3-6. Photo Location 6. West, Middle or East Alternative Heading North toward Knight Substation Sites (from Horseshoe Bend Road, Looking Northwest toward Mt. Adams)

Existing View: from Horseshoe Bend Road at Crafton Road

Simulated View: Single-Circuit Option

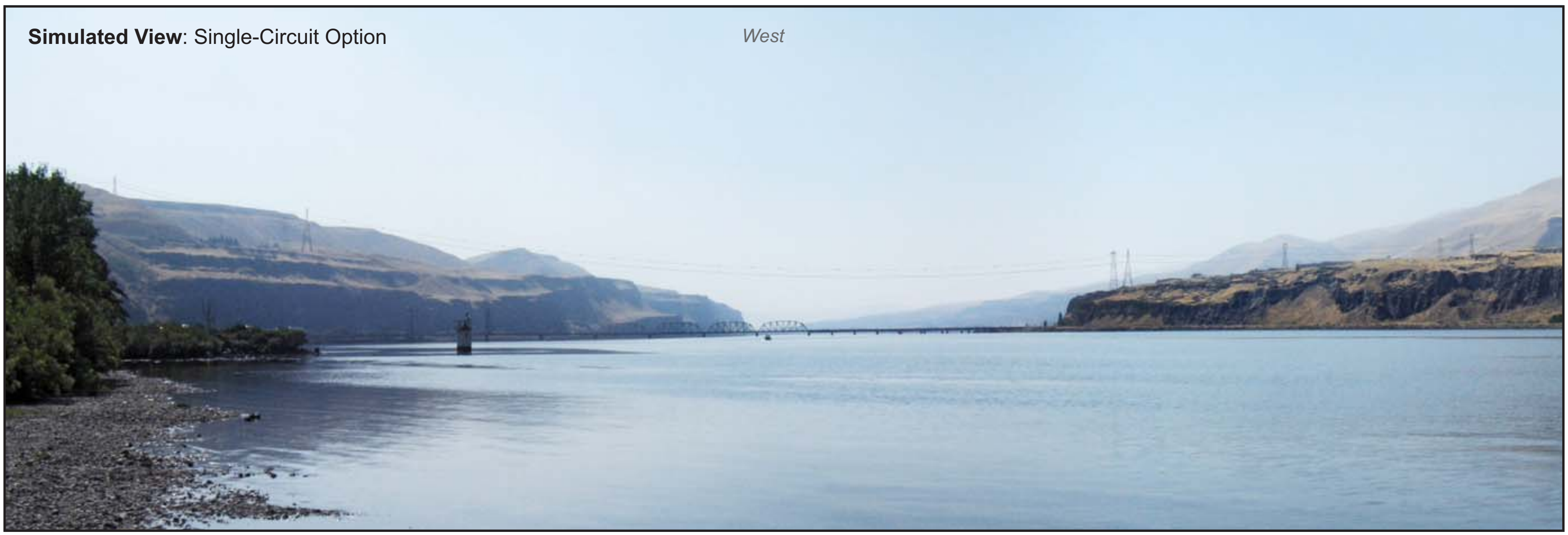
Figure 3-7. Photo Location 7. West, Middle or East Alternative Approaching Knight Substation Sites (from Knight Road, Looking Southwest)

Existing View: from Knight Road, 0.58 mile south of Pine Forest Road at existing Wautoma-Ostrander and North Bonneville-Midway lines

Simulated View: Single-Circuit Option

Figure 3-8. Photo Location 8. Middle or East Alternative Crossing of Columbia River (from Celilo Park Looking West; 1.15 miles from line crossing)

Existing View: from the Columbia River at Celilo Park



Simulated View: Single-Circuit Option

Photo Location 8, continued. Middle or East Alternative Crossing of Columbia River (from Celilo Park Looking West; 1.15 miles from line crossing)

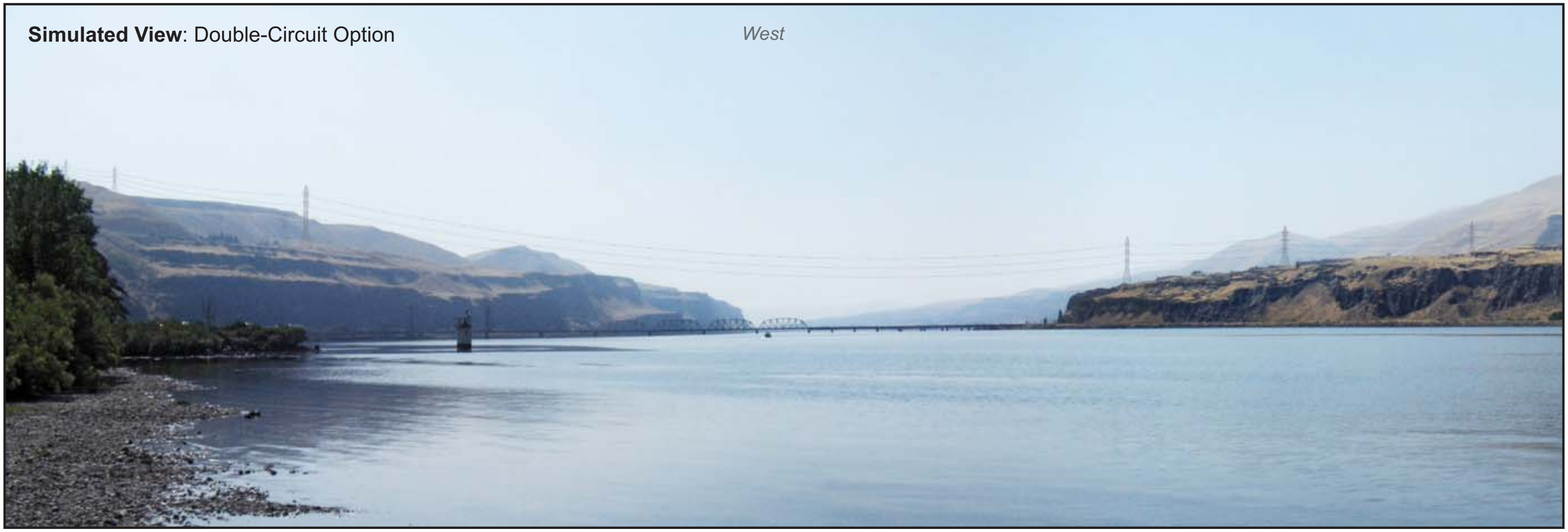


Figure 3-9. Photo Location 9. Middle or East Alternative along Columbia Hills (from Celilo Park, Looking North)

Photo Location 9, continued. Middle or East Alternative along Columbia Hills (from Celilo Park, Looking North)

Figure 3-10. Photo Location 10. Middle or East Alternative Crossing of SR14 (from SR14 Looking West; 0.12 mile from crossing)

Photo Location 10, continued. Middle or East Alternative Crossing of SR14 (from SR14 Looking West; 0.12 mile from crossing)

Figure 3-11. Photo Location 11. East Alternative along Columbia Hills (from SR14 at Wishram Road, Looking Northwest)

Photo Location 11, continued. East Alternative along Columbia Hills (from SR14 at Wishram Road, Looking Northwest)

Simulated View: Double-Circuit Option

Middle Alternative

Columbia Gorge and National Scenic Area Impacts

For its first 11 miles, as the Middle Alternative travels from Big Eddy Substation, over the Columbia River and through the National Scenic Area, the line would be visible from portions of two parks, two scenic highways, and residences of Celilo and Wishram. (See Table 3-8 and Map 3-2.) The first 9 miles of the Middle Alternative would follow or replace an existing BPA lattice-steel line (Harvalum-Big Eddy 230-kV), so the proposed line would not create a new intrusion across this landscape. However, the proposed line would increase the industrial look and sense of clutter if it were built with single-circuit towers (parallel to the existing line) or increase the scale of impact if it were built with larger double-circuit towers (to carry both the proposed and existing line).

In Oregon, most of the Middle Alternative would be south of the National Scenic Area boundary and would pass five houses that would have fore and middle ground views of towers. Because some towers would exceed 200 feet tall, several towers would require lighting and possibly painting. Likewise, the wires would require marker balls where they span the Columbia River and could require them across Fifteenmile Creek and spans of deep ravines.

The line would increase the amount of steel structures and conductors, or be bigger and more noticeable where it would cross the Columbia River. However, there is an existing transmission line crossing the river at this point as well as a railroad bridge just to the west of the crossing, so natural views are already impacted by human structures (see Figure 3-8). Motorists on I-84 would likely see towers on the Washington side of the Columbia River as they look north, but they would not see towers on the Oregon side because the towers would be on a bluff above the interstate. Because Celilo is about a mile upstream from the point where the existing Harvalum-Big Eddy and the proposed line would cross the Columbia River, some Celilo residents and Celilo State Park visitors would possibly have views of the line (see Figure 3-9). From Celilo Park, four towers in Oregon and six towers in Washington would break the skyline, potentially making these towers more visible than towers that would have hills as a backdrop (see Appendix C for a skyline assessment from Celilo Park). However, given the distance, views would likely be vague except on very clear days.

People at Avery Recreation Area, located about 3 miles west of the Middle Alternative, could potentially have views of the line looking across the Columbia River to Oregon. However, the line would be in the background and would not be obvious to the causal observer.

Wishram residents would have close views of the Middle Alternative (see Appendix B). Some 25 Wishram homes, including one business, are within 800 feet of the centerline, with the closest within 71 feet (of the single-circuit option). If double-circuit towers were used, these taller towers may be more distinguishable from a distance than the somewhat shorter single-circuit towers.

Sightseers on SR-14 would pass close to towers where the highway runs under the line (see Figure 3-10) and have brief views of the line as it would ascend the Columbia Hills. This 2-mile long portion would create a new feature not already present on the steep terrain. Although the line would follow a draw up the Columbia Hills, access roads would have to zigzag up the hill and would likely be visible from a distance. Viewers from SR-14 would see two towers of the Middle Alternative break the skyline to the north as the line goes over the Columbia Hills; looking south, viewers would see six towers break the skyline. Visual impacts from SR-14 would be temporary and incremental because of curves in the road, terrain, and existing transmission lines in this area (see Figure 3-10).

Central Klickitat Plateau Impacts

The Middle Alternative would descend the Columbia Hills and share a brief stretch of right-of-way with the Big Eddy-Spring Creek 230-kV line, then turn north across rolling agricultural fields (line miles M12-13) and pass directly west of Centerville (line mile M16), introducing steel towers where none currently exist. Views for rural residents and motorists along this route segment are expansive as it is relatively flat (similar to views shown in Figure 3-4). Two houses would be within 800 feet along this portion of the Middle Alternative, with middle ground views of the towers. Views from the outskirts of Centerville would only be slightly affected because the towers would be several miles away and generally below views of Mount Adams or Mount Hood.

The Middle Alternative then joins the West Alternative (and existing Chenoweth-Goldendale line) at line mile M20, where it crosses the Little Klickitat River and would run past several large-acreage residential developments, including River Crest, which is partly developed. Because the alternative approaches from the south along a new right-of-way, introducing steel towers where none currently exists, it would be highly visible to local residential property owners. These inhabitants would be highly sensitive viewers because their properties boast views of Mount Adams (see Figure 3-6) and, in some cases, Mount Hood.

North Klickitat Plateau Impacts

The visual impacts of the Middle Alternative from line miles M20–27 would be the same as the West Alternative, passing to the west of Goldendale through a sparsely populated area with expansive views that include Mount Adams to the northwest and the Columbia Hills and Mount Hood to the south.

Overall, the Middle Alternative would have ***moderate-to-high*** impacts to visual resources; it would increase the industrial human element through the first 9 miles, though there is already a visual impact due to the existing line and other features; it would place towers and roads over the Columbia Hills where there are none currently, though not all towers would be seen as the line would be somewhat hidden in a ravine; and it would be in foreground views of two homes in the Central Klickitat Plateau area and would be seen intermittently in views of Mount Adams from roads and houses near the Little Klickitat River (with some tree removal) and heading to the Knight Substation sites.

For the Middle Alternative, options that use double-circuit towers (Middle Options 2 and 3) may have slightly less visual impact than the single-circuit option (Middle Option 1) because, although the towers would be larger and more noticeable, the double-circuit options would remove an existing lattice-steel line lessening the expanse of the visual impact.

East Alternative

Columbia Gorge and National Scenic Area Impacts

For the first 9 miles, the East Alternative would have the same visual impacts as the Middle Alternative. In this area the line would increase the industrial look and sense of clutter if it were built with single-circuit towers (parallel to the existing line) or increase the scale of impact if it were built with the larger double-circuit towers (to carry both the proposed and existing line); would pass houses in Oregon and Wishram, Washington that would have fore and middle ground views of towers; cross the Columbia River with existing transmission line and railroad bridge crossings; and would provide temporary views of the towers from I-84 and SR-14 and distant views from Celilo (see Figures 3-8, 3-9, and 3-10).

From just west of line mile E10, the East Alternative would split from the Middle Alternative and continue east along the Columbia Hills through the National Scenic Area, following the existing Harvalum-Big Eddy and McNary-Ross transmission lines (both have lattice-steel towers) until line mile E14. In this area, the East Alternative would run within view of Biggs and Deschutes River State Park in Oregon, and the Maryhill Museum of Art, Maryhill Winery and SR-14 in Washington. Some towers in the area may require lighting, and wires may require marker balls for potential aircraft safety. From SR-14, views would be periodic as the road is curvy, the line would be above the road, and the varied terrain would block direct continuous views of towers (see Figure 3-11). Views along the Columbia River and other locations would only be slightly affected because the line would have the backdrop of the hills, two transmission lines are already present, and wind turbines dominate the visible landscape just outside the National Scenic Area to the northeast. In this area, adding a single-circuit line to the corridor that has two lattice-steel tower lines already would create a wide industrial, somewhat chaotic corridor. Engineers would attempt to match tower locations such that they would be next to one another, but that would not always be feasible given topography (avoiding rock outcrops or ravines). Although the double-circuit towers would be larger, because they would allow for the incorporation of one of the existing lines, the corridor may have a cleaner look than adding single-circuit towers.

Outside the National Scenic Area boundary, the East Alternative would turn north along new right-of-way (line mile E14-16) to climb over the Columbia Hills, crossing through acres of wind turbines. Although the line and access roads would be visible and add to the industrial look of that area, motorists along both sides of the Columbia River (SR-14, US-97, and I-84) would be drawn to the presence of the much larger, white wind turbines and may not notice the transmission line.

Central Klickitat Plateau Impacts

As the East Alternative continues to head north between line miles E14-23 – running 3-4 miles west of and parallel to US-97 (a scenic byway) – it would be far enough away from the highway that it would blend into the background of motorists' views. Rural residents and roadway users closer to the alternative would be more greatly affected, because there are no existing towers along this stretch and terrain is flatter, so most towers would break the skyline. In some places, towers could be seen in front of views of Mount Adams (see Figure 3-6) or Mount Hood. The alternative would be somewhat visible from the eastern outskirts of Centerville (line miles E18-20) and the western outskirts of Goldendale (line miles E22-24), but would be less noticeable because of distance. There are several houses within 800 feet of the East Alternative (line mile E22) that would have fore and middle-ground views of the line.

The East Alternative crosses the Little Klickitat River at line mile E23. However, the terrain is flatter than other portions of the river and some trees would be removed away from the river's edges. Combined with new towers, tree removal could be a noticeable scenery change for sensitive viewers in scattered areas.

North Klickitat Plateau Impacts

The visual impacts of the East Alternative from line miles E24-28 would be the same as the Middle and West alternatives, passing to the west of Goldendale through a sparsely populated area with expansive views that include Mount Adams to the northwest and the Columbia Hills and Mount Hood to the south.

Overall, the East Alternative would have ***moderate*** impacts to visual resources; it would increase the industrial human element through the first 14 miles, but it would not be out of context as It would be in a corridor with one or two existing lattice-steel lines and would ascend the Columbia Hills through wind turbine development. Views of the East Alternative from parks or byways would be distant or intermittent. The line would be in fore and middle ground views from homes that have existing transmission line views through the Columbia Gorge and from a few scattered houses that have views of Mount Adams or Mount Hood through the Central Klickitat Valley and heading to the Knight Substation sites.

For the East Alternative, options that use double-circuit towers (East Options 2 and 3) would have less visual impact than the single-circuit option (East Option 1) because, although the towers would be larger and more noticeable, the double-circuit options would remove an existing lattice-steel line, lessening the expanse of the visual impact, especially from line miles E9-14 where there are two existing lines.

Knight Substation Options

Knight Substation Sites 1 and 2 are both in agricultural fields crossed by BPA's existing North Bonneville-Midway 230-kV and Wautoma-Ostrander 500-kV steel tower transmission lines. Few residents are nearby (none within 800 feet). Panoramic vistas extend in all directions, including the Simcoe Mountains on the north, rolling terrain to the east, the Columbia Hills to the south and Mount Adams and the Cascade Range to the west.

The substation would be mostly seen by local motorists on Knight Road. Though lights would be installed, they would be turned off except for emergencies, such as during equipment failures. Site 1 would have a lower impact than Site 2 because it is farther away from Knight Road and the terrain would partially obscure views. Property just east of Knight Road and adjacent to Site 2 has been subdivided into eight, 5-acre view lots. Though no homes have been built, a substation on Site 2 would likely be in the foreground of views toward Mount Adams from these lots.

Because of the low number of sensitive viewers nearby and some screening by topography, construction of Knight Substation at Site 1 would have ***low-to-moderate*** visual impacts, whereas because it is closer to Knight Road and potential development, Site 2 would have ***moderate*** visual impacts.

Fiber Optic Cable Options

For the Loop Back Option, no impacts to visual resources would occur beyond those already described for each action alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential visual impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.2.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on visual resources.

- Site all construction staging and storage areas away from locations that would be clearly visible from sensitive scenic areas, trails and scenic highways as much as practical.
- Implement construction site maintenance and clean-up. Keep construction areas free of debris.
- Provide regular maintenance of access roads and gates within and leading to the corridor.
- Reseed disturbed areas (see mitigation measures for Section 3.3 Vegetation).
- Implement measures to reduce the possible spread of noxious weeds (see mitigation measures in Section 3.3 Vegetation).

- Implement measures to control erosion and dust (see mitigation measures in Sections 3.4 Geology and Soils, and 3.13 Air Quality).
- Implement measures to control construction noise (see mitigation measures in Section 3.11 Noise).

3.2.4 Unavoidable Impacts Remaining after Mitigation

Even after mitigation, any action alternative would have unavoidable impacts on visual resources by permanently adding tall steel towers to landscapes that are otherwise ruggedly scenic or pastoral. Many different viewer groups, including residents, motorists and recreationists, would be affected.

3.2.5 No Action Alternative

The No Action Alternative would have no impact on visual resources because no new transmission towers or substation would be constructed. Impacts from operation and maintenance of existing towers, conductors and substations would continue unchanged.

3.3 Vegetation

This section describes vegetation resources and how the project alternatives could affect these resources.

3.3.1 Affected Environment

A variety of vegetation cover types occur in the area and are typical of those portions of the Columbia Basin Province with precipitation of about 9 to 16 inches per year (Franklin and Dryness 1988). Vegetation categories described in this section include special-status plants, grassland, shrub-steppe (including scabland and lithosols), disturbed grassland/shrub-steppe, woodlands (including riparian woodlands), cropland and weeds. Sensitive plant species with historic or suspected range in the National Scenic Area are described in Chapter 7.

Special-Status Species

Special-status species include those protected under the federal Endangered Species Act (ESA) as threatened, endangered, or proposed species; those listed by the U.S. Fish and Wildlife Service (USFWS) as candidate species or species of concern; and those listed for protection by the states of Oregon and Washington. No federally listed threatened, endangered, proposed or candidate species are known to occur in the project area (USFWS 2008, 2009). Ten state-listed species are documented as occurring within 2 miles of the proposed routes based on historical data (ORNHIC 2009; WNHP 2009c), or within 1,000–2,000 feet of the proposed corridor by current field surveys (see Table 3-9). Two of these state-listed species are also federal species of concern. These special-status species are all on the Washington portion of the project (none were documented or found in Oregon).

Four of the special status species are associated with wetlands: mousetail (*Myosurus clavicaulus*), Nuttall's quillwort (*Isoetes nuttallii*), smooth goldfields (*Lasthenia glaberrima*), and western ladies-tresses (*Spiranthes porrifolia*). All four species were found during field surveys conducted in spring 2010 in vernal pool type wetlands on the West Alternative in Washington near line mile W3. Mousetail was also found in wetlands where the West and Middle alternatives share a route near line mile WM21 and in a wetland on the Middle Alternative near line mile M11. (See Section 3.5 Water Resources and Wetlands for more discussion about wetlands.)

Four other special-status species are associated with high quality grasslands: clustered lady's-slipper (*Cypripedium fasciculatum*), Douglas' draba (*Cusickiella douglasii*), hot-rock penstemon (*Penstemon deustus* var. *variabilis*), and obscure buttercup (*Ranunculus triternatus*). These species have been mapped (ORNHIC 2007 and WNHP 2009c) and are known to occur along the West Alternative in the grasslands of the Columbia Hills State Park and Columbia Hills Natural Area Preserve. During project field surveys (spring 2010), only the obscure buttercup was found. Because of the unusual spring weather (early heat, then a late snow) it is assumed that the field surveys missed the plant flowering times of the other three special species grassland plants and their presence could not be verified. Because both the park and preserve biologists have recorded their presence, it is assumed that all four of the special-status grassland type species occur in this area.

Table 3-9. Special-Status Plants Documented along Action Alternatives

Special-Status Species	State or Federal Listings[1]	Vegetation Cover Type	Historical Occurrences within 2 Miles of Alternatives[2]	Field Verified Occurrences along Alternatives[3]
Mousetail (*Myosurus clavicaulus*)	WA (S)	Wetland	No occurrences	West, Middle
Nuttall's quillwort (*Isoetes nuttallii*)	WA (S)	Wetland	West	West
Smooth goldfields (*Lasthenia glaberrima*)	WA (E)	Wetland	No occurrences	West
Western ladies-tresses (*Spiranthes porrifolia*)	WA (S)	Wetland	West	West
Clustered lady's-slipper (*Cypripedium fasciculatum*)	WA (S), SoC	Grassland	West	Not found
Douglas' draba (*Cusickiella douglasii*)	WA (T)	Grassland	West	Not found
Hot-rock penstemon (*Penstemon deustus* var. *variabilis*)	WA (T)	Grassland	West	West
Obscure buttercup, also called Dalles Mountain buttercup (*Ranunculus triternatus*)	OR (LE)[4], WA (E), SoC	Grassland	West	West
Gooseberry-leaved alumroot (*Heuchera grossulariifolia* var. *tenuifolia*)	WA (S)	Rock Outcrops/Cliffs	No occurrences	West
Smooth desert-parsley (*Lomatium laevigatum*)	WA (T)	Rock Outcrops/Cliffs	Middle, East	Not found

[1] SoC = USFWS Species of Concern. The species is in jeopardy, but sufficient information does not exist to support listing.
E/LE = State Endangered/Listed Endangered. In danger of becoming extinct or extirpated.
T = State Threatened. Likely to become endangered.
S = State Sensitive. Vulnerable or declining and could become endangered or threatened in the state.
[2] Historical Data from ORNHIC 2007 and WNHP 2009c.
[3] Field verified occurrences include those found within 1,000–2,000 feet of the proposed corridor.
[4] Although this species is listed in both Oregon and Washington, it was only found in Washington.

Two of the special-status species along the project are associated with cliffs and rock outcrops: gooseberry-leaved alumroot (*Heuchera grossulariifolia* var. *tenuifolia*) and smooth desert-parsley (*Lomatium laevigatum*). The gooseberry-leaved alumroot was found during field surveys along the West Alternative near Swale Creek and the Klickitat Trail (line mile W11). Smooth desert-parsley has historically been located along the Middle and East alternatives near Wishram (line mile ME9), but was not found during field surveys.

The CRGNSA Management Plan protects a number of endemic and species of special interest within the National Scenic Area. Many of those species are discussed in this EIS section; a table listing all the National Scenic Area protected species is found in Appendix D, with a determination of whether the species are likely present or affected along the action alternatives.

Priority Ecosystems

Priority ecosystems are areas designated for the conservation and management of habitats, natural areas, or vegetation assemblages with unique or significant value. In Washington, priority ecosystems are those that are designated by the Washington Natural Heritage Program as high-quality or rare ecosystems based on global, national, and state data (WNHP 2007). These designations help guide general planning and conservation efforts as well as the selection of natural areas to be protected under the Natural Area Preserves Act (WNHP 2009a). WNHP priority ecosystems are crossed by all three action alternatives (WNHP 2009c). Five different priority ecosystem types were found in Washington during field surveys within 1,000–2,000 feet of one or more of the project alternatives: two ecosystem types are in grasslands, two are in shrub-steppe, and one is in woodlands. These are described in the next section by vegetation type. No Oregon priority areas, as designated by the Oregon Natural Heritage Program, are crossed by the action alternatives (ONHP 2003).

Grassland

High quality grassland (also known as east-side steppe) was historically the most widespread vegetation type in the project area (Franklin and Dyrness 1988), although it is now quite rare. Grassland consists of a dominant cover of native bunchgrasses and herbaceous forbs, with a species composition similar to that of shrub-steppe communities, but with low or no shrub cover. High-quality grassland is found along the West Alternative where it crosses the Columbia Hills State Park and Columbia Hills Nature Preserve (line miles W6.5-11; see Map 3-5)

In addition to the four special-status species in grassland along the West Alternative, this area also contains two WNHP priority ecosystems: bluebunch wheatgrass-Sandberg's bluegrass lithosol and Idaho fescue-houndstongue hawkweed (*Hieracium cynoglossoides*). Common native dominants in this area include squirreltail (*Elymus elymoides*), needle-and-thread (*Hesperostipa comata*), Idaho fescue (*Festuca idahoensis*), Sandberg's bluegrass (*Poa secunda*), and bluebunch wheatgrass (*Pseudoroegneria spicata*). Common forbs in this area include fern leaf desert parsley (*Lomatium dissectum*), narrow leaf desert parsley (*Lomatium triternatum*), barestem desert parsley (*L. nudicale*), small-flowered woodland star (*Lithophragma parviflorum*), grass widow (*Sisyrinchium inflatum*), and several common species of pussytoes (*Arenaria spp*.), milk vetch (*Astragalus spp*.), and lupine (*Lupinus spp*.).

Cryptogamic crusts—which are composed of lichens and mosses that form a protective layer over the soil, aiding in soil stability and water infiltration—are also found.

Scabland lithosol communities (also referred to as Columbia plateau scabland shrubland [WNHP 2008]) can also occur in small patches within grassland or shrub-steppe communities (Franklin and Dryness 1973; WNHP 2008), including the grassland areas along the West Alternative. These communities have very shallow soils such that exposed rock and gravel is common, with the dominant species frequently either dwarf-shrub species or grasses. Common species include stiff sage (*Artemisia rigida*), along with many dwarf-shrub buckwheats (*Eriogonum* ssp.), balsamroot (*Balsamorhiza* ssp.), and Sandberg's bluegrass.

Shrub-Steppe

High quality shrub-steppe has historically not been as widespread as grassland in the area (Franklin and Dyrness 1988; WNHP 2008), and, like grassland, is now quite rare. Shrub-steppe shares many of the same grass and herbaceous species as grassland communities, but also has a major shrub component (Franklin and Dyrness 1988). High-quality shrub-steppe can be found along the Little Klickitat River in the West and Middle alternatives (line miles W18, W19.5, and WM21; see Map 3-5). Within these shrub-steppe areas, two WNHP priority ecosystems were identified: Douglas' buckwheat (*Eriogonum douglasii*)-Sandberg's bluegrass, and bitterbrush-Idaho fescue.

The dominant native vegetation found in this cover type includes antelope bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), and little sagebrush (*Artemisia arbuscula* ssp. *arbuscula)*. Other shrubs and dwarf shrubs present are sulfur and arrowleaf buckwheat (*Eriogonum umbellatum* and *E. compositum)* and other species of *Artemisia*. Common grasses include Idaho fescue, bluebunch wheatgrass, and Sandberg's bluegrass. Some patches of intact cryptogamic crusts were present in this cover type but are generally small.

Disturbed Grassland/Shrub-Steppe

Disturbed grassland/shrub-steppe includes areas of historic grasslands and shrub-steppe that have been disturbed over time due to grazing or other land use activities. Disturbed grasslands and shrub-steppe are discussed together since neither are high quality vegetation communities, the herbaceous components of the two communities are similar, and their historic (pre-disturbance) distributions are uncertain. Disturbed grassland/shrub-steppe is the most prevalent vegetation type along the project alternatives and is found along the project alternatives in Oregon, the Columbia Hills, the West Alternative as it runs northeast, and along the Little Klickitat River. Disturbed grassland/shrub-steppe is often interspersed with cropland and ranges from fairly intact to somewhat degraded as much of the area surveyed was lightly grazed or showed no evidence of recent grazing, and had some native species present. (See Map 3-5 for locations of disturbed grassland/shrub-steppe along the project alternatives.)

Species composition in this vegetation type includes bulbous bluegrass (*Poa bulbosa*), cheatgrass (*Bromus tectorum*), quackgrass, yarrow (*Achillea millefolium*), stork's bill (*Erodium cicutarium)*, desert parsleys (*Lomatium* spp.), yellow starthistle, and common fiddleneck (*Amsinckia menzieii*). Shrubs such as green and grey rabbitbrush (*Chrysothamnus viscidiflorus* and *C. nauseous*), or sagebrush (*Artemisia* spp.) are also present. Some patches of intact cryptogamic crusts were present in this cover type, but are generally small. This vegetation cover type is depicted as rangeland in Section 3.1 Land Use and Recreation.

Woodlands

There are small woodland or treed areas along the project; they occur primarily in the riparian zones and upland areas around rivers, creeks, and dry washes. Eighteen woodland areas were identified for all project alternatives: 11 crossed by the West Alternative, seven crossed by the Middle Alternative, and six crossed by the East Alternative. Woodland areas are found where the alternatives cross Fifteenmile Creek and orchards in Oregon, along drainages of the Columbia Hills, around a house on the West Alternative, and along the Little Klickitat River area (see Map 3-5and/or Appendix B). Trees in these areas include Oregon white oak (*Quercus garryana*), ponderosa pine (*Pinus ponderosa*), black locust (*Robinia pseudoacacia*), Hawthorn (*Crataegus phaenopyrum*), and orchard trees. Understory plants present include taller shrubs such as mixed willow (*Salix* spp.), oceanspray (*Holodiscus discolor*), mock orange (*Philadelphus lewisii*), black hawthorn (*Crataegus douglasii*), Himalayan blackberry (*Rubus armeniacus*), and snowberry (*Symphoricarpos albus*).

The woodlands with Oregon white oak or with a combination of Oregon white oak and ponderosa pine are high quality intact native communities. The Oregon white oak-ponderosa pine woodland is a WNHP priority ecosystem. This priority ecosystem is found in woodland areas on the West Alternative and where the alternatives cross the Little Klickitat River.

Cropland

Cropland is a general cover type that combines irrigated and nonirrigated agriculture, orchards, and vineyards. It is the second most prevalent vegetation type in the project area after disturbed grassland/shrub-steppe. Cropland also is discussed in Section 3.1 Land Use and Recreation.

Weeds

Undesirable plant species (weeds) are identified by the federal government as those that are "undesirable, noxious, harmful, nonnative, injurious, or poisonous, pursuant to state or federal law," and that should be managed where county or private management plans are in place, as stated in the Federal Noxious Weed Act. Noxious weeds are specifically defined in the Plant Protection Act as those plant species that can damage cultivated or natural vegetation, livestock, and other resources. Weeds can reduce crop yields and forage production, injure livestock, and displace native plant species. State and county noxious weed lists classify weeds according to the threats they pose, their distribution, and their potential for eradication or control. Generally, those species posing a higher risk but that have a lower distribution are rated higher. One hundred thirty-seven weed species are on the combined federal and county noxious weed lists for Klickitat and Wasco counties (Wasco County Weed Department 2008; Klickitat County Weed Board 2009; USDA 2010). Of these, four are listed by the U.S. Department of Agriculture (USDA), 42 by Wasco County, and 123 by Klickitat County.

The following 10 noxious weed species are found along the project alternatives: Canada thistle (*Circium* spp.), Diffuse knapweed (*Centaurea* spp.), Russian knapweed (*Centaurea* spp.), perennial pepperweed (*Lepidium latifolium*), puncturevine (*Tribulus terrestris*), rush skeleton weed (*Chondrilla juncea*), white top (*Cardaria draba*), yellow starthistle (*Centaurea solstitialis*), scotch thistle (*Onopordum acanthium L*.), and medusa head (*Taeniatherum canput-medusae*) (field survey spring 2010). All these species except medusa head, are rated Class B noxious weeds in Oregon and in Klickitat County. Medusa head is not rated in Klickitat County, but in Oregon it is a Class B noxious weed. Class B noxious weeds are designated for control in regions where they are not yet widespread, but in regions where the weeds are already abundant, control is decided at the local level, with containment as the primary goal.

The weeds along the project alternatives are primarily in disturbed shrub-steppe along the benches above the Columbia River. On the north side of the Columbia Hills, few noxious weeds are found. The West Alternative has the fewest weeds. Rush skeletonweed and diffuse knapweed are found along the West Alternative from Big Eddy Substation and through The Dalles and Dallesport areas, with skeletonweed patches continuing into the Dalles Mountain Ranch Columbia Hills State Park (line miles W0-8). Punturevine is found in the Dallesport area south of SR 14 (line miles W2.5-4).

In Oregon, the Middle and East alternatives traverse areas of skeletonweed and diffuse knapweed, with yellow starthistle in the Fifteenmile creek drainage and areas of puncturevine, whitetop, and scotch thistle. As the Middle and East alternatives cross into Washington, there is an abundance of diffuse knapweed and puncturevine, with patches of skeletonweed. On the north side of SR 14 patches of perennial pepperweed are evident. From where the East Alternative departs from the Middle Alternative and continues east (line miles E9-E14), yellow starthistle is abundant, and is one of the more prominent plant species in portions of the entire landscape.

Many other weed species, not considered noxious, are also along the alternatives, including cheatgrass, reed canarygrass (*Phalaris arundinacea*), barnyardgrass (*Echinochloa crus-galli*), and cereal rye (*Secale cereale L*.).

3.3.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Impacts to vegetation would include removal, disturbance, changes in vegetation type, and the spread of noxious weeds. Where disturbed vegetation could not be restored to its preconstruction cover type, the impact would be permanent. Where disturbed vegetation could be reestablished, impacts would be temporary.

The project would require removal of some trees within the right-of-way for the life of the line. Trees or other vegetation that can grow taller than 10 feet would typically be removed from the proposed transmission line right-of-way. In addition, trees outside of the right-of way that have the potential to fall or grow close enough to the conductors to cause a flashover would be removed. Permanent tree removal would not only affect the trees, but could also change the understory vegetation, which tends to be shade tolerate species that may not survive exposure to full sun.

Actual tree removal would depend on the terrain and how far the conductor would be from the top of the tree's growth potential. In the project area, many trees are associated with rivers or creeks and are located in deeply incised channels. Trees in these areas would likely be well below the conductors and would not require removal. In addition, some of the trees in the area are older, slow-growing Oregon white oak which, depending on the situation, could be left in place where they would have little potential of growing close enough to the conductors to cause problems. Existing orchards crossed by the project would require a special-use permit to ensure that the trees would be maintained well below electrical clearances.

At tower sites and along new access roads, vegetation would be permanently removed and soils would be compacted. The impact level would depend on both the amount and quality of vegetation removed. In disturbed grassland/shrub steppe communities, some vegetation would likely return to and recover at least some of the area beneath the towers. Road beds would be graveled and would be periodically mowed if vegetation returned. In addition, habitat fragmentation could occur where new or expanded rights-of-way or access roads would cross through sensitive plant communities, particularly woodlands, special-status plant populations, or priority ecosystems that may occur over a restricted or reduced area. Fragmenting vegetation habitats can limit the spread of plant seeds and isolate plant communities.

Temporary impacts due to construction activities would include vegetation removal or trampling and soil compaction from crew activity and construction equipment. Temporary impacts would occur in construction areas surrounding new towers, including counterpoise, pulling and tensioning sites, staging areas, and along the right-of-way during tree removal. Where an existing line would be removed, tower removal would temporarily disturb that area. However, the existing tower location would either be used for the proposed tower, or could revegetate permanently.

The one or two staging areas that would be needed (to store materials, house a small office trailer, and park vehicles) would be located on already developed areas, either paved of previously graded parking lots. Vegetation impacts would be limited to possible mowing or trampling of highly disturbed grassland/shrub-steppe. The staging areas would be about 5 -15 acres and would be identified just prior to construction. There would be ***no-to-low*** impacts to vegetation due to staging areas, as the areas would either be void of vegetation or be highly disturbed, no special-status plant species would be present or affected, trees would not be removed, and, if vegetation were present, it would be allowed to reestablish or be reseeded following construction.

Maintenance activities could also create temporary impacts by trampling vegetation in work areas around towers or in the right-of-way where trees would need to be removed. In addition, construction and maintenance activities could start fires which would result in the loss of vegetation. Because of higher fuel loads created by cheatgrass and similar species, there would be a greater risk of fires igniting and spreading in disturbed grassland/shrub-steppe communities. Fire would act to further reduce the native components of the system and facilitate the spread of weeds. However, fire-control measures would be taken and the potential for fire impacts would be ***no-to-low.*** (See Section 3.3.3 Mitigation Measures.)

Although vegetation disturbed through construction or maintenance activities would be allowed to reestablish in many areas, these would be vulnerable to noxious weed infestations, and the ability for the preconstruction vegetation type to reestablish would depend on the vegetation present. Under good growing conditions, grasslands and disturbed grassland/shrub-steppe would have the potential to reestablish within three growing seasons, while shrub-steppe and sensitive plant species would take five years or longer. Areas disturbed would be reseeded (see Section 3.3.3 Mitigation Measures). In agricultural areas, crops could be reestablished the following growing season, but areas around tower legs would be left untilled, creating areas that could harbor weeds if not treated.

Noxious weeds and other invasive species such as cheatgrass grow quickly and thrive in disturbed areas, outcompeting native grasses, forbs and/or shrubs. Once established, weed species are hard to control. Impacts of weed infestations would be more pronounced on native plant communities than in areas that have already been disturbed. Areas would be vulnerable to noxious weeds because existing vegetation would be disturbed and soil exposed during construction, and because vehicles would drive (both during construction and maintenance activities) along access roads and potentially carry weed seeds from one area to another. However, mitigation measures would be taken to lessen the risk of introducing or spreading existing noxious weeds during and after construction and throughout the life of the line; the potential for spreading weeds would be ***low***. (See Section 3.3.3 Mitigation Measures.)

Proposed project work at Big Eddy Substation would occur within the existing electrical yard where no vegetation exists; work at Big Eddy Substation would have ***no*** impacts on vegetation.

West Alternative

Of the nine special-status species found along the West Alternative, eight would potentially be impacted by the West Alternative (see Table 3-10). The special-status species gooseberry-leaved alumroot was also found along the West Alternative, but would not be impacted because it is not on the proposed right-of-way and is away from potential construction zones.

About 7–10 acres (depending on the tower type used) of grassland containing the obscure buttercup would be impacted by a combination of towers and roads. In addition, about 3–4 acres of hot-rock penstemon, 2–3 acres of clustered lady's slipper, and 0.2–0.7 acre of Douglas' draba would also be impacted by tower and road placement. Although neither clustered lady's slipper nor Douglas' draba were found during field surveys, they are assumed to be present and potential impacts were determined using WNHP 2009 data.

Because special-status species are more sensitive to disturbance, especially compaction and removal of associated species, BPA assumed that even temporary construction impacts (areas around towers disturbed during construction) could create a permanent loss of these species. Therefore, all disturbance to special-status species would be considered permanent.

All four special-status species associated with wetlands found along the West Alternative would also potentially be impacted: about 0.4–0.5 acre of Nuttall's quillwort, smooth goldfields, and western ladies tresses; and 0.5–0.7 acre of mousetail. These species are all found in the same wetland areas, and the mousetail is also found in a separate location that would only be impacted if double-circuit towers were used.

Table 3-10. Permanent Impacts[1] on Special-Status Plants along the West Alternative

Vegetation Cover Type	Special-Status Species	Tower Impacts (acres)[2]	Road Impacts (acres)	Total Impacts (acres)
Grassland	**Clustered lady's slipper**	2–3	1	2–3
	Douglas' draba	0.2	0.5	0.2–0.7
	Hot-rock penstemon	0.5–1.7	2	3–4
	Obscure buttercup	2–5	5	7–10
Wetland	**Nuttall's quillwort**	0.2–0.3	0.2	0.4–0.5
	Mousetail	0.2–0.4	0.3	0.5–0.7
	Smooth goldfields	0.2–0.3	0.2	0.4–0.5
	Western ladies-tresses	0.2–0.3	0.2	0.4–0.5

[1] Construction impacts are considered permanent impacts for special-status species based on the assumption that individual plants for these species could be destroyed.

[2] Acreage ranges represent tower options – the smaller acreage is for single-circuit options, the larger acreage is for double-circuit options.

Disturbed grassland/shrub-steppe is the most abundant vegetation type crossed and affected by the West Alternative. About 84–101 acres of disturbed grassland/shrub-steppe would be permanently impacted (removed) by tower footprints and roads. An additional 35–84 acres would be temporarily impacted around tower sites during construction (see Table 3-11). Most conductor and fiber optic cable pulling sites would be in disturbed grassland/shrub steppe, temporarily impacting about 14 acres. Disturbed areas would be reseeded following construction. In temporarily impacted areas, this vegetation type would likely return to preconstruction coverage within three growing seasons.

The West Alternative is the only alternative that crosses high-quality grasslands. About 24-30 acres of grassland would be permanently impacted. An additional 7–23 acres would be temporarily impacted during construction (see Table 3-11). Two conductor and fiber optic cable pulling sites would likely impact an additional 1.5 acres. The Idaho fescue-houndstongue hawkweed priority ecosystem would be impacted. Bluebunch wheatgrass-Sandberg's bluegrass lithosol would be spanned by the line and would not be impacted.

Table 3-11. Impacts to Vegetation Types and Priority Ecosystems on the West Alternative

	Permanent Impacts				Temporary Impacts		
Vegetation Cover Types and Associated Priority Ecosystems[1]	Towers (acres)[2]	New Roads (acres)	Upgrading Existing Roads (acres)	Total Permanent Impacts per Cover Type (acres)	Towers (acres)[2]	Temporary Roads (acres)	Total Temporary Impacts per Cover Type (acres)
Shrub-Steppe	0.9–2.5	3.9	0.7	**6–7**	3–8	0	**3–8**
Grassland	2–8	11	11	**24–30**	7–23	0	**7–23**
Idaho fescue-houndstongue hawkweed[3]	*0.3–0.6*	*0.4*	*1.7*	***2.4–2.7***	*0.8*	*1.80*	***5-5.3***
Disturbed Shrub-Steppe/Grassland	10–27	52	22	**84–101**	31–80	4 [1]	**35–84**
Woodland[4]	2–3	0	0	**2–3**	0	0	**0**

[1] Associated Priority Ecosystems are listed in italics beneath their associated Vegetation Cover Type in this column.
[2] Impacts for tower construction are presented in a range because they differ by tower option. Single-circuit tower options have lower impacts; double-circuit tower options higher impacts.
[3] Idaho fescue-houndstongue hawkweed values are included with grassland values, and so are not added into the totals.
[4] Impacts to woodlands are calculated based on tree removals, which are considered permanent impacts only.

Because high-quality grasslands are vulnerable to weed invasion and habitat disturbance, the likelihood is low that temporarily disturbed areas can be restored to preconstruction conditions. Disturbed areas would create opportunities for skeletonweed found in this area to spread, and care would need to be taken to prevent equipment from carrying weed seeds from other areas of the project. Noxious weed spread within high-quality grasslands would affect their integrity and the priority ecosystem that is designated for protection by the state of Washington.

Three areas of high-quality shrub-steppe found along the West Alternative would be impacted. About 6–7 acres would be permanently removed and an additional 3–8 acres would be disturbed during construction (see Table 3-11). The two WNHP priority ecosystems found in this area (Douglas' buckwheat-Sandberg's bluegrass, and bitterbrush-Idaho fescue) would not be impacted.

Because these high-quality shrub-steppe communities are relatively small and broken up by disturbed grassland/shrub-steppe—where weeds are more likely present—and because shrub-steppe communities take longer to recover, there would be a higher risk that the disturbed vegetation would not completely recover to its preconstruction state.

Eight of the 11 woodland/tree areas along the West Alternative would be impacted by tree removal (see Table 3-12). About 93–130 trees would be removed, permanently impacting about 2–3 woodland acres, including the understory. Fewer trees would be impacted by tower options that would remove the existing wood-pole line and build a new line in its place.

In Oregon near Big Eddy Substation, a cherry orchard (Woodland 1) would be spanned and the terrain and height of the trees would likely allow the trees to remain untouched – with an agreement with the landowner to ensure the trees stay well below the conductors. However, there is a windbreak of poplar trees around the orchard where several trees on the north side may be removed, leaving a gap that could expose the orchard to wind. Trees along the Fifteenmile Creek drainage (Woodland 2) are low-growing Oregon white oaks in a ravine and would not require removal. In Washington, between line miles W3-7, trees in several woodlands near Threemile, Fivemile, and Eightmile creeks (Woodlands 3, 4, and 6) would be removed: black locust would be removed in Woodlands 3 and 4, and several Oregon white oaks would be removed in Woodland 6. Woodland 7, located in the Columbia Hills Nature Preserve, would require the removal of Oregon white oak and ponderosa pine trees that are part of a priority ecosystem. Other trees requiring removal along this alternative include some ponderosa pine growing around a house (Woodland 8), and growing in the Little Klickitat River area (Woodlands 9, 10, and 11). Although most trees along the route are associated with ravines or drainages, only the Hawthorn trees near the intermittent Threemile Creek drainage would require removal in the riparian zone; all other trees would be removed in upland areas.

Because tree removal along the West Alternative would not create a clear swath through any given wooded area, but would be at the edges of narrow or scattered treed areas, woodland habitat would be impacted but not fragmented.

Overall, because the West Alternative would impact seven special-status species, a high-quality grassland, and three high-quality shrub-steppe communities; would remove vegetation from two priority ecosystems; and impact woodland areas that are scarce in the area, the impacts of the West Alternative on vegetation would be ***high.***

Although still considered a high impact, the option that would include removal of the existing wood-pole line and use of single-circuit towers in an existing alignment (West Option 3), would have the least impact of the tower options because it would have a smaller tower footprint, would allow vegetation regeneration where the wood-pole towers are currently located, and it would require less tree removal since the right-of-way expansion would be less. The option that would use the most double-circuit towers, for about 21 miles (West Option 5), would have the greatest impact because of the larger tower footprints. The impacts of West Options 1, 2, 4, and 6 would be between the options with the least and greatest impacts.

Table 3-12. Woodland Locations and Potential Tree Removals along the Action Alternatives

Woodland Group No. (line mile)	Woodland/Tree Description	Tree Removal		
		Parallel Tower	Rebuild Tower	Access Roads
1 (W1)	Cherry orchard, poplar windbreak trees	No orchard trees; About 5 poplar windbreak trees	N/A	None
2 (W1)	Oregon white oak, big leaf maple, black locust, in Fifteenmile Creek ravine.	None - Span Ravine/Creek	N/A	None
3 (W3)	Oregon white oak and Hawthorn grove (about 30 trees, isolated woodland) in marshy Threemile Creek drainage	About 20 Hawthorn	N/A	None
4[1] (W5)	Hawthorn, Oregon white oak, Lombardi poplar in Threemile Creek draw and ridge	About 15 Hawthorn	N/A	Possible
5[1] (W7)	Oregon white oak in Fivemile Creek draw	Likely none	Likely none	None
6[1] (W7)	Oregon white oak in Eightmile Creek draw	About 10 Oregon white oak	About 10 Oregon white oak	None
7[1] (W9)	Oregon white oak grove in draw; isolated ponderosa pines	About 10 Oregon white oak in upland; about 5-10 ponderosa pine	About 10 Oregon white oak in upland; 5-10 ponderosa pine	Possible
8 (W12)	Ponderosa pine around house	None	About 20 Ponderosa pine	None
9 (W18)	Isolated ponderosa pine over a 1,000 ft length	About 10 ponderosa pine	About 10 ponderosa pine	None
10[1] (W19)	Ponderosa pine along 1,200 ft stretch of Little Klickitat River. Oregon white oak and ponderosa pine in river drainage.	About 35 ponderosa pine in upland areas	About 35 ponderosa pine in upland areas	None
11 (WM20)	Ponderosa pine woodland, about 100 trees	About 10–15 ponderosa pine	N/A	Possible
12 (ME1)	Orchard, Oregon white oak on either side of orchard	No orchard trees, about 6 Oregon white oak	No orchard trees, 6 Oregon white oak	None
13 (ME1)	Orchard	None	None	None
14 (ME1)	Oregon white oak along Fifteenmile Creek	None–Span Creek	None–Span Creek	None
15 (ME2.5)	Oregon white oak along Fifteenmile Creek	None–Span Creek	None–Span Creek	None
16 (ME3)	Oregon white oak along Fifteenmile Creek	None–Span Creek	None–Span Creek	None
17[1] (M19)	Oregon white oak, willows along Little Klickitat River, ponderosa pine upland	Span Creek–no trees About 5 ponderosa pine in upland area	N/A	None
18[1] (E22)	Oregon white oak and willows in Little Klickitat River draw, isolated ponderosa pine upland	About 5 Oregon white oak and 5 ponderosa pine in upland areas	N/A	None

[1] May contain Oregon white oak-ponderosa pine woodland WNHP priority ecosystem.

Middle Alternative

Both special-status species found along the Middle Alternative would be potentially impacted. Although smooth desert-parsley was not found during field surveys, it is assumed present and potential impacts were determined using WNHP 2009 data. About 0.7–0.9 acre of smooth-desert parsley found along the rock outcrops near the Columbia River in Washington would potentially be removed by tower and new road construction. About 0.5 acre of this smooth-desert parsley area would be impacted due to temporary construction activities, but it is assumed that the plant would not regenerate and the impact would be permanent.

About 0.2 acre of the special-status wetland species mousetail (found near the Little Klickitat River), would be removed. This species would not be expected to regenerate, and the impact would be permanent.

Disturbed grassland/shrub-steppe is the most abundant vegetation type crossed and affected by the Middle Alternative. About 75–77 acres of disturbed grassland/shrub-steppe would be permanently impacted (removed) by tower footprints and roads. An additional 34–47 acres would be temporarily impacted during construction (see Table 3-11). Pulling sites would likely disturb about 16 acres. Disturbed areas would be reseeded following construction. In temporarily impacted areas, this vegetation type would likely return to preconstruction coverage within three growing seasons. As most noxious weeds were found in disturbed grassland/shrub-steppe areas along the Columbia River, the potential risk for weeds to spread would be high. Mitigation measures would help prevent further infestations.

Where the Middle Alternative crosses over the Columbia Hills (between line miles M9–10.5), the disturbed grassland/shrub-steppe community is in relatively good condition with only light disturbance. In this area, impacts would be greater, as the alternative would create a new corridor and most access roads would be new.

Table 3-13. Impacts to Vegetation Cover Types and Priority Ecosystems on the Middle Alternative

	Permanent Impacts				Temporary Impacts		
Vegetation Cover Types and Associated Priority Ecosystems[1]	Towers (acres)[2]	New Roads (acres)	Upgrading Existing Roads (acres)	Total Permanent Impacts per Cover Type (acres)	Towers (acres)[2]	Temporary Roads (acres)	Total Temporary Impacts per Cover Type (acres)
Shrub-Steppe	0–0.3	3	0	3	0.8–7.5	0	0.8–7.5
Grassland	0	0	0	0	0	0	0
Disturbed Shrub-Steppe/Grassland	10–12	44	21	75–77	31–45	3	34–47
Woodland 3	0.5–0.7	0	0	0.5–0.7	0	0	0

[1] There were no Priority Ecosystems found on the Middle Alternative.

[2] Impacts for tower construction are presented as the range of tower options.

[3] Impacts to woodlands are calculated based on tree removals, which are considered permanent impacts only.

No high-quality grasslands would be affected by the Middle Alternative, since no grassland is present along the route.

Of the small amount of high-quality shrub-steppe found along the Middle Alternative, about 3 acres would be permanently impacted and an additional 0.8–7.5 acres would be disturbed during construction (see Map 3-5). The two WNHP priority ecosystems (Douglas' buckwheat-Sandberg's bluegrass and bitterbrush-Idaho fescue) would not be impacted. Because this high-quality shrub-steppe community is small and surrounded by disturbed grassland/shrub-steppe—where weeds are more likely present—and because shrub-steppe communities take longer to recover, there would be a higher risk that the disturbed vegetation would not completely recover to its preconstruction state.

Three of the seven woodlands found along the Middle Alternative would be impacted (see Table 3-12). About 26 trees would be removed, impacting roughly 0.7 woodland acre, including the understory. In Oregon near Big Eddy Substation, the Middle Alternative would span an orchard (Woodland 12); the trees in the orchard would be allowed to remain (with an agreement with the landowner to ensure the trees stay well below the conductors), but several Oregon white oak trees on either side of the orchard would be removed. The alternative would then span another orchard and Fifteenmile Creek three times (Woodland 13, 14, 15, and 16). No trees in these four woodland areas would be removed because the terrain would provide enough clearance for the conductors.

Where the Middle Alternative crosses the Little Klickitat River (Woodland 17), several ponderosa pines would be removed in upland areas on the north side of the crossing. The alternative would also impact a small portion of ponderosa pine in a large woodland area (Woodland 11) to the north of the river (this woodland would also be impacted by the West Alternative).

None of the trees removed would be part of a priority ecosystem. The number of trees removed would be the same for all tower options proposed for the Middle Alternative.

In summary, the Middle Alternative would impact two special-status species and one high-quality shrub-steppe community, but would not impact high-quality grasslands or priority ecosystems, and would require only a small number of trees to be removed. Disturbed grassland/shrub-steppe that would be impacted is common in the area and would return in temporarily disturbed areas following construction. Overall impacts of the Middle Alternative on vegetation would be ***moderate***.

The three options for the Middle Alternative would have similar overall moderate impacts to vegetation. Although use of double-circuit towers in some places would have a greater footprint and would create disturbance during removal of the existing line, the existing tower footprints would be allowed to revegetate and the total footprint would be smaller by combining two lines on one tower.

East Alternative

The one special-status species, smooth desert-parsley, found along the East Alternative would potentially be impacted. As described for the Middle Alternative, smooth desert-parsley was not found during field surveys, but is assumed present and potential impacts were determined using WNHP 2009 data. About 0.7–0.9 acre of smooth-desert parsley found near the Columbia River in Washington (an area in which the Middle and East alternatives follow the same route) would potentially be removed by tower and new road construction. About 0.5 acre of this smooth-desert parsley area would be impacted due to temporary construction activities, but it is presumed that the plant would not regenerate and the impact would be permanent.

Disturbed grassland/shrub-steppe is the most abundant vegetation type crossed and affected by the East Alternative. About 89–92 acres of disturbed grassland/shrub-steppe would be permanently removed along the East Alternative, and an additional 37–45 acres would be temporarily disturbed during tower construction (see Table 3-14 and Map 3-5). Pulling sites would disturb about 16 acres.

Since various weeds are found in the disturbed grassland/shrub-steppe areas along the East Alternative from Big Eddy Substation through line mile 14, there would be the potential that with disturbance these species would spread. With reseeding and noxious weed mitigation measures, temporarily disturbed grassland/shrub-steppe vegetation communities would likely return within three growing seasons.

Table 3-14. Impacts to Vegetation Cover Types and Priority Ecosystems on the East Alternative

	Permanent Impacts				Temporary Impacts		
Vegetation Cover Types and Associated Priority Ecosystems[1]	Towers (acres)[2]	New Roads (acres)	Upgrading Existing Roads (acres)	Total Permanent Impacts per Cover Type (acres)	Towers (acres)[2]	Temporary Roads (acres)	Total Temporary Impacts per Cover Type (acres)
Shrub-Steppe	0	0	0	**0**	0	0	**0**
Grassland	0	0	0	**0**	0	0	**0**
Disturbed Shrub-Steppe/Grassland	11–14	41	37	**89–92**	33–41	4	**37–45**
Woodland 3	0.4–0.8	0	0	**0.4–0.8**	0	0	**0**

[1] There were no Priority Ecosystems found along the East Alternative.
[2] Impacts for tower construction are presented as the range of tower options.
[3] Impacts to woodlands are calculated based on tree removals, which are considered permanent impacts only.

Since no high-quality grasslands or shrub-steppe are found along the East Alternative, these plant communities would not be impacted.

Of the six woodlands identified along the East Alternative, two would be impacted (see Table 3-12). About 16 trees would be removed, impacting roughly 0.8 acre of woodland, including the understory. In Oregon, the tree impacts would be the same as described for the Middle Alternative: conductors would span an orchard at Woodland 12 with removal of several Oregon white oak trees on either side of the orchard; and span Woodlands 13, 14, 15, and 16, which include those next to Fifteenmile Creek, with no tree removal. Where the East Alternative crosses the Little Klickitat River, some ponderosa pine in the upland area above the river and some Oregon white oak trees in an adjacent oak woodland would be removed. The oak woodland is part of a more expansive woodland following the river, and removal of trees from this woodland would contribute to some fragmentation of this wooded corridor.

In summary, although the East Alternative would potentially impact one special-status species, it would not impact high-quality grassland, high-quality shrub-steppe communities, or priority ecosystems, and would require only a small number of trees to be removed. Disturbed grassland/shrub-steppe that would be impacted is common in the area and in temporarily disturbed areas would return following construction. Therefore, overall impacts of the East Alternative on vegetation would be ***low***.

The three options for the East Alternative would have similar overall low impacts to vegetation. Although use of double-circuit towers where appropriate has a greater footprint and would create disturbance during removal of an existing line, the existing tower footprints would be allowed to revegetate and the total footprint would be smaller by combining two lines on one tower.

Knight Substation Options

Knight Substation would permanently convert 10 acres of nonirrigated cropland to a nonvegetated substation yard at either site, with 5 additional acres of cropland impacted temporarily by construction activities. There would be ***no*** impacts to grassland/shrub-steppe vegetation, special-status species, or priority ecosystems at either site. Impacts to croplands are discussed in Section 3.1 Land Use and Recreation.

Fiber Optic Cable Options

For the Loop Back Option, ***no*** impacts on vegetation would occur other than those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential vegetation impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.3.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on noncultivated vegetation from construction and operation and maintenance of the action alternatives:

- Locate towers and roads outside of priority ecosystems, high-quality vegetation communities, and areas of special-status plants as much as possible. Avoid these areas during construction (staging areas, pulling sites, etc.).
- Avoid tree removal to the extent possible.
- Cut or crush vegetation rather than blade in areas that would remain vegetated to maximize the ability of native plants to resprout.
- Work with the appropriate state agency to mitigate impacts to federal species of concern or state-listed species if impacts are unavoidable.
- Seed all disturbed areas to prevent colonization by weeds and facilitate reestablishment of the preconstruction plant community. Use approved (local Farm Service Agency) native seed mixtures in high quality vegetation communities and a combination of native and non-native seed in disturbed vegetation communities. Include the dominant native species from the impacted community in the seed mix.
- Conduct invasive weed surveys prior to and following construction to determine potential weed spread and appropriate corrective actions.
- Collaborate with the Klickitat County Weed Board or Wasco County Weed Department and landowners to determine and carry out the best control measures deemed locally effective.
- Use certified weed-free mulch, if mulch is used for erosion control.
- Pressure or steam wash vehicles and other equipment that have been in weed-infested areas at established wash stations upon leaving the infested areas to prevent spreading weeds to uninfected areas during construction.
- Equip all vehicles with basic fire-fighting equipment, including extinguishers and shovels to prevent fires that could encourage weed growth.

3.3.4 Unavoidable Impacts Remaining after Mitigation

Unavoidable impacts would include permanent vegetation loss in the footprint of new towers, substation, and roads as well as temporary disturbance of vegetation during construction and maintenance activities. Depending on the alternative, special-status species, priority ecosystems, and high-quality grassland or shrub-steppe communities would be impacted.

3.3.5 No Action Alternative

The No Action Alternative would have no impact on vegetation because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.4 Geology and Soils

This section describes the geology and soils found in the project area and how the proposed alternatives could affect these resources. It also discusses potential landslide risks.

3.4.1 Affected Environment

Geology

The project vicinity is predominantly volcanic rock, composed specifically of the Wanapum and Grande Ronde Basalt units of the Columbia River Basalt Group and younger basalts of the Simcoe Mountains at the project area's northern edge. The Columbia River Basalt Group consists of tens of thousands of vertical feet of basalt flows that emanated from fissures in southeastern Washington and northeastern Oregon, covering the southeastern quarter of Washington and adjacent areas in Oregon. The Grande Ronde and Wanapum Basalt flows are from 14.5 to 16.5 million years old (Walsh et al. 1987).

Overlying the basalt flows are much thinner (10- to 90-foot) accumulations of volcanic sediments, alluvial materials, and soils that were deposited on the land surface after eruptive events, including ash from the 1980 Mount St. Helens' eruption. These sediments include volcanic-rich alluvial sands, gravels, silts, and clays.

Topography consists of plateaus and gently rolling hills bordered by steeper slopes on the south (on either side of the Columbia River) and north (flanks of the Simcoe Mountains). Elevation ranges from 160 feet at normal pool elevation of Lake Celilo behind The Dalles Dam to 2,628 feet above sea level at the crest of the Columbia Hills north of the Columbia River.

Landslide Areas

All route alternatives travel through an area in Oregon, just south of the Columbia River and east of The Dalles, where Wasco County has determined there may be some risks of landslides (see Map 3-6). Risks are obviously higher on the area's steep slopes, although none of the larger landslide sites appear recent. More recent, active landslides are small and appear related to headwaters of drainages on steep slopes or failed banks of incised streams.

There are also some landslide areas present along the Columbia Hills on the Washington side of the Columbia River, including a large, potentially active landslide on the north side of Highway 14 above Wishram. Landslide risk mapping in Klickitat County was performed by Washington's Division of Geology and Earth Resources and by interpretation of aerial photographs. No landslide areas were found along the route alternatives north of the Columbia Hills, but there are steep slopes in the Little Klickitat River area.

The West Alternative crosses two possible landslide areas south of I-84 in Oregon (between line miles W1.2-1.8) and a large inactive landslide on Washington Parks and DNR lands between line miles W7.6-8.4. Small landslides may also be associated with the headwaters of drainages on the north flank of the Columbia Hills near line mile W9.5. Other steep slopes along the West Alternative can be found at line miles W0-2 on the Oregon side of the Columbia River, W5.5-10 where it would climb over the Columbia Hills, W11 and W13 on either side of Swale Creek, and W19.6-20.5 near the Little Klickitat River.

The Middle Alternative crosses many steep slopes for its first 9 miles. In addition, it crosses short segments of steep terrain much farther north between line miles M19.6-20 near the Little Klickitat River. Some areas on the steep slopes between line miles M0.5-7 along the Columbia River are identified as moderate to high landslide risk areas by Wasco County. Where the Middle Alternative parallels the existing Harvalum-Big Eddy line in Oregon, it crosses landslides not previously mapped, but recognized on aerial photographs at line miles M3.2 and M6.5-6.8 (see Map 3-6). It also crosses the edge of a large landslide on the north side of Highway 14 above Wishram in Washington (line miles M9-9.4). The Oregon landslides do not appear currently active, but the slide above Wishram has deformed Highway 14 in places, indicating that portions of it are still moving.

The East Alternative shares the same corridor as the Middle Alternative from Big Eddy Substation to about line mile E9.3 before turning east on a separate route. Like the Middle Alternative, steep slopes can be found at line miles E0.5-1.5, E2.2-6.2, E6.5, E7, and E7.8-8.6. In addition, the East Alternative crosses steep slopes between line miles E9.3-14, east of Wishram, Washington, and E14.6- E15, where it descends from the Columbia Hills. Some areas on the steep slopes between line miles E0.5-7 are identified as moderate to high landslide risk areas and include three inactive landslides. On the Washington side, there is a large and active landslide above Wishram (line miles E9-10). Where the East Alternative is in a new corridor, many actively eroding stream banks would be crossed (near line miles E10.4, E12, E12.7, and E12.8), as well as an old slide from line miles E13.6-14.7.

Seismic Risks

There are no known active faults in the area. Earthquakes occurring elsewhere in the Northwest could cause ground shaking or ground failure – landslides or liquefaction (severe settling of soil) – in large landslide areas, in floodplain sediments and alluvial fill in the Swale Creek Valley, and in floodplain sediments around Fifteenmile Creek in Oregon and the Little Klickitat River in Washington.

Soils

Soils throughout the area are typically varieties of silty loams—a mix of sand, silt, and clay—or coarser variants (sandy or gravelly loams). Soils are a mixture of weathering products of the underlying materials (i.e., basalt or fluvial sediments) with substantial amounts of loess (silty or loamy material deposited by glaciers) and lesser amounts of volcanic ash. The most dominant soil is Goldendale silt loam, covering more than 2,300 acres in the project area. This soil has slow to moderate water-infiltration traits. Soil thickness varies, with thinner soils on steep slopes and exposed bedrock, and thicker soils in basins.

Many soil types in the area are either considered prime farmland or support “farmlands of statewide importance.” (See Section 3.1 Land Use and Recreation.) About half of the soils are mildly to moderately expansive (absorb water easily). Dirt roads in the Centerville and Klickitat Valley portion of the project area, with a high proportion of volcanic ash in the soil, are nearly all signed as impassible when wet. As a result of these erodible soil properties and the potential for frost action, which can cause soil softening or heaving, road construction and maintenance is challenging in some areas.

3.4.2 Environmental Consequences

Common Impacts

The project could affect soils by exposing soils to rain and wind, causing erosion; compacting soil; or by removing soils from use by either taking it off-site or covering with impervious surfaces. Landslides can affect the integrity of the towers and roads, and construction in slide areas can trigger further slides.

Construction activities would involve excavation (for tower footings, substation ground mat, equipment, and counterpoise), grading and cut-and-fill for roads, tree removal, movement of heavy equipment, and lay-down of materials. All these activities would disturb soils and remove or damage vegetative cover. The exposed soil would be vulnerable to movement off-site through water runoff, wind dispersal, or movement by gravity (soil/rocks rolling down hill). Soil compaction also contributes to erosion as rainfall is less easily absorbed (increasing runoff) and it is more difficult for plants to grow (creating areas with patchy or no vegetation coverage).

The area of soil disturbed at each tower site would be about 0.5 acre (including counterpoise installation impacts) for single-circuit towers and about 0.8 acre for double-circuit towers. Where existing lines would be removed, wood pole removal would disturb about 0.1 acre of soil and lattice steel tower removal would disturb about 0.43 acre. About 18 conductor tensioning sites would be required and would disturb about 14 acres of soil. Impacts from roads are based on an average road width of about 30 feet (smaller on straight stretches, larger at turns).

The amount of predicted soil loss is based on the disturbance area, type of underlying soil and terrain, and is calculated as "tons per year." A ton is equivalent to 40 cubic yards of soil (4 feet by 5 feet by 2 feet). Even without building the project, soil is lost through existing conditions such as rain, wind, grazing, farming, driving, and construction. Mitigation measures such as installing silt fences during rainy periods, covering piles of soil, dust control, and reseeding disturbed areas, are essential for reducing erosion and soil loss.

Some soil would be removed from potential use, such as in localized areas around transmission tower footings, road beds, and at the new substation. The ground beneath new or improved access roads would be subject to long-term compaction. Where footings and roadways are built on expansive soil, impacts would be greater because more work (e.g., grading, graveling, more extensive foundations) would be required to ensure stability. Roads on steep slopes would be the most likely to cause erosion by removing the ground cover, compacting the soil, and potentially changing drainage patterns. Proper road design (such as gravelling surfaces, selecting appropriate road locations and grades, and installing water bars or other appropriate drainage) would be essential to help avoid long-term erosion impacts (see Section 3.4.3 Mitigation Measures).

Typical operations and maintenance would have minimal effects on soils. Annual vehicle ground inspections and vegetation maintenance activities could cause some dust, create ruts on wet roads, or disturb vegetation that could expose soil. Where temporary roads would be constructed, maintenance vehicles and equipment may need to drive through fields and could cause temporary soil erosion or compaction. BPA would mitigate impacts to restore soil function and compensate landowners for damages.

Landslides would potentially affect the integrity of towers and road stability. Towers and roads would be generally sited to avoid possible unstable locations. Where this is unavoidable, civil engineers would walk locations to select the best tower and road locations, use appropriate design standards for the given soils of the area, and monitor the area as part of routine maintenance.

Seismic issues can also affect tower construction (i.e., siting, type of footing used). All facilities would be built to applicable seismic standards and combined wind- and ice-loading tower design criteria typically exceed earthquake-induced loads.

Specific soil erosion impacts and landslide impacts for each route alternative are discussed below.

Proposed project work at Big Eddy Substation, which would be the same for all alternatives, would occur within its existing yard. Excavation would be required for dead-end towers and electrical switching equipment and would range from minor (less than 5 feet) for burial of key lines to more extensive (up to 15 feet) for footings for the dead-end towers. About 1 acre would be disturbed for this work. Some footing excavations could require limited drilling or blasting in bedrock.

Soil at Big Eddy Substation averages about 4 feet deep. While not likely at this site, footing construction could require temporary dewatering if perched groundwater is present at the time of construction. Excavated soil would be used on site as needed and, if required, remaining soil would be transported to an appropriate certified site after being tested for contamination – particularly for hydrocarbons and polychlorinated biphenyls (PCBs). The yard is currently graveled and newly disturbed areas would be immediately re-graveled. Estimated soil loss from the site due to erosion would be about 1.30 tons per year. This is a typical low loss rate for soils of the area (Renard et al. 1997; Toy and Hadley 1987; SCS 1978). Overall, there would be ***low*** erosion impacts due to project additions at Big Eddy Substation.

West Alternative

Tower installation and construction of some 40 miles of new, improved and temporary access roads for the West Alternative would disturb about 169-268 acres of land; 169 acres for West Option 1, which uses all single-circuit towers, and 268 acres for West Option 5, which has the greatest use of double-circuit towers of the options. Disturbance acreages for West Options 2, 3, 4, and 6 fall between Options 1 and 5. Estimated soil loss along the West Alternative due to erosion would be about 28-41 tons per year (see Table 3-15). This rate was determined with the use of appropriate erosion control mitigation measures (see Section 3.4.3 Mitigation Measures) and would be similar to typical erosion rates for the area. If left bare, disturbed soil would erode at a much higher rate.

The West Alternative would potentially be affected by three possible landslide areas: south of I-84 in Oregon (between line miles W1.2-1.8), a large inactive landslide on Washington Parks and DNR lands between line miles W7.6-8.4 (see Map 3-6), and small areas associated with the headwaters of drainages on the north flank of the Columbia Hills near line mile W9.5. The route also crosses steep terrain at line miles W0-2 on the Oregon side of the Columbia River, W5.5-10 where it would climb over the Columbia Hills, W11 and W13 on either side of Swale Creek, and W19.6-20.5 near the Little Klickitat River. Actual construction in landslide areas would total about 2.5 acres (see Table 3-16). BPA’s existing wood-pole transmission runs through many of these areas and has had no history of landslides.

Overall impacts of the West Alternative on geology and soils would be ***low***. Although work could disturb up to 268 acres of land, the disturbance would be spread over 27 miles and erosion rates would be similar to exsiting erosion rates without the project and would be controlled through mitigation. In addition, the amount of tower and road construction needed in landslide areas would be small (appropriate engineering designs would lessen potential risk of landslides in these areas).

West Option 1 would have the least impact on soils and West Option 5 would have the greatest, although both are still considered a low impact. Impact levels for West Options 2, 3, 4, and 6 fall between Options 1 and 5.

Table 3-15. Potential Erosion (Soil Loss) Impacts[1] by Action Alternative

	Tower Construction[2] (tons/year)	Access Roads—New, Upgraded and Temporary (tons/year)	Total (tons/year)
West Alternative			
Predicted Soil Loss: Existing Conditions Without Project	9–23	21	30–44
Predicted Soil Loss: Project with Mitigation	9–22	19[3]	28–41
Middle Alternative			
Predicted Soil Loss: Existing Conditions Without Project	11–13	26	37–39
Predicted Soil Loss: Project with Mitigation	10–12	23	33–35
East Alternative			
Predicted Soil Loss: Existing Conditions Without Project	11–20	26	37–46
Predicted Soil Loss: Project with Mitigation	12–27	30	42–57

[1] Analysis of surface erosion potential from water was based on NRCS erosion coefficients for specific soil map units and slope erosion coefficients used in the Revised Universal Soil Loss Equation (RUSLE) model (Renard et al. 1997; Toy and Hadley 1987; SCS 1978). Analysis of erosion by other processes, including surface erosion by wind, erosion from mass wasting, and erosion of stream banks, was qualitative.

[2] Range of quantities reflects range of impacts that could occur from different tower options. For example, double-circuit options disturb about 20-30% more land than single-circuit options.

[3] This number reflects potential soil erosion from upgrading existing access roads as well as existing county roads. About 5 miles of county roads would be improved for the West Alternative.

Table 3-16. Landslide Areas Disturbed by Action Alternative

Alternative	Tower Construction[1] (acres)	Access Roads—New, Upgraded, and Temporary (acres)	Total (acres)
West Alternative	1.1–1.3	1.3	2.4–2.6
Middle Alternative	2.4–3.9	5.3	7.7–9.2
East Alternative	5.2–11.9	17.2	22.4–30.1

[1] Range of quantities reflects different tower options.

Middle Alternative

Installing towers and construction of about 37 miles of new, improved and temporary access roads for the Middle Alternative would disturb about 159-179 acres: 159 acres for Middle Option 1, which uses all single-circuit towers, and 179 acres for Middle Option 3, which has the greatest use of double-circuit towers of the options (disturbance acreages of Middle Option 2 falls between these acreages). Estimated soil loss along the Middle Alternative due to erosion would be about 33-35 tons per year (see Table 3-15). This rate was determined with the use of appropriate erosion control mitigation measures (see Section 3.4.3 Mitigation), and would be similar to typical erosion rates for the area. If left bare, disturbed soil would erode at a much higher rate.

The Middle Alternative would potentially be affected by steep slopes for its first 9 miles, and steep terrain much farther north between line miles M19.6-20 near the Little Klickitat River (see Map 3-6).

Actual construction in landslide areas would total about 8-9 acres (see Table 3-16), 2 of those acres would be for upgrading existing roads. Between line miles M0.5-7, tower and roads would mostly avoid the landslide areas, since much of the existing access road system along the Harvalum-Big Eddy line could be used. In addition, these landslides in Oregon do not appear to be active and the existing Harvalum-Big Eddy line and its associated access roads have been in place for over 50 years through these areas with no history of landslides.

Where the Middle Alternative would cross the edge of a large landslide on the north side of Highway 14 above Wishram in Washington (line miles M9-9.4) and further north at line mile M10, towers and new roads would likely be located in these areas. Since these are steep slopes, road work would likely require cut-and-fill or benching into hillsides.

Overall, impacts of the Middle Alternative on geology and soils would be ***low-to-moderate***. Impacts related to erosion would be low since, although work would disturb up to 179 acres of land, the disturbance would be spread over 27 miles, erosion rates would be similar to existing soil erosion rates without the project, and erosion would be controlled through mitigation. Impacts related to landslide risk would be moderate because about 9 acres in landslide areas could be disturbed, but appropriate engineering designs would lessen potential risk of landslides in these areas.

Middle Option 1 would have the least impact on soils and Middle Option 3 would have the greatest, although still considered a low-to-moderate impact. The impact level for Middle Option 2 would be in between these options.

East Alternative

Installing towers and construction of about 37 miles of new, improved and temporary access roads for the East Alternative would disturb about 169-212 acres: 169 acres for East Option 1, which uses all single-circuit towers, and 212 acres for East Option 3, which has the greatest use of double-circuit towers of the options (disturbance acreages of East Option 2 falls between these acreages). Estimated soil loss along the East Alternative due to erosion would be about 42-57 tons per year (see Table 3-15). This rate was determined with the use of appropriate erosion control mitigation measures (see Section 3.4.3 Mitigation), and would be greater than typical erosion rates for the area. If left bare, disturbed soil would erode at an even higher rate.

Because it crosses a larger stretch of steep terrain, the East Alternative would have the greatest potential impact on landslides. The East Alternative crosses steep slopes for its first 16 miles (see Map 3-6). The East Alternative would not encounter steep slopes where it would cross the Little Klickitat River as the other routes do.

Actual construction in landslide areas would total about 22-30 acres (see Table 3-16), 9 of those acres would be for upgrading existing roads already present. Because the first 9 miles of the route is the same route as the Middle Alternative, the impacts would be the same, and the risk would be minor crossing landslide areas based on use of existing roads and history of use. Where the East Alternative would cross through an active landslide area near Wishram, and continue east crossing actively eroding stream banks, towers and roads would be built across these areas, with extensive use of the existing access road system in addition to short sections of new road. The existing line has not had any history of erosion problems associated with slides in this area.

New line and extensive road work would be required through a possible slide area as the East Alternative heads north up steep slopes at line mile E14.

Overall, impacts of the East Alternative on geology and soils would be ***moderate-to-high*** since work would disturb up to 212 acres of land spread over 28 miles and erosion rates would be higher than existing rates without the project (though erosion would be controlled through mitigation). In addition, about 30 acres in landslide areas could be disturbed, though appropriate engineering designs would lessen potential risk of landslides in these areas.

Although still considered overall moderate impacts, East Option 1 would have the least impact on soils and East Option 3 would have the greatest; the impact level for East Option 2 would be between these options.

Knight Substation Options

Knight Substation would impact about 10 acres. About 250,000 cubic yards of soil would be excavated to level the site and to create a 1-acre retention pond. Although the substation yard would not create an impervious surface, soil would be compacted. Portions of the substation would be covered with impervious surfaces (the control house and equipment locations), and although the yard itself would be graveled, it would be compacted and have less water absorption ability than if it remained agricultural land. Up to 5 additional acres would be temporarily disturbed during construction for staging and equipment. The stormwater retention pond would retain water runoff, allowing slow release, which would lessen water erosion from the site. The graveled yard would lessen possible wind erosion.

Other soil excavated would range from minor amounts (less than 5 feet) for installing a ground mat, to more extensive amounts (up to 15 feet) for footings of the dead-end towers. Excavating for these footings could require limited drilling or blasting in bedrock due to their depths, and could require temporary dewatering depending on groundwater levels at the time of construction.

Once constructed, erosion at Site 1 would be at an estimated rate of 1 ton of soil per year. At Site 2, the erosion rate would be about half that – 0.5 tons of soil per year. Erosion rates differ between the two sites because Site 1 has slightly more rolling terrain. Because access to Site 1 would require a longer road than that of Site 2, soil disturbance from roads would also be greater for Site 1. Overall, soil impacts would be ***moderate*** for both sites. There would be ***no*** landslide impacts at either site.

Fiber Optic Cable Options

For the Loop Back Option, no impacts on soils would occur beyond those already described for each route alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential soil erosion impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.4.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on geology and soils.

- Minimize the project ground disturbance footprint, particularly in sensitive areas (i.e., steep slopes and landslides areas).
- Prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) for construction activities to lessen soil erosion and improve water quality of stormwater runoff.
- For the SWPPP, use management practices contained in the Storm Water Management Manual for Eastern Washington (e.g., use silt fences, straw bales, interceptor trenches, or other perimeter sediment management devices; place them prior to the onset of the rainy season and monitor and maintain them as necessary throughout construction).
- Prepare a Fugitive Dust Control Plan to control dust.
- Water or use palliatives on exposed soil surfaces in areas disturbed during construction.
- Water, use palliatives, or cover construction materials if they are a source of blowing dust.
- Gravel access road surfaces in areas of sustained wind and potential dust erosion.
- Ensure construction vehicles travel at low speeds on access roads and at construction sites to minimize dust.
- Limit the amount of time soils are left exposed.
- Reseed disturbed areas (see mitigation measures in Section 3.3 Vegetation).
- Conduct additional site-specific evaluations in areas of potential landslides to determine degree of recent activity, likelihood of activation or reactivation, potential setbacks, and site-specific stability as appropriate.
- Design roads to limit water accumulation and erosion; install appropriate access road drainage (ditches, water bars, cross drainage, or roadside berms) to control and disperse runoff.

3.4.4 Unavoidable Impacts Remaining after Mitigation

With any of the action alternatives, even with the implementation of mitigation measures, soil would be disturbed, some erosion would occur during construction, access roads would contribute to small amounts of long-term erosion and water diversion, soils would be removed from productive use at tower sites, roads, and Knight Substation, and project components would be exposed to some landslide risk in certain areas.

3.4.5 No Action Alternative

The No Action Alternative would have no impact on geology or soils in the project area because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.5 Water Resources and Wetlands

This section describes the rivers, streams, groundwater and wetlands found in the project area and how each of the proposed alternatives could affect these resources.

3.5.1 Affected Environment

Water Resources

Surface Water and Floodplains

Four primary stream channels drain east to west across the project area. From south to north, these stream channels are Fifteenmile Creek in Oregon, the Columbia River dividing Oregon and Washington, and Swale Creek and the Little Klickitat River in Washington (see Map 3-7).

Fifteenmile Creek southeast of The Dalles drains the area east of the city and west of the Deschutes River. It reaches the Columbia River on the east side of The Dalles at the base of the hill below Big Eddy Substation. Wasco County Geographic Information System (GIS) coverage indicates the presence of a floodplain along Fifteenmile Creek. Flood flows are expected to be from 200 cubic feet per second (cfs) to potentially over 1,000 cfs for a 100-year event, based on flows in nearby streams such as Mill Creek. In the areas crossed by the alternatives, Fifteenmile Creek is in a ravine with oak riparian trees on either side.

The **Columbia River** flows through the Columbia River Gorge. Behind The Dalles Dam, the Columbia River is a reservoir called Lake Celilo (at elevation 160 feet above mean sea level). Typical summer stream flows at The Dalles' gaging station range from 70,000-100,000 cfs with mid-spring peak flows as high as 350,000 cfs (USGS 2009). Though there is a floodplain designated along the Columbia River, the river's water level is controlled by various dams, including The Dalles Dam, and John Day Dam (east of the project alternatives). Where crossed by the alternatives, riparian vegetation along the river is mostly grasses and shrubs, with some small trees.

Swale Creek is an unmeasured, intermittent stream with discontinuous flow from mid-summer through fall. It drains the Centerville Valley on the north flank of the Columbia Hills, turning northward west of the project alternatives to flow into the Klickitat River. Throughout much of the area, Swale Creek is shallow and wide, crossing relatively flat terrain, and it often floods to some degree each winter and spring. Swale Creek has a wide 100-year floodplain, particularly between Uecker and Cameron roads. Riparian vegetation along Swale Creek is grasses and shrubs.

The **Little Klickitat River** flows at the base of the Simcoe Mountains near the project's northern margin. Mill Creek, Blockhouse Creek, and Spring Creek drain the mountains' south flank into the Little Klickitat River. Median flows in the Little Klickitat River range from 10 cfs in summer to 300 cfs in mid-winter. Peak flow at the mouth exceeded 17,000 cfs twice between 1946 and 1980, the last date for which peak flow is available (USGS 2009). The Federal Emergency Management Agency (FEMA) has established a 100-year floodplain from upstream of Goldendale (at a point just east of Highway 97) to about Olson Road to the west. In the areas crossed by the alternatives, the Little Klickitat River is in a shallow ravine with an oak and pine riparian corridor.

In addition to the Columbia River and these creeks, the alternatives cross many tributaries to these larger water bodies, including Threemile, Fivemile, and Eightmile creeks along the West Alternative, and

Spring Creek along all alternatives where they head to the Knight Substation sites. These tributaries are intermittent or dry washes, only containing water seasonally or during heavy rains, with little or no flow by mid-summer.

Rivers and streams in the area have designated buffer zones. Regulating agencies establish buffers as boundaries between local waterways and existing or future development that help protect rivers and streams by filtering pollutants, providing flood control, preventing bank erosion, mitigating warming, and providing room for lateral movement of the waterway channel.

In Wasco County, stream buffers differ depending on whether the waterway is within the National Scenic Area. Within the National Scenic Area, minimum buffers are 200 feet for perennial or fish-bearing streams (some of which can be intermittent) and 50 feet for intermittent, non-fish-bearing streams (Wasco County Planning Department 2006b). Outside the National Scenic Area (where the Middle and East alternatives cross Fifteenmile Creek), the buffer for fish-bearing streams is 100 feet, but the same 50-foot buffer applies to non-fish-bearing streams (Wasco County Planning Department 2006a). Similarly, in Klickitat County, buffers range from 25-200 feet, depending on stream flow (continuous or intermittent) and the presence of fish (Klickitat County Planning Department 2004).

Water Quality

Water quality standards require regulating agencies to rank impaired water bodies and develop total maximum daily loads (TMDLs) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. Fifteenmile Creek in Oregon has a proposed temperature TMDL pending approval by the U.S. Environmental Protection Agency (EPA). This stream is listed as impaired for sedimentation, habitat modification, and flow.

TMDLs have been established in the Columbia River for dioxin (with waste load allocations for pulp and paper mills upstream and downstream of the project) and dissolved gas (a result of dam operations on the lower river). Samples taken from the Columbia River above The Dalles Dam in the mid-‘90s found two detectable pesticides (endosulfan and DDT/DDD/DDE). Measurements for bacteria, conductivity, and turbidity have been within acceptable limits (DEQ 2009b). Riparian shading of the Columbia River does not influence thermal conditions because the river is so large.

The Little Klickitat River and its tributaries, including Swale Creek, have a temperature TMDL because mid-summer temperatures typically exceed 59 degrees Fahrenheit (°F), a critical threshold for anadromous fish (fish that spend most of their adult life in salt water and return to freshwater streams and rivers to spawn). Turbidity in the Little Klickitat River is moderate, suspended sediment concentrations are low, and dissolved oxygen concentrations are adequate.

Groundwater

Two types of aquifers occur along the project alternatives: shallow alluvial aquifers connected directly to local surface waters, and basalt aquifers with groundwater elevations that reflect levels of the Columbia and Little Klickitat rivers. Surfacing groundwater, in the form of springs and seeps, occurs where bedrock is permeable, such as in the Columbia Hills.

Groundwater is used for domestic and municipal potable water and to irrigate crops throughout the region. It provides part of the water supply for The Dalles and—from both springs and wells—all of the water supply for Goldendale. Most houses in areas beyond urban services are served by wells tapping aquifers at depths exceeding 30 feet below the ground surface in valleys, and at greater depths on ridges.

The only protected aquifer is The Dalles Critical Groundwater Area, designated by the Oregon Water Resources Department (2009b). Additional water withdrawal is restricted in the confined basalt aquifers in and around the city of The Dalles.

Wetlands

Wetlands are areas of transition between aquatic and terrestrial systems, where water is the dominant factor determining soil characteristics and vegetation species. Wetlands can be biologically productive and help maintain or improve water quality, contribute to flood control, provide wildlife habitat, and have recreational or aesthetic value.

Two main wetlands categories occur along the project alternatives:

Palustrine—wetlands dominated by trees, shrubs, and persistent emergents, including mosses and lichens. Within the palustrine category, two subclasses occur: palustrine emergent, which has at least 30 percent cover of emergent herbaceous vegetation; and palustrine scrub-shrub, which has at least 30 percent cover of woody vegetation less than 20 feet tall. Both types of palustrine wetlands can be found along the transmission line alternatives (USFWS 1981). (See Map 3-7.) These palustrine wetlands are generally near rivers, streams, or creeks and are part of a larger wetland complex or are smaller wetlands in agricultural areas.

Lacustrine—large wetlands (20 acres or more) lacking trees and vegetation located in depressions or dammed river channels. Lacustrine wetlands include permanently flooded lakes and reservoirs and tend to have extensive areas of deep water (Cowardin et al. 1979). The only mapped lacustrine wetland along the alternatives is the Columbia River where it is dammed by The Dalles Dam, forming Lake Celilo.

Within these categories, wetlands can vary in quality. Relatively undisturbed wetlands along rivers and streams (such as Fifteenmile Creek in Oregon and the Little Klickitat River in Washington) contain a higher diversity of plants, thereby providing greater habitat opportunities and maximum erosion and flood control and are considered high quality wetlands. In some cases, these wetlands may have rare or special characteristics protected at federal, state (Washington "Natural Heritage Sites"), or local levels. Examples include bogs, characterized by spongy, acidic peat soil formed from decaying mosses; vernal pools, which are temporary shallow ponds on rocky outcroppings or hard-pan soil depressions; alkali wetlands; and forested wetlands. Smaller, disturbed, lesser quality wetlands can be found in active agricultural fields (such as where manure or fertilizer runoff is possible). (See tables under each alternative for the quality of individual wetlands.)

Like rivers and streams, wetlands have designated buffers—areas surrounding them that provide access to wetlands for a variety of wetland-dependent or upland wildlife species. Disturbance within these buffers can affect a wetland's ability to provide suitable habitat for these species. Wetland buffers can be other wetlands, deep open water, or upland areas (Hruby 2004).

Buffers are determined for each wetland according to procedures outlined in the Wasco County National Scenic Area Land Use and Development Ordinance and the Klickitat County Critical Areas Ordinance. Wasco County's maximum wetland buffer is 200 feet (Wasco County Planning Department 2006b) and Klickitat County's maximum is 300 feet (Klickitat County Planning Department 2004).

3.5.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Water Resources

Transmission line and access road construction (digging for tower footings, blading for access roads, etc.) would cause ground disturbance that could affect surface waterways and groundwater. Water quality could be impacted if appropriate erosion control measures were not implemented and sediment from eroded soils reached water bodies. In the long term, if trees or vegetation were removed, especially in riparian areas, water quality could be impacted due to more run off (that would have been absorbed or lessened by the vegetation), or by removal of vegetation that provides shade to keep water temperatures lower.

Although each action alternative would have some towers within 50 feet of smaller, intermittent streams in the project vicinity, no towers would be built in waterways or within 50 feet of the Columbia River and other primary creeks and rivers. These larger waterways would be spanned from bank-to-bank high above water level. No new access roads would cross rivers or larger creeks, but new access roads would invariably cross intermittent tributaries or drainages. Where intermittent drainages would be crossed, culverts would be used to ensure unobstructed water passage.

No towers or new access roads would be built in floodplains. Any work within floodplains would be coordinated with regulating jurisdictions to minimize potential water flow obstructions. Generally, floodplains can be impacted if encroachments block flood flows or restrict storage of flood waters, if impermeable surfaces are created lessening water absorption into the soil, or if the grade of the floodplain is changed such that water cannot spread during high flow events. Although tower installation in a floodplain does not generally prohibit water flow (water can flow around tower legs), road construction can change the original grade and compact soil, which allows less water absorption.

There would be some groundwater impacts, although BPA would work to minimize them. Generally, groundwater can be impacted by disrupting water flow by building new roads, increasing turbidity through soil disturbing activities or drilling, and by contamination through accidental spills of hazardous materials (such as fuels, oil) or excavation of existing contaminated soils.

Erosion in areas of soil disturbance and vegetation removal could result in increased groundwater turbidity. This impact would be greatest where new access roads would be constructed. The potential for impacts would be less likely with the upgrades of existing roads. Interception of groundwater seeps in road cut banks could also alter the hydrology or water quality of adjacent wetlands and streams. However, use of erosion control measures in all areas where soils are exposed during construction is expected to minimize the transport of sediment to groundwater recharge areas, including intermittent streams.

Most refueling and equipment maintenance would be done at staging areas located at least 100 feet from streams and wetlands, with spill containment and clean-up procedures in place.

Contaminated soils and underground structures may exist along the alternative routes as remnants of earlier road, pipeline, and agricultural projects. Excavation of contaminated soils, primarily during road construction, could mobilize contaminants into a previously uncontaminated groundwater body. In addition, abandoned or orphaned wells could be disturbed, providing a direct pathway for contaminants to flow to an underlying aquifer. Existing contaminated areas, orphaned wells, and underground infrastructure would be identified and avoided prior to construction.

Where excavations require blasting into bedrock, minor amounts of nitrate residue from explosives could get into groundwater. These impacts would only temporarily affect localized areas.

Overall, there would be ***no-to-low*** impacts on groundwater for all alternatives as culverts would allow water flow; contaminated areas, abandoned wells, and underground infrastructure would be identified and avoided; and mitigation measures for erosion would be implemented.

Operations and maintenance tasks along any of the alternatives would have ***no*** impacts on water resources. Twice-yearly helicopter inspections would not disturb any ground. Maintenance vehicles used for annual ground inspections would stay on established access roads and little vegetation maintenance would be needed along any of the alternatives.

Proposed project work at Big Eddy Substation would occur within its existing yard. The closest water body is Fifteenmile Creek about a third of a mile from the substation across Fifteenmile Road. Groundwater at the substation is typically 20 to 50 feet below the surface (WRD 2009a); dewatering during excavating is unlikely to be required. Because of the distance from surface water and mitigation measures that would be taken to control erosion (see Section 3.5.3 Mitigation), construction at Big Eddy Substation would have ***no-to-low*** impacts on water resources.

Wetlands

Wetlands could be impacted by fill (through tower or road placement), vegetation removal, diversion of surface water flows, and by contamination from accidental spills or oil from machinery. Removal of forested vegetation could decrease evapo-transpiration rates and increase soil and water temperatures due to lack of shading. The transmission line would span wetlands wherever possible.

Typical operations and maintenance tasks—including annual ground inspections—would have ***no*** impact on wetlands. Maintenance vehicles would stay on established access roads and little vegetation maintenance would be needed in wetland areas along any of the alternatives.

Because there are no wetlands at Big Eddy Substation, work within the substation yard would have ***no*** wetland impacts.

West Alternative

Water Resources

From south to north, the West Alternative would cross Fifteenmile Creek (line mile W0.5), the Columbia River (between line miles W2-3), and then many small drainages until traversing Swale Creek at line mile W11 and the Little Klickitat River from line miles W20-21.5. Several drainages to the Little Klickitat via Spring Creek would be crossed as all the alternatives head north to the Knight Substation Sites (line miles W23, W23.5, W24, and W26).

About nine towers along the West Alternative would be within 50 feet of intermittent streams, disturbing about 2 acres during construction (see Table 3-17). New access roads would cross 17 intermittent streams, drainages or dry-washes; in addition, improvements would be made to 15 existing access roads that cross such streams (see Table 3-18). Up to 25 new culverts would be installed for these various crossings. Some new and improved access roads would need to be built near the Little Klickitat River's north bank between line miles W20-21. The closest portion of the road would be about 250 feet from the edge of the riparian area. With proper road design and erosion control measures used during construction, sedimentation and runoff from tower or road construction would not reach water bodies.

Table 3-17. Tower Disturbance within 50 Feet[1] of Intermittent Streams by Action Alternative

Alternative	Number of towers	Disturbance (acres)
West Alternative	9	2.0
Middle Alternative	12	2.2
East Alternative	4–5[2]	2.7–2.9

[1] For this report, impacts were analyzed within 50 feet of the centerline of streams regardless of possible buffer size. If an action alternative is selected, potential tower impacts within applicable stream buffers will be a fully assessed to help guide tower placement.
[2] Number of towers depends on which tower option is selected.

Table 3-18. Number of Streams Crossed by Access Roads by Action Alternative

Alternative	Total Stream[1] Crossings	
	New Roads	Improved Roads
West Alternative	17	15
Middle Alternative	10	10
East Alternative	22	8

[1] Streams crossed by access roads are seasonal (intermittent) or dry-washes.

Fifteenmile Creek has a woody riparian cover in a ravine that would be well below the West Alternative line (line mile W0.5); no riparian vegetation would need to be removed. No riparian vegetation along the Columbia River would be impacted; the towers at the Columbia River crossing would be far from the edge of the river, no trees would be removed, and any riparian vegetation present would not affect the river water temperature given the expanse of the river.

Crossings of a Threemile Creek tributary (line mile W3.5) and of Threemile Creek (line mile W5.5) would require that some riparian vegetation be removed. Loss of the vegetation could affect water temperature slightly before the creek runs dry in late summer. The amount of trees removed (about 15 to 20) for each crossing is relatively small compared to the number of existing trees in the riparian area, but losing the vegetation would leave a 150-foot wide swath of exposed water.

Riparian vegetation along the incised Fivemile Creek (line mile W7) would likely be spanned and no trees would need removal. Because the heavily wooded Eightmile Creek is in a draw where the West Alternative crosses (line mile W7.5), the riparian areas (where trees are providing shade) would be spanned with no tree removal necessary. Some trees in the upland portions of the creek would be removed, but impacts to the stream would be minimal because many trees would remain in the area to provide water absorption and shading.

There are no trees at the Swale Creek crossing at line mile W11, so no riparian vegetation would be impacted.

The West Alternative would cross intermittent tributaries to the Little Klickitat River as well as the river itself (line miles W18 - 22), but no riparian vegetation would be removed because the drainages are incised and would be well below the transmission line. However, scattered groups of trees in upland areas along the Little Klickitat River would be removed, which could potentially affect sedimentation and runoff to the river.

Overall, because the West Alternative would disturbed about 2 acres within 50 feet of intermittent streams and this amount would be spread over nine areas where erosion control measures would be used to ensure sedimentation would not reach water; most riparian areas would be left untouched with the exception of Threemile Creek, where some shade tree removal could have a small impact on water temperatures when the water level is low; and because access road crossings would be limited to intermittent streams, where culverts would be used to ensure unobstructed flows, the West Alternative would have a ***low*** impact on water resources.

The West Alternative tower options would all have similar low Impacts on water resource. However, West Option 1 would have the smallest ground disturbance and so would potentially have the least risk of erosion and possible sedimentation; West Option 5 would have the greatest ground disturbance and the greatest potential for sedimentation impacts. Ground disturbance amounts for West Options 2, 3, 4, and 6 would fall between the two other options.

The floodplains of the four main water ways crossed by the West Alternative are narrow and would be avoided. No towers or access roads would be within floodplains; therefore the West Alternative would have ***no*** impact on floodplains.

Wetlands

Potentially impacted wetland areas (and some wetland buffers) along the West Alternative are all in Klickitat County, located just north of the Columbia River and scattered along the proposed transmission line corridor from line mile W11 near Swale Creek to line mile W24 northwest of Goldendale. (See Map 3-7 and Table 3-19. Map 3-7 shows all wetlands near each alternative, of which only some could be potentially impacted by tower footings or access roads.
Table 3-19 lists only wetlands and buffers that could be impacted.)

> **References to Wetlands**
>
> To assess potential impacts of the transmission line alternatives on specific wetlands and buffers, wetlands within 1,000-2,000 feet of the proposed rights-of-way were identified and analyzed. Each wetland is identified as WL (for wetland) and followed by a letter and number. For example, WL-W10 is Wetland 10 found along the West Alternative. WL-WME2 is Wetland 2 in the vicinity of all alternatives (West, Middle and East) where they share a common alignment. These labels, and corresponding line miles, are used in several tables in this section.

Along the West Alternative, about 0.8-1.2 acres in 13 different palustrine emergent or mixed palustrine emergent and scrub-shrub wetlands could be permanently impacted by fill (dirt, rock, or concrete) required for tower footings and upgrading or building new access roads (see Table 3-20). An additional 0.8-1.8 acres of wetlands could be temporarily impacted during tower construction activities.

Impacts would vary depending on wetland quality (or “functional level”). Three wetlands that could be impacted by tower footings and access road construction are high quality because of their special characteristics, with two having vernal pool features (see Table 3-19). Four wetlands could have more than 0.10 acre (an acreage threshold for requiring compensation mitigation) impacted, and three of these wetlands are considered high quality. Impacts to wetlands from the West Alternative would be ***high****.*

West Option 1 would impact the least amount of wetlands, whereas Options 5 and 6 would have the highest potential impact (West Options 2, 3, and 4 would have impacts that would fall between the other options).

Table 3-19. Potentially Impacted Wetlands/Buffers along the West Alternative

Line Mile	Wetland ID	Classification	Size[1] (acres)	Type and Size (acres) of Potential Impact[2]	Functional Level[3]
W2.5[4]	WL-W10	Palustrine scrub-shrub and emergent	5	Tower (0.12–0.15), Road (0.19)	High
W3.5[4]	WL-W12	Palustrine scrub-shrub and emergent	5	Tower in buffer	N/A
W3.8[4]	WL-W23	Palustrine emergent	1.9	Tower (0.12–0.14), Road (0.03)	High–vernal pool characteristics
W10	WL-W26	Palustrine emergent	1.2	Road (0.02)	N/A
W10.3	WL-W27	Palustrine emergent	0.4	Road (0.01)	N/A
W10.5	WL-W28	Palustrine emergent	1.4	Tower (up to 0.01), Road (0.01)	Low
W10.5	WL-W29	Palustrine emergent	<0.1	Tower (up to 0.01), Road (0.001)	N/A
W10.8	WL-W30	Palustrine emergent	0.1	Tower (up to 0.05), Road (0.08)	Low
W12.3	WL-W14	Palustrine emergent	0.7	Road in buffer	N/A
W13.8	WL-W15	Palustrine emergent	0.5	Road (0.05)	Low
W15	WL-W16	Palustrine emergent	1.4	Tower in buffer	N/A
W16.5	WL-W20	Palustrine scrub-shrub and emergent	0.3	Road in buffer	Moderate
W16.5	WL-W33	Palustrine scrub-shrub and emergent	0.7	Road (0.11)	Moderate
W18	WL-W35	Palustrine scrub-shrub and emergent	0.9	Tower (up to 0.04), Road (0.03)	Moderate
W18.8	WL-W37	Palustrine emergent	1.5	Tower in buffer	N/A
W20.8	WL-WM2	Palustrine scrub-shrub and emergent	9.3	Tower (0.02–0.03)	High
W21.5	WL-WM4	Palustrine emergent	1.6	Tower (up to 0.15), Road (0.12)	High–vernal pool characteristics
W24	WL-WME2	Palustrine scrub-shrub and emergent	17.6	Road (0.02)	Moderate

[1] Approximate size of wetland within 1,000-2,000 feet of proposed right-of-way.

[2] Permanent impacts. Road impacts include those from both new and improved access road construction.

[3] Functional level based on Ecology Wetland Rating Form for Eastern Washington. N/A means functional level could not be assessed.

[4] Wetlands located within the National Scenic Area.

Note: Indirect impacts to wetlands (i.e., buffer impacts) were not fully assessed in this analysis, but would be once an alignment is selected, wetland delineations are completed and buffer widths are established.

Table 3-20. Potential Wetland Impacts by Action Alternative[1]

Wetlands Type	Tower Construction (acres)		Access Road Construction[2] (acres)	
	Permanent Disturbance	Temporary Disturbance	Permanent Disturbance from New Road Construction	Permanent Disturbance from Upgrading Existing Roads
West Alternative				
Palustrine Emergent	0.1–0.4	0.4–1.1	0.3	0
Mixed Palustrine Emergent and Scrub-Shrub	0.1–0.2	0.4–0.7	0.2	0.1[3]
Total	0.2–0.6	0.8–1.8	0.5	0.1
Middle Alternative				
Palustrine Emergent	0.1	0.4–0.7	0.6	0.3
Mixed Palustrine Emergent and Scrub-Shrub	0	0–<0.1	<0.1	0
Total	0.1	0.4–0.7	0.6	0.3
East Alternative				
Palustrine Emergent	<0.1	0.4	0.2	0.2
Mixed Palustrine Emergent and Scrub-Shrub	0	0	<0.1	0
Total	<0.1	0.4	0.2	0.2

[1] Range of impacts reflects different tower options.
[2] There would be no temporary disturbance to wetlands from access road construction.
[3] For the West Alternative, this number reflects improvements to both access roads and 5 miles of county roads.

Middle Alternative

Water Resources

From south to north, the Middle Alternative would cross Fifteenmile Creek three times (once at line mile M0.5 and twice between line miles M2.5-3.2) and the Columbia River (between line miles M7-8). It would cross drainages to the Columbia River on the south side of the Columbia Hills, and drainages to Swale Creek on the north side of the hills. The Middle Alternative would then cross Swale Creek at line mile M15, more small intermittent creeks, and the Little Klickitat River just before line mile M20. As with the other alternatives, several drainages to the Little Klickitat via Spring Creek would be crossed as routes head north to the Knight Substation sites (line miles M23, M23.5, M24, and M26).

Eight to 12 towers along the Middle Alternative would be within 50 feet of intermittent streams, disturbing about 2.2 acres during construction (see Table 3-17). New access roads would cross 10 intermittent streams, drainages or dry-washes; in addition, improvements would be made to 10 existing access roads that cross streams (see Table 3-18). Up to 28 new culverts would need to be installed. One existing access road would be upgraded where it runs adjacent to the stream buffers of Fifteenmile Creek (south of the creek near line mile M2). As with the West Alternative, some new and improved access roads would be built near the Little Klickitat River's north bank between line miles M20-21. The closest portion of the road would be about 250 feet from the edge of the riparian area. With proper road design and erosion control measures used during construction, sedimentation and runoff from tower or road construction would not reach water bodies.

Fifteenmile Creek has a woody riparian cover in a ravine that would be well below all three crossings of the Middle Alternative line (line miles M1, M2.5, and M3); no riparian vegetation would be removed. No riparian vegetation along the Columbia River would be impacted; the towers at the Columbia River crossing would be far from the edge of the river, no trees would be removed, and any riparian vegetation present would not affect the river water temperature given the expanse of the river.

There are no trees at the Swale Creek crossing at line mile M15, so no riparian vegetation would be impacted.

Where the Middle Alternative crosses the Little Klickitat River (line mile M19.5), riparian vegetation would not be removed because the river is in a draw and the vegetation would be well below the transmission line. Some pine trees would be removed in upland areas on either side of the river, which could potentially affect sedimentation and runoff to the river.

Overall, because about 2.2 acres disturbed within 50 feet of intermittent streams would be spread over 8-12 areas where erosion control measures would be used to ensure sedimentation would not reach water; riparian areas would be left untouched; and access road crossings would be limited to intermittent streams where culverts would be used to ensure unobstructed flows, the Middle Alternative would have a ***low*** impact on water resources.

The Middle Alternative tower options would all have similar low Impacts on water resource. However, Middle Option 1 would have the smallest ground disturbance and so would potentially have the least risk of erosion and possible sedimentation, and Middle Option 3 would have the greatest ground disturbance and the greatest potential for sedimentation impacts. Ground disturbance amounts for Middle Option 2 would be between Options 1 and 3.

No towers or new access roads would be built in floodplains. A portion of one existing access road paralleling the southeast bank of Fifteenmile Creek is within the creek's floodplain and would need to be upgraded. Although the upgrade may increase the compacted soil surface area somewhat, it would have little effect on the floodplain because the road has been in place for several decades and the upgrade would not change the grade or water storage capability of the floodplain. The Middle Alternative would have ***low*** impacts in floodplains.

Wetlands

Potentially impacted wetlands along the Middle Alternative are on either side of the Columbia River crossing, at line miles M7 and M8, and then scattered along the proposed transmission line corridor from line mile M11 at the base of the Columbia Hills to M24 northwest of Goldendale (see Map 3-7 and Table 3-21). About 1 acre in nine different palustrine emergent or mixed palustrine emergent and scrub-shrub wetlands could be permanently impacted by installation of tower footings and upgrading or building new access roads (see Table 3-20). An additional 0.4-0.7 acre could be temporarily impacted during tower construction.

Six wetlands would potentially be impacted by more than 0.10 acre (a threshold requiring compensation mitigation). One is identified as a high-quality wetland with vernal pool characteristics; two of the wetlands are considered low quality; and the functional levels of the other three are unknown given lack of permission to enter the property. Impacts to wetlands from the Middle Alternative would be ***moderate-to-high***.

Middle Option 1 would impact the least amount of wetlands, whereas Options 2 and 3 would have the highest potential impact.

Table 3-21. Potentially Impacted Wetlands/Buffers along the Middle Alternative

Line Mile	Wetland ID	Classification	Size[1] (acres)	Type and Size (acres) of Potential Impact[2]	Functional Level[3]
M7[4]	WL-ME3	Palustrine emergent	0.5	Road in buffer	Moderate
M8[4]	WL-ME11	Palustrine emergent	4.8	Road (0.19)	Low
M8.3[4]	WL-ME13	Palustrine emergent	0.1	Road in buffer	Low
M10.8[4]	WL-M1	Palustrine emergent	0.6	Road (0.07)	N/A
M11.3[4]	WL-M4	Palustrine emergent	0.6	Tower in buffer Road (0.07)	Low
M13.5	WL-M5	Palustrine emergent	1.5	Road (0.15)	N/A
M14.8	WL-M9	Palustrine emergent	1.3	Road (0.10)	N/A
M15	WL-M12	Palustrine emergent	8.8	Tower (0.13) Road (0.10)	N/A
M17	WL-M13	Palustrine emergent	2.0	Road in buffer	Low
M17.5	WL-M15	Palustrine emergent	2.3	Tower in buffer	Low
M18.5	WL-M16	Palustrine emergent	2.3	Road (0.13)	Low
M20.8	WL-WM4	Palustrine emergent	1.6	Road (0.12)	High–vernal pool characteristics
M24.3	WL-WME2	Palustrine scrub-shrub and emergent	17.6	Road (0.02)	Moderate

[1] Approximate size within 1,000–2,000 feet of proposed right-of-way.
[2] Permanent impacts. Road impacts include those from both new and improved access road construction.
[3] Functional level based on Ecology Wetland Rating Form for Eastern Washington. N/A means functional level could not be assessed.
[4] Wetlands within the National Scenic Area.

East Alternative

Water Resources

From south to north, the East Alternative would cross Fifteenmile Creek three times (once at line mile E0.5 and twice between line miles E2.5-3.2) and the Columbia River (between line miles E7-8). It would cross drainages to the Columbia River on the south side of the Columbia Hills, and drainages to Swale Creek on the north side of the hills. The East Alternative would then cross Swale Creek at line mile E18.5, more small intermittent creeks, and the Little Klickitat River at line mile E23. As with the other alternatives, several drainages to the Little Klickitat via Spring Creek would be crossed as routes head north to the Knight Substation sites (line miles E24.5, E25, M25.5, E27.5).

Four to five towers along the East Alternative would be within 50 feet of intermittent streams, disturbing about 2.7-2.9 acres during construction (see Table 3-17). New access roads would cross 22 intermittent streams, drainages or dry-washes; in addition, improvements would be made to eight existing access roads that cross streams (see Table 3-18). Up to 30 new culverts would be installed. One existing access road would be upgraded where it would run next to the stream buffers of Fifteenmile Creek (south of the creek near line mile E2). With proper erosion control measures used during construction, sedimentation and runoff from tower or road construction would not reach water bodies.

Fifteenmile Creek has a woody riparian cover in a ravine that would be well below all three creek crossings of the East Alternative (line miles E1, E2.5, and E3); no riparian vegetation would be removed. No riparian vegetation along the Columbia River would be impacted; the towers at the Columbia River crossing would be far from the edge of the river, no trees would be removed, and any riparian vegetation present would not affect the river water temperature given the expanse of the river.

There are no trees at the Swale Creek crossing at line mile E19, so no riparian vegetation would be impacted.

Where the East Alternative would cross the Little Klickitat River (line mile E23), riparian vegetation would not be removed because the river is in a draw and the vegetation would be well below the transmission line. Some trees would be removed in upland areas on either side of the river, which could potentially affect sedimentation and runoff to the river.

Overall, because the total 2.7-2.9 acres disturbed within 50 feet of intermittent streams would be spread over four to five areas with erosion control measures used to ensure sedimentation would not reach water; riparian areas would be left untouched; and access road crossings would be limited to intermittent streams where culverts would be used to ensure unobstructed flows, East Alternative would have a ***low*** impact on water resources.

The East Alternative tower options would all have similar low Impacts on water resource. However, East Option 1 would have the smallest ground disturbance and so would potentially have the least risk of erosion and possible sedimentation, and East Option 3 would have the greatest ground disturbance and the greatest potential for sedimentation impacts. Ground disturbance amounts for East Option 2 would be between Options 1 and 3.

No towers or new access roads would be built in floodplains. As with the Middle Alternative, a portion of the existing access road paralleling the southeast bank of Fifteenmile Creek is within the creek's floodplain and would be upgraded. This upgrade would have little effect on the floodplain because the road has been in place for several decades and, although the upgrade may further compact a small area of the surface, it would not change the grade of the floodplain or the water storage capability. The East Alternative would have ***low*** impacts in floodplains.

Wetlands

Potentially impacted wetlands along the East Alternative are on either side of the Columbia River crossing, at line miles E7 and E8, and then much farther north along the alternative's proposed route between line miles E18 (southeast of Centerville) and E26 (northwest of Goldendale). (See Map 3-7 and Table 3-22.)

About 0.5 acre in five different palustrine emergent and mixed palustrine emergent and scrub-shrub wetlands could be permanently impacted by installation of tower footings and upgrading or building new access roads—the least wetland disturbance of all alternatives (see Table 3-20). An additional 0.4 acre could be temporarily impacted during tower construction.

Two wetlands would potentially be impacted by more than 0.10 acre (a threshold for requiring compensation mitigation). One of those wetlands is identified as a low quality wetland; the functional level of the other wetland is unknown given lack of permission to enter the property. Impacts to wetlands from the East Alternative would be ***low-to-moderate***.

The East Alternative tower options would all have the same potential impacts on wetlands.

Table 3-22. Potentially Impacted Wetlands/Buffers along the East Alternative

Line Mile	Wetland ID	Classification	Size[1] (acres)	Type and Size (acres) of Potential Impact[2]	Functional Level[3]
E7[4]	WL-ME3	Palustrine emergent	0.5	Road in buffer	Moderate
E8[4]	WL-ME11	Palustrine emergent	4.8	Road (0.19)	Low
E8.3[4]	WL-ME13	Palustrine emergent	0.1	Road in buffer	Low
E18	WL-E4	Palustrine emergent	4.5	Tower (0.02)	Low
E19	WL-E7	Palustrine emergent	5.3	Road (0.24)	N/A
E20.8	WL-E9	Palustrine emergent	1.0	Tower, road in buffer	N/A
E22.3	WL-E11	Palustrine emergent	1.7	Tower (0.02)	Low
E22.3	WL-E12	Palustrine emergent	1.0	Road in buffer	Low
E25.5	WL-WME2	Palustrine scrub-shrub and emergent	17.6	Road (0.02)	Moderate

[1] Approximate size within 1,000–2,000 feet of proposed right-of-way.
[2] Permanent impacts. Road impacts include those from both new and improved access road construction.
[3] Functional level based on Ecology Wetland Rating Form for Eastern Washington. N/A means functional level could not be assessed.
[4] Wetlands within the National Scenic Area.

Knight Substation Options

The closest water body to the Knight Substation sites is the intermittent Spring Creek located about 1 mile to the south. A mapped drainage to Blockhouse Creek runs through Site 1, but no sign of the drainage was found during field surveys. Because there are no water bodies in the vicinity of the substation sites, there are no designated floodplains. Because water bodies are far from the sites and the terrain is relatively flat, with implementation of appropriate erosion control measures, construction at either site would result in ***no*** impacts on surface water.

Groundwater at both sites is about 20 to 50 feet below the surface and likely limited. Dewatering during excavating is unlikely to be required. Substation construction would result in ***no-to-low*** impacts on groundwater.

There are no wetland areas on Site 1. A potential palustrine emergent wetland near Site 2 would not be impacted by substation or road construction. There would be ***no*** wetland impacts.

Fiber Optic Cable Options

For the Loop Back Option, no impacts on water resources and wetlands would occur beyond those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential river, stream and wetland impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.5.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on water resources.

- Minimize the project ground disturbance footprint, particularly in sensitive areas such as stream crossings and wetlands, and stream and wetland buffers.
- Develop and implement a Spill Prevention, Control and Countermeasure Plan to minimize the potential for spills of hazardous material, including provisions for storage of hazardous materials and refueling of construction equipment outside of riparian zones, spill containment and recovery plan, and notification and activation protocols.
- Prepare and implement a SWPPP (see mitigation measures in Section 3.4 Geology and Soils) to improve water quality of stormwater runoff.
- Prepare to manage dewatering, including proper disposal of drilling fluids and mud away from wetlands or surface waters.
- Prepare for management of excess concrete.
- Remove and dispose of sediment properly, away from wetlands or surface waters.
- Install culverts for access roads in the dry season or during low-flow conditions if possible to minimize sediment delivery to streams.
- Limit tracking of soil onto paved roads by gravelling road approaches, washing vehicle wheels, and cleaning mud and dirt from paved roads to reduce sediment delivery to roadside ditches and nearby streams.
- Avoid use of heavy equipment and vegetation removal in wetlands and wetland buffer zones to avoid soil compaction, destruction of live plants, and potential alteration of surface water patterns. Use track equipment or matting, if appropriate.
- Avoid placing staging areas in wetlands or stream buffers.
- Avoid placing new access roads through wetland complexes around the Columbia River, Fifteenmile Creek, Little Klickitat River, Spring Creek, Swale Creek, and Blockhouse Creek to minimize the potential for altering surface water patterns and isolating connected wetlands.
- Use high-visibility fencing around wetland buffer zones to avoid inadvertent activity (e.g., parking and driving) in wetlands or buffers or streams.
- Reseed disturbed areas (see mitigation measures in Section 3.3 Vegetation).

3.5.4 Unavoidable Impacts Remaining after Mitigation

Potential Impacts to water resources should be avoided by mitigation measures, though some slight sedimentation could occur to water bodies and ground water and adjustment of surface water flows due to project construction and access roads. Some portions of wetlands would likely be filled, though project design would attempt to avoid wetlands if possible.

3.5.5 No Action Alternative

The No Action Alternative would have no impact on water resources because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.6 Wildlife

This section describes wildlife resources and how the project alternatives could affect these resources. Related vegetation and wetlands information can be found in Sections 3.1 Land Use and Recreation, 3.3 Vegetation, and 3.5 Water Resources and Wetlands.

3.6.1 Affected Environment

The proposed project would cross lands that provide habitat to a wide variety of wildlife. In addition to more common wildlife species, several species known to occur or that could potentially occur in the vicinity have special federal or state status.

Special-Status Species

Special-status species include those protected under the federal Endangered Species Act (ESA) as threatened, endangered, or proposed species; those listed by the U.S. Fish and Wildlife Service (USFWS) as candidate species or species of concern; and those listed for protection by the states of Oregon and Washington.

One species federally listed as threatened and one species listed as a candidate for listing are found in Klickitat County, Washington, but are not likely to occur along any of the action alternatives. The Mardon skipper butterfly (*Polites mardon*) is federally listed as threatened. Habitat for the Mardon skipper consists of native prairie vegetation including Idaho fescue (*Festuca idahoensis*) and blue violet (*Viola* spp.), which can occur in glacial outwash prairies and openings and ridgetops in ponderosa pine (*Pinus ponderosa*) woodlands (Larson 1995). The closest known location is in ponderosa pine woodlands in the Cascade Mountains about 21 miles north of the project.

The Oregon spotted frog (*Rana pretiosa*) is a candidate species. There are only three documented populations of the Oregon spotted frog in Washington, two of which are in Klickitat County about 18 miles northwest of the project in the easternmost extent of its historic range (Larsen 1997).

Thirty-four other special-status species categorized as federal species of concern or state-listed species have the potential to occur in the project area, many of which could occur in two or more habitats (ORNHIC 2007; ODFW 2009; WDFW 2009a). See Table 3-23 for a list of those species according to the habitat(s) they occupy. Fourteen of these are likely to be in the project area according to state databases or field observations.

Table 3-23. Special-Status Species Documented[1] or with Potential to Exist along the Action Alternatives

Common Name[2] *Latin Name*	Habitat Type	Found in Project Vicinity[1]	Alternative Location (state)	Oregon State Status	Washington State Status	Federal Status[3]
Croplands (Agricultural Fields)						
Golden eagle ***Aquila chrysaetos***	Breeding, foraging	Yes	Middle (WA), East (OR, WA)	None	Sensitive	None
Prairie falcon ***Falco mexicanus***	Breeding, foraging	No		None	Monitor	None
Peregrine falcon ***Falco peregrines***	Breeding, foraging	No		Sensitive-vulnerable	Candidate	Species of concern (delisted, monitor)
Burrowing owl ***Athene cunicularis***	Breeding, foraging	No		Sensitive-critical	Candidate	Species of concern
Long-billed curlew ***Numenius americanus***	Foraging	Yes	Middle, East (WA)	Sensitive-vulnerable	Monitor	None
Ferruginous hawk ***Buteo regalis***	Breeding, foraging	No	West, Middle, East (OR, WA)	Sensitive-Critical	Threatened	Species of Concern
Grassland/Shrub-Steppe						
Sharptail snake ***Contia tenuis***	Breeding, foraging	No		None	Candidate	Species of concern
Burrowing owl ***Athene cunicularis***	Breeding, foraging	No		Sensitive-critical	Candidate	Species of concern
Loggerhead shrike ***Lanius ludovicianus***	Breeding, foraging	No		Vulnerable	Candidate	Species of concern
Long-billed curlew ***Numenius americanus***	Foraging	Yes	West (WA)	Sensitive-vulnerable	Monitor	None
White-tailed jackrabbit ***Lepus townsendii***	Breeding, foraging	No		None	Candidate	None
Black-tailed jackrabbit ***Lepus californicus***	Breeding, foraging	No		None	Candidate	None
Black-tailed deer ***Odocoileus hemionus columbianus***	Foraging	Yes	West (WA)	None	Priority	None
Mule deer ***Odocoileus hemionus hemionus***	Foraging	Yes	West (WA)	None	Priority	None
Golden eagle ***Aquila chrysaetos***	Breeding, foraging	Yes	West (WA)	None	Sensitive	None
Prairie falcon ***Falco mexicanus***	Breeding, foraging	Yes	West, Middle (WA)	None	Monitor	None
Peregrine falcon ***Falco peregrines***	Breeding, foraging	Yes	West (WA)	Sensitive-vulnerable	Candidate	Species of concern (delisted, monitor)

Common Name[2] *Latin Name*	Habitat Type	Found in Project Vicinity[1]	Alternative Location (state)	Oregon State Status	Washington State Status	Federal Status[3]
Ferruginous hawk ***Buteo regalis***	Breeding, foraging	No	West, Middle, East (OR, WA)	Sensitive-Critical	Threatened	Species of concern
Woodlands (Oregon White Oak Woodland/Oregon White Oak-Ponderosa Pine)						
Western gray squirrel ***Sciurus griseus***	Breeding, foraging	Yes	West, Middle (WA)	None	Threatened	Species of concern
Black-tailed deer ***Odocoileus hemionus columbianus***	Wintering	Yes	West (WA), Middle/East (OR)	None	Priority	None
Mule deer ***Odocoileus hemionus hemionus***	Wintering	Yes	West (WA), Middle/East (OR)	None	Priority	None
Lewis' woodpecker ***Melanerpes lewis***	Breeding, foraging	Yes	West (WA)	Sensitive-critical	Candidate	Species of concern
Olive-sided flycatcher ***Contopus cooperi***	Breeding, foraging	No		Sensitive-vulnerable	None	Species of concern
Long-eared myotis ***Myotis evotis***	Breeding, foraging	No		None	Monitor	Species of concern
Wild turkey ***Melanerpes gallopavo***	Breeding, foraging	Yes	West (WA), Middle/East (OR)	None	Priority	None
Sharptail snake ***Contia tenuis***	Breeding, foraging	No		None	Candidate	Species of concern
Silver-haired bat ***Lasionycterius noctivagans***	Breeding, foraging	No		Sensitive-vulnerable	None	Species of concern
California mountain kingsnake ***Lampropeltis zonata***	Breeding, foraging	No		Sensitive-vulnerable	Candidate	None
Wetlands						
Oregon spotted frog ***Rana pertiosa***	Breeding, foraging	No		Sensitive-critical	Endangered	Candidate
Northern leopard frog ***Rana pipens***	Breeding, foraging	No		Sensitive-critical	Endangered	None
Western toad ***Anaxyrus boreas***	Breeding, foraging	No		Sensitive-vulnerable	Endangered	Species of concern
Western painted turtle ***Chrysemys picta bellii***	Breeding, foraging	No		Sensitive-critical	None	None
Western pond turtle ***Actinemys marmorata***	Breeding, foraging	Yes	West (WA)	Sensitive-critical	Endangered	Species of concern
Pallid bat ***Antrozous pallidus***	Breeding, foraging	No		Sensitive-vulnerable	Monitor	Species of concern

Common Name[2] *Latin Name*	Habitat Type	Found in Project Vicinity[1]	Alternative Location (state)	Oregon State Status	Washington State Status	Federal Status[3]
Townsend's big-eared bat ***Corynorhinus townsendii***	Foraging	No		Sensitive-critical	Candidate	Species of concern
Long-eared myotis ***Myotis evotis***	Breeding, foraging	No		None	Monitor	Species of concern
Long-legged myotis ***Myotis volans***	Breeding, foraging	No		Sensitive-vulnerable	Monitor	Species of concern
Small-footed myotis ***Myotis ciliolabrum***	Breeding, foraging	No		None	Monitor	Species of concern
Yuma myotis ***Myotis yumanensis***	Breeding, foraging	No		None	None	Species of concern
Riparian Areas						
Mountain quail ***Oreortyx pictus***	Breeding, foraging	Yes	East (WA)	None	Priority	Species of concern
Black-tailed deer ***Odocoileus hemionus columbianus***	Wintering	Yes	West (WA), Middle/East (OR)	None	Priority	None
Mule deer ***Odocoileus hemionus hemionus***	Wintering	Yes	West (WA), Middle/East (OR)	None	Priority	None
Rock Outcrops						
Sagebrush lizard ***Sceloporus graciosus***	Breeding, foraging	Yes	East (WA)	Sensitive-vulnerable	Candidate	Species of concern
Cliffs						
Golden eagle ***Aquila chrysaetos***	Breeding, foraging	Yes	East (OR, WA)	None	Sensitive	None
Prairie falcon ***Falco mexicanus***	Breeding, foraging	Yes	East (OR, WA)	None	Monitor	None
Peregrine falcon ***Falco peregrines***	Breeding, foraging	Yes	West, Middle, East (OR, WA)	Sensitive-vulnerable	Candidate	Species of concern (delisted, monitor)
Pallid bat ***Antrozous pallidus***	Breeding, foraging	No		Sensitive-vulnerable	Monitor	Species of concern
Spotted bat ***Euderma maculatum***	Breeding, foraging	No		Sensitive-vulnerable	Monitor	Species of concern
Small-footed myotis ***Myotis ciliolabrum***	Breeding, foraging	No		None	Monitor	Species of concern
Long-legged myotis ***Myotis volans***	Breeding, foraging	No		Sensitive-vulnerable	Monitor	Species of concern
Yuma myotis ***Myotis yumanensis***	Breeding, foraging	No		None	None	Species of concern

Common Name[2] *Latin Name*	Habitat Type	Found in Project Vicinity[1]	Alternative Location (state)	Oregon State Status	Washington State Status	Federal Status[3]
Open Water						
Bald eagle ***Haliaeetus leucocephalus***	Foraging	Yes	West (OR), Middle/East (OR, WA)	Threatened	Sensitive	Species of concern (delisted, monitor)
American white pelican ***Pelecanus erythrorhynchos***	Foraging	Yes	West (OR), Middle/East (OR, WA)	Sensitive-vulnerable	Endangered	None

[1] Documented occurrences of species either come from state database information (see sources below) or BPA field surveys in 2009 and 2010.

[2] Some species are listed more than once if they occur in more than one habitat.

[3] Species of Concern is a designation given by the USFWS. No threatened, endangered, or candidate species under the Endangered Species Act are likely to occur in the project area.

Sources: Oregon Department of Fish and Wildlife 2009; Oregon Natural Heritage Information Center 2007; Washington Department of Fish and Wildlife 2009; Washington Department of Fish and Wildlife 2010a.

The USFS protects sensitive invertebrate species on USFS lands crossed by the Middle and East alternatives (see Appendix D for a list of these species). These sensitive invertebrate species require habitat with some kind of water source (cold springs, streams) or moist conifer forest; this type of habitat is not found along the Middle or East alternatives where they cross USFS land, so these species are not present. The USFS land in this area is not covered by the Northwest Forest Plan, so USFS Survey and Manage species requirements are not applicable to these lands.

The project area is in the Pacific Flyway. In addition to ESA and state regulations, the Migratory Bird Treaty Act and CRGNSA Management Plan also provide protection for birds. Most native bird species are protected under the Migratory Bird Treaty Act, which prohibits taking, killing, or possessing protected birds and their eggs and nests. The CRGNSA Management Plan protects a number of endemic species and species of special interest within the National Scenic Area. Many of those species are discussed in this EIS section; a table listing all of those protected species is found in Appendix D, with a determination of whether the species are likely present or could be affected along the action alternatives.

Habitats and Associated Wildlife Species

A variety of habitats occur across the project area: grassland/shrub-steppe, woodlands, riparian areas and wetlands, rock outcrops and cliffs, and cropland. Within these habitats, the states of Oregon and Washington have designated habitats for protection. In Oregon, "strategy" habitats are those habitats that have experienced a high degree of historic loss since 1850 and meet a number of other risk criteria (ODFW 2006). Seven strategy habitats are crossed by the action alternatives including riparian habitats, sagebrush steppe and shrublands, wetlands, and rock habitats (ODFW 2006).

In Washington, priority habitats are those habitat types "with unique or significant value to a diverse assemblage of species," and that are used in guiding conservation and management priorities (WDFW 2008, 2010b). Five priority habitats were identified along the action alternatives using the Washington database and field observations: eastside steppe (grassland), shrub-steppe, Oregon white oak woodland, cliffs, riparian zones, and freshwater wetlands.

Wildlife species may be associated with a specific habitat or may use several habitats; wildlife species are discussed according to the habitat(s) they occupy.

Grassland/Shrub-Steppe

Native shrub-steppe and eastside steppe (grassland) are two WDFW priority habitats found in limited qualities along the action alternatives. High quality native grasslands occur for about 3 miles between line miles W7 and W10 in the Columbia Hills State Park and Columbia Hills Natural Area Preserve. Small areas of native shrub-steppe are found near the Little Klickitat River at line miles W18, W19.5 and WM21. For more information about the vegetation found in these habitats, see Section 3.3 Vegetation.

Much of the shrub-steppe and grassland habitat has been disturbed by agricultural practices and is dominated or co-dominated by nonnative species or more disturbance-tolerant species. These disturbed grassland/shrub-steppe habitats can be found along the length of the action alternatives and at Substation Site 2, and are often interspersed with cropland (see Map 3-5).

Nine special-status species could reside and/or forage in both the high quality and the disturbed grassland/shrub-steppe habitats (see Table 3-23). Special-status species were observed during field surveys in several areas of grassland/shrub-steppe along the West Alternative in Washington, including long-billed curlew, black-tailed deer, mule deer, prairie falcon, and a juvenile golden eagle. The prairie falcon was the only special-status species observed during field surveys along the Middle Alternative in the disturbed grassland/shrub-steppe habitat just north of line mile M13. No special-status species were found in surveys of disturbed grassland/shrub-steppe habitat along the East Alternative. The ferruginous hawk could occur in this habitat, but is rare and has not been observed.

Although still considered disturbed grassland/shrub-steppe due to grazing, areas of dense good quality sagebrush habitat were found in Oregon along north-facing slopes of Fifteenmile Creek and the Columbia River. These communities could provide habitat for breeding pairs of state-listed species such as loggerhead shrike and black-tailed jack rabbit, as well as wintering habitat for mule deer and black-tailed deer.

Common species associated with high quality native grasslands and shrub-steppe include northern harrier (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), western meadowlark (*Sturnella neglecta*), horned lark (*Eremophila alpestris*), and many other passerine bird species that rely on this habitat type for breeding and foraging. The lack of active or intensive farming practices in the high quality habitats allows species to breed and nest without disturbance.

Common species associated with both disturbed and native grassland/shrub-steppe include mammals such as coyote (*Canis latrans*) and various species of rodents, reptiles such as western rattlesnake (*Crotalus viridis*) and western fence lizard (*Sceloporus occidentalis*), and birds such as red-tailed hawk (*Buteo jamaicensis*) and northern flicker (*Colpates auratus*). This habitat type is also important for a variety of passerines and game birds such as Mountain quail (*Oreotryx pictus)*, California quail (*Callipepla californica*), and ring-necked pheasant (*Phasianus colchicus*).

Woodlands

Extensive woodlands are scarce along the action alternatives, however, the alternatives cross, in total, 18 woodland areas (see Table 3-12 and Map 3-5 in Section 3.3 Vegetation). These woodlands are mostly associated with riparian habitat and are found along Fifteenmile Creek in Oregon, on the West Alternative along drainages of the Columbia Hills and through the Columbia Hills State Park and the Columbia Hills Natural Area Preserve, and where the alternatives cross or parallel the Little Klickitat River.

All the woodlands support wildlife species, but woodlands that are considered priority habitat may be the only place some special-status species are found. Oregon white oak woodlands greater than 5 acres are WDFW priority habitats that occur within the transition zone between conifers and grassland/shrub-steppe along the action alternatives. The Oregon white oak-ponderosa pine designation includes pure Oregon white oak stands or oak-conifer associations (usually with ponderosa pine in the project area), with oak trees having 25 percent of the canopy cover, or 50 percent if overall canopy cover is less than 25 percent (Larson and Morgan 1998). Seven of the woodland areas crossed are priority woodland habitat. The West Alternative crosses these priority habitats along the Columbia Hills between line miles W5-7 (Woodlands 4, 5, 6, and 7) and near the Little Klickitat River at line mile W19 (Woodland 10); the Middle and East alternatives cross these priority habitats near the Little Klickitat River at line miles M19 (Woodland 17) and E22 (Woodland 18).

In addition, a number of widely dispersed stands of ponderosa pine also occur in the more upland portions of the area at line miles W12, W18, and WM20 (Woodlands 8, 9, and 11).

The woodlands have the potential to support 10 special-status wildlife species (see Table 3-23). Five special-status woodland species were found during field surveys, including wild turkey, wintering mule and black-tailed deer along the action alternatives, as well as western gray squirrel and Lewis' woodpecker along the West Alternative. Multiple sightings and potential nesting platforms for western gray squirrel were observed in the Oregon white oak and ponderosa pine woodland where the West Alternative follows the Little Klickitat River (line miles W18-20, Woodland 9 and 10). Additional special-status species likely to occur in these woodlands include olive-sided flycatcher, long-eared myotis, wild turkey, sharptail snake, silver-haired bat, the California mountain kingsnake and black-tailed deer, and mule deer.

Common wildlife species that can also be found in these woodlands include mammals such as western skink (*Eumeces skiltonianus*), raccoon (*Procyon lotor*), and small rodents such as deer mouse (*Peromyscus maniculatus*); reptiles such as southern alligator lizard (*Elgaria multicarinata*); and birds such as Cooper's hawk (*Accipiter cooperii*), barn owl (*Tyto alba*), downy woodpecker (*Picoides pubsecens*), ash-throated flycatcher (*Myiarchus cinerascens)*, and red-tailed hawk (*Buteo jamaicensis*). For example, red-tailed hawks were found nesting just south of Woodland 17 along the Middle Alternative. Unoccupied raptor nests were observed in riparian trees near Fivemile Creek at line mile W7 (Woodland 5) and near Fifteenmile Creek at line mile M1 (Woodland 14). An active long-eared owl (*Asio otus*) nest was also observed in the Oregon white oak between line miles W7-8 (Woodland 6).

Riparian and Wetland Habitats

Riparian habitats are vegetation areas that rely on the presence of surface water. They can be found along rivers, creeks, and dry washes. Riparian habitats include the wooded areas along rivers and creeks (see woodlands discussion), Swale Creek (which is not wooded where the alternatives cross), and the vegetated areas along wetlands.

The shrubs and trees of riparian woodlands and scrub-shrub wetlands provide suitable breeding habitat and migration and dispersal corridors for many bird and mammal species, including three special-status species: mule deer, black-tailed deer, and mountain quail.

Common species that use these areas for nesting and/or foraging include birds such as the red-winged blackbird *(Agelaius phoeniceus*), red-tailed hawk, American kestrel (*Falco sparverius*), barn owl (*Tyto alba*), great horned owl (*Bubo virginianus*), and song sparrow (*Melospiza melodia*); and mammals such as the raccoon. Also, an inactive raptor nest was observed in the riparian corridor along Fifteenmile

Creek, and mountain quail have also been documented near the East Alternative by Swale Creek and one of its tributaries (line mile E19) (WDFW 2009b).

The Swale Creek area along the West Alternative (line mile W11) was observed to have a particularly diverse concentration of paired shorebirds, waterfowl, passerines, raptors, and game birds. Species observed during the field surveys in this area include paired long-billed curlews, a flock of mountain quail, a bald eagle that flew over the area, an active great horned owl nest with fledglings, an active ruffed grouse (*Bonasa umbellus*) nest, and several unoccupied songbird nests likely leftover from last year's nesting season.

Wetlands occur along perennial and seasonal streams and drainages; they can form naturally or be created by humans (e.g., stock ponds). These habitats are important foraging and breeding habitats for a variety of common amphibians, shorebirds, and waterfowl.

About 63 wetlands are found along the West Alternative, creating about 69 acres of wetland habitat within 1,000–2,000 feet of the West Alternative. About 41 wetlands are found along the Middle Alternative, creating about 104 acres of wetland habitat within 500–1,000 feet of the Middle Alternative. About 37 wetlands are found along the East Alternative, creating about 72 acres of wetland habitat within 500–1,000 feet of the East Alternative. (See Map 3-7 and Section 3.5 Water Resources and Wetlands for more details about wetlands).

Seasonal wetlands and ponds as well as pools and backwater areas along creeks that have emergent vegetation and areas of standing water most of the year provide suitable breeding habitat for amphibians and turtles, including five special-status species: Oregon spotted frog (*Rana pertiosa),* Northern leopard frog (*Rana pipens),* western toad (*Anaxyrus boreas),* Western toad (*Anaxyrus boreas),* and western pond turtle (*Actinemys marmorata)* (see Table 3-23). These wetland areas could also provide foraging habitat for six special-status bat species: Pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii*), Long-eared myotis (*Myotis evotis*), Long-legged myotis (*Myotis volans*), Small-footed myotis (*Myotis ciliolabrum*), and Yuma myotis (*Myotis yumanensis*). The western pond turtle was found in a wetland along the West Alternative near line mile W3.

Open Water

The action alternatives cross Fifteenmile Creek, the Columbia River, Swale Creek, and the Little Klickitat River. These water sources could be used by various species of waterfowl and raptors as foraging habitat. Also, waterfowl and shorebirds are known to concentrate at Spearfish Lake and Horsethief Lake, which are less than 1 mile from the West Alternative. The Columbia River in particular provides suitable foraging habitat for such special-status bird species as the bald eagle and American white pelican, and common species such as osprey (*Pandion haliaetus*) and double-crested cormorant (*Phalacrocorax auritus*). The bald eagle and white pelican were both observed along the Columbia River along the action alternatives (see Table 3-23).

Rock Outcrops and Cliffs

There are small, isolated patches of rock outcrops scattered throughout the project area among the agricultural fields north of the Columbia Hills or co-occurring with cliff habitat (see Map 3-5). A large concentration of high quality rock outcrops interspersed with grassland/shrub-steppe and sandy soils occurs along the Columbia River between line miles W2–3, W4–5, near W8 and W11, and between line miles ME7–9, E9-14. Rock outcrops provide potential habitat for sagebrush lizard (*Sceloporus graciosus*), a federal species of concern, and common reptiles such as gopher snake (*Pituophis catenifer catenifer*) and western fence lizard (*Sceloporus occidentalus*). Sagebrush lizard was not found during field surveys on rock outcrops in the project area, though it has been found historically along the East Alternative in Washington.

Cliffs are a WDFW priority habitat and provide suitable raptor nesting locations along ledges and bat roosting sites in cracks and crevices. Eight special-status species of raptors and bats could reside in these habitats along the proposed routes; golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrines*), pallid bat (*Antrozous pallidus*), spotted bat (*Euderma maculatum*), small-footed myotis (*Myotis ciliolabrum*), long-legged myotis (*Myotis volans*), and Yuma myotis (*Myotis yumanensis*) (see Table 3-23).

Peregrine falcon was the only special-status raptor species observed along the West Alternative in the cliff habitat along the Columbia River in both Oregon and Washington, and a peregrine falcon nest has been documented along the cliffs on the south bank of the Columbia River north of the Middle and East alternatives (ORNHIC 2009).

Three falcon eyries (nest sites) were observed near the Middle and East alternatives' Columbia River crossing: two were observed on the Oregon side of the crossing (line mile ME7) and one was observed on the Washington side (ME8). It was difficult to get a view into these eyries, so species occupancy and activity are unknown. An unknown, unoccupied raptor nest was observed along the cliff line just south of the Middle and East alternatives on the Washington side. A known golden eagle nest was observed just south of the East Alternative near line mile E12 (WDFW 2009b). This nest is unoccupied. Also south of the East Alternative, there is a known prairie falcon eyrie near line mile E12 (WDFW 2009b). The status of this nest is unknown.

Common species using these cliffs include the common raven (*Corvus corax*), American crow (*Corvus brachyrhynchos*), Swainson's hawk (*Buteo swainsoni*), violet-green swallow (*Tachycineta thalassina*), northern rough-winged swallow (*Stelgidopteryx serripennis*), cliff swallow (*Petrochelidon pyrrhonota*), and yellow-bellied marmot (*Marmota flaviventris*).

Cropland

Cultivated fields and farmsteads are widespread in the area and provide foraging or nesting and roosting habitat for many birds and bats. Farm buildings and trees in farmsteads and along field edges also provide potential nesting and roosting sites for six special-status bird species (golden eagle, prairie falcon, peregrine falcon, ferruginous hawk, burrowing owl, long-billed curlew) and common species such as owls, hawks, and bats. Cultivated fields provide foraging habitat for horned lark, mountain quail, and others.

No burrowing owl burrows were found during field surveys; however there is some suitable burrowing owl habitat along field margins and fence rows. Isolated stands of trees were often observed to be used as nesting sites throughout the project area. Several nests were observed in these isolated trees, including raptor nests at line mile M16, a long-eared owl nest just east of the East Alternative near line mile E16, an active raven's nest between line miles WM20-21, two active red-tailed hawk nests near line miles WM20, WM22-23 and E24 and an active great horned owl nest near line miles WM24-25 (E26), and unoccupied remnant raptor nests at line miles W13, WM21, and between line miles WM25 (E26) and the end of the transmission line routes.

The long-billed curlew was found in cultivated fields near the Middle and East alternatives in Washington and golden eagle was found in cultivated fields along the Middle and East alternatives in Oregon and along the East Alternative in Washington.

3.6.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

None of the action alternatives would impact federal threatened or endangered wildlife species. Other species, including federal species of concern and state-list species could be impacted through construction disturbance, habitat loss, collisions with lines, and to a lesser extent maintenance activities.

New tower footings and access roadbeds would permanently alter current wildlife breeding, roosting, nesting, and foraging sites in all habitats. The loss of trees, shrubs, groundcover, woody debris, and soil or rock could result in habitat losses for mammals, reptiles, birds, and invertebrates. The loss of these resources could also decrease prey populations and other food such as acorns and seeds. Conversely, new towers could provide new or additional roosts for raptors, which would benefit raptor populations, but may adversely affect small mammal, lizard and snake populations due to the increased predation. Impacts would affect both special-status and common species. However, the permanent loss of habitats of special-status species would be a greater impact than the loss of habitats for common species because of the sensitive species' limited distribution and number. Similarly, loss of habitats would be a greater impact on raptors and migratory birds because of federal protection laws; and the loss of WDFW priority habitats would be a greater impact than the loss of other habitats.

Construction disturbances could result in temporary displacement and elevated stress levels for most types of wildlife species in or near the construction area. Disturbances could include noise from heavy equipment, helicopters, blasting, explosive fittings, vehicles, and humans. Most invertebrates, reptiles, and amphibians, including those in wetland areas, in woodlands, in grassland/shrub-steppe, and on rock outcrops, would not typically move great distances to avoid construction activities. These species would experience increased stress where the nearby noise and human disturbance could disrupt foraging, breeding, and other normal activities. Furthermore, these species would likely suffer disproportionate impacts from habitat loss and physical destruction since they are relatively immobile. For more mobile species, displacement both within and near construction sites would occur but would be temporary. In both cases, the impact level would increase if the increased stress or the displacement occurs during the breeding season and results in decreased reproductive capacity or the abandonment and loss of a nest or young, or if the displacement becomes permanent due to habitat alteration.

On cliffs or rock outcrops, lizards and snakes would likely move during construction. However, blasting or drilling in these areas would increase potential direct impacts to reptiles in the vicinity. After construction activities end, reptiles would return.

Noise from maintenance activities would be infrequent and brief, consisting primarily of one to two maintenance vehicles with workers inspecting the area, or transmission line and tower inspections by helicopter. Because of the dry climate and the few trees that would pose a potential threat to the line, there would be little vegetation maintenance needed. Maintenance vehicles would use established access roads; however, if work is required within the right-of-way, habitat in these areas could be trampled. If towers were located in wetlands such that maintenance workers would have to traverse the wetland, wetland species could be impacted. Typical operations and maintenance impacts on wildlife would be much less than impacts that would occur during construction and would be brief and minimally invasive; overall operation and maintenance impacts on wildlife would be ***low*** for the action alternatives.

Electrocution of birds is not an issue with high-voltage transmission lines, even for birds with the largest wingspans. Electrocution is a factor considered in line design: the "physical separation between energized and/or grounded structures, conductors, hardware, or equipment that can be bridged by birds to complete a circuit" (APLIC 2006). Electrocution is more commonly a problem with lower voltage distribution lines that have conductors generally spaced 2 to 6 feet apart. The conductor-to-conductor spacing for the proposed lattice-steel tower would be at least 23 feet.

However, birds can collide with conductors or ground wires. The frequency of bird collisions with transmission lines depends on line placements and configurations and the numbers and species of birds present (Hunting 2002). Installing lines in areas of high bird use or migration is the biggest factor in avian collisions. Transmission lines with a flat configuration (the conductors are on the same horizontal plane) are easier for birds to avoid, while lines that have the conductors stacked (the same vertical plane) can create a fence effect and are harder for birds to avoid. This fence effect can also be created by locating lines next to each other. However, the conductors of 500-kV transmission lines are relatively large and more visible to birds and they fly higher to avoid them. The smaller ground wire strung at the top of the tower is often the wire that birds run into.

Most collisions with power lines occur during flights in areas used daily by a relatively large number of birds. The risk of collisions with power lines also increases when birds are migrating in groups at night or in low visibility conditions such as fog. Waterfowl, shorebirds, and other waterbirds such as egrets and cranes appear to be more susceptible to collision where lines span river valleys, wetland areas, and lakes, or where lines are between waterfowl feeding and roosting areas (McNeil et al. 1985). Important factors in determining the risk of collisions for a bird species include body size, maneuverability, age of the bird, and the height at which the bird flies (Crowder and Rhodes 1999). Mountain quail, pheasant, and other low-flying birds do not typically fly high enough to collide with conductors. Raptors and passerines appear to be more susceptible in upland habitats (Hunting 2002). Also, because the project area is within the Pacific Flyway, migrating birds could collide with the lines. Although bats can be susceptible near wind turbines, bats do not tend to collide with transmission lines because the lines are stationary.

Bird diverters would be installed on overhead ground wires spanning open water or other areas of high bird use to avert possible collisions.

Previous studies have found that electromagnetic fields (EMF) associated with transmission lines do not cause any adverse health, behavioral, or productivity effects in animals, including both wildlife and livestock (Exponent 2009). Some limited research has suggested possible effects of low frequency EMF on biological mechanisms involved in the navigation abilities of honeybees, birds, and bats. For example, some studies report that honeybees and some bird species have the ability to detect EMF and use magnetic navigation. In addition, some recent experiments have reported findings that suggest magnetic field exposure might affect these magnetic navigation systems in both birds and bees (Gill 2007, Hsu et al. 2007). However, there is no conclusive evidence that quantifies these effects, or determines if such effects are found in high-voltage transmission line environments.

Construction, operation, and maintenance of Big Eddy Substation would have ***no*** impact on wildlife, since the Big Eddy Substation yard where upgrade work would occur is highly disturbed (gravel with no vegetation), and contains no wildlife habitat. In addition, the existing substation facility has been in place and operating for many years, so species in the surrounding area are accustomed to construction, operations and maintenance activities.

West Alternative

As described in Section 3.3 Vegetation, about 6–7 acres of high quality shrub-steppe (along the Little Klickitat River) and 24–30 acres of high quality grasslands (through the Columbia Hills State Park and Columbia Hills Natural Area Preserve areas) would be removed from use for towers and access roads on the West Alternative. The lower acreage would be removed if the line is built using single-circuit towers, and the higher acreage would be removed if the line is built using double-circuit towers (larger footprint) for the length of the Chenoweth-Goldendale line. Temporary tower construction activities would affect an additional 3–8 acres of shrub steppe and 7–23 acres of grassland.

The alternative crosses through the middle of the grassland habitat, and would impact those species that use the habitat by removing and fragmenting the habitat. Because grassland habitat could continue to thrive under the transmission line between towers, the lines would not fragment habitat as much as a new access road might. However, even fragmentation from new access roads would be relatively minimal because access roads use would be infrequent and access roads are relatively narrow, so wildlife species could traverse these areas with little impact. Wildlife species in this area, including the long-billed curlew, golden eagle, peregrine falcon, black tailed deer, and mule deer would be disturbed if construction occurred during nesting or breeding season. Species that forage in the area would likely migrate to less disturbed grassland areas within Columbia Hills State Park or the Columbia Hills Natural Area Preserve.

Since the West Alternative crosses the edges of the high quality shrub-steppe, it would not contribute to habitat fragmentation in these areas, but would lessen the overall size of the habitat. Species that use these areas would likely migrate to more contiguous shrub-steppe habitat areas.

Disturbed grassland/shrub-steppe is the most common habitat in the project area and could accommodate species that would be displaced by the West Alternative. If construction occurs during nesting, impacts could lead to displacement or physical disturbance and the loss of a nest or young.

Where the West Alternative crosses woodland areas, the right-of-way would not require a cleared swath through woodlands, because either the woodlands are not dense or intact, or because they are within ravines that would be spanned. About 2–3 acres of woodland (trees and undergrowth) would be removed over eight different woodland areas. Tree removal would involve a few select trees on the fringes of the woodland habitats. Some Oregon white oaks would be removed in the Eightmile Creek draw within the Columbia Hills State Park, which is potential western gray squirrel habitat. However, this woodland area is small and it is unlikely that it provides enough contiguous habitat for the squirrel. Farther north, on the DNR nature preserve, the alternative would cross the eastern edge of oak habitat, but tree removal would be limited to taller ponderosa pines on the high sides of the ravines, and would not substantially impact the habitat. More extensive western gray squirrel habitat is located around the Little Klickitat River, but the West Alternative would pass to the south of this habitat, and tree removal required in this area would be at the fringes of the habitat. Although treed areas are relatively rare in this area and provide essential habitat for many species, species that nest or live in these wooded areas would be less impacted by the limited amount of habitat removal than they would be by disturbance to the surrounding habitat during construction (especially if construction occurred during the nesting or breeding seasons).

Although there is about 69 acres of wetland habitat within 1,000–2,000 feet of the West Alternative, potential impacts to wetlands would be limited to a loss of about 0.5 acre spread over 11 wetlands (see Section 3.5 Water Resources and Wetlands), with an additional 2 acres disrupted during construction. Some of these are considered high quality wetlands that provide good habitat. Impacts on these wetlands would in turn impact species in the wetlands. For less mobile species (amphibians, turtles, and invertebrate species), physical disturbance could result in death of individuals or destruction of eggs. More mobile species (birds, deer, or bats) that use the wetlands for foraging would not be directly harmed. In the long-term, all wetland species would be impacted somewhat because the wetland habitat would be reduced.

Wetland birds could be injured or killed if they collide with overhead ground wires. The largest concentration of wetland birds are expected to congregate in wetlands associated with open water (the Columbia River, the Little Klickitat River, Swale Creek) and other wetlands near line mile WM24.

Impacts on open water species would be limited to birds, as the project would not impact water habitat. Bald eagle and white pelicans seen in the area, as well as migratory birds, water birds, and raptors foraging in these areas could be injured or killed if they collide with overhead ground wires. Potential areas where water birds or foraging raptors could collide with lines include the crossings of the Columbia River, Swale Creek and Little Klickitat River as well as near line mile W3 where birds are likely to fly between Spearfish Lake and Horsethief Lake. Options with double-circuit towers would have more conductors and the conductors would be stacked creating more of a fence effect, making it harder for the birds to navigate. However, the use of bird diverters on overhead ground wires would lessen possible collisions.

Construction noise could also disturb nesting. Construction during nesting could lead to displacement or physical disturbance and the loss of a nest or young. Construction at other times of year would lead to temporary displacement from the area and a temporary shift in foraging areas.

Towers and new access roads could be placed on about 4.5 acres of rock outcrops or cliff habitat, which would create an additional 4 acres of temporary impacts. This acreage would be spread between the Oregon and Washington sides of the Columbia River. Sagebrush lizard, peregrine falcon and possible bat habitat could be impacted. Along cliffs, the West Alternative could create an increased risk of bird collisions with transmission lines. Bird diverters would be placed on overhead ground wires to avert collisions.

Noise during construction could impact peregrine falcon nesting in cliff habitat along the West Alternative as well as possible bat usage.

About 11–13 acres of cropland foraging habitat would be lost due to the placement of towers and access roads and an additional 11–17 acres would be temporarily impacted by construction activities (see Section 3.1 Land Use and Recreation). Since no burrowing owl burrows were found during field surveys, it is unlikely that the owl would be impacted. However, there is some suitable burrowing owl habitat along field margins and fence rows that would be taken up by towers and access roads. Cropland is habitat that is used with the seasons, more when fields are planted and growing than when being tilled. It is not considered high quality habitat and it is abundant along the West Alternative.

Overall, the West Alternative would impact some of the most high quality habitat in the project area (grasslands, shrub-steppe, woodlands, rock and cliff, and wetlands). The transmission line would often cross over the habitat or remove vegetation on the fringes of the habitat. Though some habitat would be removed, the habitat spanned would be available to special status and other wildlife species. Slight impacts would be likely to the western gray squirrel, to amphibians, turtles, and invertebrate species associated with wetlands, the sage lizard and to other common species of birds and wildlife. Impacts would be greater if construction occurred during the nesting or breeding season. Impacts of the West Alternative on wildlife would be ***moderate-to-high*** because special priority habitats, status species and other wildlife would be affected.

The option that would include removal of the existing Chenoweth-Goldendale line and building single-circuit towers in an existing alignment (West Option 3), would have the least impact of the tower options because it would have a smaller tower footprint, would allow habitat regeneration where the wood-pole towers are currently located, and it would require less tree removal since the right-of-way expansion would be less. The option that would use the most double-circuit towers (for about 21 miles, West Option 5), would have the greatest impact because of the larger tower footprints. The impacts of West Options 1, 2, 4, and 6 would be between these options.

Middle Alternative

The Middle Alternative would not impact native high quality grassland habitat because this habitat is not found along the route.

The Middle Alternative would affect about a 1-mile long patch of high quality shrub-steppe habitat along the Little Klickitat River at line mile M21 (same area impacted by the West Alternative). About 3 acres of this native habitat would be removed for towers and access roads (see Section 3.3 Vegetation). Additional areas of impact would occur for temporary construction activities and would affect 0.8-3 acres. Although this high quality habitat would be affected, the area affected is at the fringe of the habitat, an existing line and access road run through it, and species using this habitat would likely migrate deeper into more contiguous shrub-steppe areas.

As with all the action alternatives, disturbed grassland/shrub-steppe habitat common in the area would be impacted. Towers and access roads would occupy about 75–77 acres of possible foraging and nesting habitat and an additional 34–47 acres would be temporarily impacted by construction activities. Prairie falcon seen at line mile M13 would likely move to other habitat in the area during construction activities.

The Middle Alternative would impact about 0.7 acres of woodland habitat (trees and understory vegetation). This includes removal of some Oregon white oak trees flanking an orchard near Big Eddy Substation, some ponderosa pine trees above the riparian zone where the line would cross the Little Klickitat River, and additional pines at the edge of a larger woodland (also on the West Alternative) along the river (see Section 3.3 Vegetation). None of these woodlands provide priority habitat, but species using these areas could be affected by losing habitat and construction activities. In areas where black-tailed deer and mule deer wintering habitat was found (Oregon side M2–4), about 6 trees would be removed next to an orchard. The ponderosa pines removed near the Little Klickitat River are next to western gray squirrel habitat.

Although there are about 69 acres of wetland habitat within 1,000–2,000 feet of the Middle Alternative, potential impacts to wetlands would be limited to a loss of about 0.5 acre spread over 11 wetlands (see Section 3.5 Water Resources and Wetlands), with and additional 2 acres temporarily disrupted during construction. One of these wetlands (line mile M20.8; also crossed by the West Alternative) is considered a high quality wetland providing good habitat. Impacts on this wetland would in-turn impact species in the wetlands. For less mobile species (amphibians, turtles, and invertebrate species), physical disturbance could result in death of individuals or destruction of eggs. More mobile species (birds, deer, or bats) that use the wetlands for foraging would not be harmed directly.

Wetland birds could collide with overhead ground wires. The largest concentration of wetland birds are expected to congregate in wetlands associated with open water (Fifteenmile Creek, Columbia River, the Little Klickitat River, Swale Creek) and other wetlands near line mile WM24. In addition, wetland bird species in wetlands occurring between line miles M9.5–20, and from M22–27 would be exposed to a new transmission line where there are no lines now.

Impacts on open water species would be limited to birds, as the project would not impact water habitat. Bald eagle and white pelicans seen in the area, as well as migratory birds, water birds, and raptors foraging in these areas could be injured or killed if they collide with over-head ground wires. Potential areas where water birds or foraging raptors could collide with lines include the crossings of Fifteenmile Creek, the Columbia River, Swale Creek and the Little Klickitat River. In areas where there are options for double-circuit or single-circuit towers, it is unknown which options would create greater obstacles for birds and have a greater potential for collision. With single-circuit parallel options there would be two sets of towers in the corridor; with double-circuit options all the conductors would be placed on the same towers. The use of bird diverts on overhead ground wires would lessen possible collisions for any option.

Construction noise could also disturb nesting. Construction during nesting could lead to displacement or physical disturbance and the loss of a nest or young.

Although the Middle Alternative crosses some rock outcrops and cliff habitat near the Columbia River crossing, towers and access roads would not likely be placed in these habitats so no acreage would be disturbed. In these areas, as with the crossing of open water habitat, there is increased risk of bird collisions. However, raptors using the cliff habitat are not as likely to collide with lines as are the waterfowl associated with open water habitats.

About 25–27 acres of cropland foraging habitat would be lost due to the placement of towers and access roads, and an additional 22–27 acres would be temporarily impacted by construction activities (see Section 3.1 Land Use and Recreation). The known golden eagle breeding and foraging habitats at line mile M6 are relatively far from the line route and would not be impacted by habitat loss. However, they could be disturbed by noise if construction occurred during nesting season. The long-billed curlew sighted at line miles M13 and M15 would likely move to other cropland areas during construction activities and would not be impacted because this type of habitat is plentiful in the area. Though no burrowing owl burrows were found during field surveys, there is some suitable burrowing owl habitat along field margins and fence rows that would be taken up by towers and access roads. However, the habitat removed would be a small proportion of the total amount of affected croplands. Losses of croplands would have little effect on cropland species due to the small amount of land removed and the relatively low-quality foraging habitat provided.

Since the Middle Alternative would mostly impact common habitat that is abundant in the area, would barely impact high-quality habitats (the fringe of one shrub-steppe area, but no grasslands or rock and cliff), would only slightly impact woodlands and wetlands, and would have few potential impacts to special–status species (amphibians, turtles associated with wetlands, bald eagle, white pelican, and mule and black-tailed deer), impacts of the Middle Alternative on wildlife would be ***low-to-moderate***.

The single and double-circuit tower options for the Middle Alternative would have similar impacts to wildlife.

East Alternative

The East Alternative would not impact native high-quality grassland or shrub-steppe habitat because this habitat is not found along the route.

As with all the action alternatives, the commonly found disturbed grassland/shrub-steppe habitat would be affected by the East Alternative. Towers and access roads would occupy about 89–92 acres of possible foraging and nesting habitat, and an additional 37–45 acres would be temporarily affected from construction activities. This habitat is used by common species such as coyote, rattlesnake, lizards, and birds. Tower and road footprints would remove only a small amount of the total habitat in the area and would not fragment this habitat because these species could navigate between the towers and across the right-of-way.

Wildlife species associated with woodlands—including those along riparian corridors—would experience isolated disturbances as trees and ground cover are removed. About 16 trees could be removed from two woodlands areas (see Section 3.3 Vegetation) over about 0.4–0.8 acre. This includes six Oregon white oak trees flanking an orchard (as for the Middle Alternative), and five ponderosa pine and five Oregon white oak trees in the upland area above the Little Klickitat River. The ponderosa pine and Oregon white oaks could potentially be considered priority habitat, but it is likely too isolated from the larger woodland area to provide western gray squirrel habitat. Although upland from the river's edge, these trees are part of a thin riparian woodland that follows the river and removal of trees from this woodland would have a slight contribution to fragmenting the river corridor, impacting species that would use this area as refuge near the water.

Of the 72 acres of wetland habitat within 1,000–2,000 feet of the East Alternative, potential impacts to wetlands would be limited to a loss of about 0.3 acre spread over 5 wetlands (see Section 3.5 Water Resources and Wetlands). The five wetlands potentially impacted are low quality and are of limited habitat value. Wetland birds could be impacted by colliding with overhead ground wires. As with the other alternatives, the largest concentration of wetland birds are expected to congregate in wetlands associated with open water (Fifteenmile Creek, Columbia River, the Little Klickitat River, Swale Creek) and other wetlands near line mile E25 (WM24). In addition, wetland bird species in wetlands occurring between line miles E15–E28 would be exposed to a new transmission line where there are no lines now.

As with the Middle Alternative, year round open water habitats crossed by the East Alternative include Fifteenmile Creek, and the Columbia and Little Klickitat rivers. Special-status species, as well as other common waterfowl species that use this habitat, would primarily experience impacts from the risk of transmission line collisions.

The East Alternative crosses cliff habitat at the Columbia River crossing, and passes near this habitat as it climbs the Columbia Hills, but no acreage would be impacted by towers or access roads. In these areas, as with the crossing of open water habitat, there is increased risk of bird collisions. However, raptors using the cliff habitat are not as likely to collide with lines as the waterfowl associated with open water habitats. Prairie falcon, golden eagle, and peregrine flacon are known to nest in these cliffs, and though they would not likely be impacted by the line itself because there are existing lines in the area, noise from construction would impact breeding or nesting if it occurred during that season.

About 18–21 acres of cropland foraging habitat would be lost due to the placement of towers and access roads, and an additional 30–37 acres would be temporarily impacted by construction activities (see Section 3.1 Land Use and Recreation). The known golden eagle breeding and foraging habitats at line miles E6 and E18-19 are relatively far from the line route and would not be impacted by habitat loss. However, they could be disturbed by noise if construction occurred during nesting season. The long-billed curlew sighted at line mile E18 would likely move to other cropland areas during construction activities and would not be impacted because there this type of habitat is plentiful in the area. Though no burrowing owl burrows were found during field surveys, there is some suitable burrowing owl habitat along field margins and fence rows that would be removed for towers and access roads. However, the amount of habitat removed would be small when compared to that available in the area. Loss of cropland habitat would have little effect on cropland species because the amount is small, and it is of low quality for foraging species.

Since the East Alternative would mostly impact common habitat that is abundant in the area, would not impact high-quality habitats (grasslands, shrub-steppe, or rock and cliff), would only slightly impact woodlands and wetlands, and would have few potential impacts to special–status species (golden eagle, prairie falcon, peregrine falcon, bald eagle, white pelican, and mule and black-tailed deer), impacts of the East Alternative on wildlife would be ***low-to-moderate***.

The single and double-circuit tower options for the East Alternative would have similar impacts to wildlife.

Knight Substation Options

Construction of Knight Substation at Site 1 or Site 2 would remove 10 acres of cropland habitat from use. (Site 2 is fallow cropland.) Because no special-status species, nests, or burrowing owl burrows were found at either substation site, they would not likely be impacted. Because both sites are a small area relative to the total amount of the habitat type present in the area, and because this habitat provides relatively low quality habitat to special-status and other common species, impacts to wildlife from Knight Substation would be ***low*** at either substation site.

Fiber Optic Cable Options

For the Loop Back Option, ***no*** impacts on wildlife would occur other than those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential wildlife impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.6.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on wildlife:

- Minimize the project ground disturbance footprint, particularly in special-status areas such as priority ecosystems, which can include riparian areas, wetlands, and grassland/shrub-steppe.
- Avoid tree removal to the extent possible.
- In locations where nests for special-status species have been identified, determine construction schedules through consultation with WDFW or Oregon Department of Fish and Wildlife to avoid breeding season disturbance. The following mitigation schedules will be considered:
    - Peregrine falcon—avoid construction activities within 0.25 mile of any active nests during the breeding season (March 15 through August 31).
    - Prairie falcon and golden eagle—avoid construction activities within 0.25 mile of active nests during the breeding season (February 15 through July 15).
    - Western gray squirrel—avoid construction activities within 400 feet of all nest trees during the breeding season (March 1 through August 31). Avoid blasting within 0.25 mile of nest trees during this same period. Protect all western gray squirrel nests and nest trees. Maintain a 50-foot no-cut buffer around each nest tree.
- Install bird diverters on overhead ground wires in high risk areas (over river and stream crossings and near wetlands).
- Prepare and implement a SWPPP and a Spill Prevention and Contingency Plan (see mitigation measures for Sections 3.4 Geology and Soils and 3.5 Water Resources and Wetlands) to protect wetland habitats.

- Reseed disturbed areas (see mitigation measures for Section 3.3 Vegetation).
- Prepare for fire control (see mitigation measures for Section 3.3 Vegetation) to protect habitats.

3.6.4 Unavoidable Impacts Remaining after Mitigation

Construction of towers, substations, access roads, and other associated facilities would affect local wildlife populations through temporary displacement of individuals or groups and permanent loss of wildlife habitat. An incremental increase in avian collisions with transmission lines may occur at river crossings, and in areas of high concentrations of waterfowl and other birds.

3.6.5 No Action Alternative

The No Action Alternative would have no impact on wildlife because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.7 Fish

This section describes fish resources and how the project alternatives could affect these resources. Related vegetation and water resources information can be found in Sections 3.3 Vegetation and 3.5 Water Resources and Wetlands.

3.7.1 Affected Environment

The action alternatives cross four fish-bearing rivers or streams: Fifteenmile Creek in Oregon, the Columbia River in Oregon and Washington, and the Little Klickitat River and Swale Creek in Washington (see Map 3-7). Other streams in the project area are intermittent and may be fish-bearing seasonally; however, no fish have been documented in these streams.

Some of the fish-bearing streams have the potential to provide habitat for special status species (species with federal or state protections) and other common fish species such as redband rainbow trout, mountain whitefish, walleye, and smallmouth bass. This section describes the fish-bearing streams and the possible fish present. See Table 3-24 for a list of the special-status fish species present in the streams crossed.

The CRGNSA Management Plan protects a number of endemic species and species of special interest within the National Scenic Area. Many of those species are discussed in this EIS section; a table listing all the National Scenic Area protected species is found in Appendix D, with a determination of whether the species are likely present or affected along the action alternatives.

Fifteenmile Creek. Fifteenmile Creek in Oregon is a tributary to the Columbia River and is designated as critical habitat for one steelhead distinct population segment (DPS) where the action alternatives cross it. The West Alternative crosses Fifteenmile Creek at line mile W0.5, and the Middle and East alternatives cross it three times at line miles ME0.5, ME2.5, and ME3.25. Chinook salmon and steelhead are found in this portion of Fifteenmile Creek (StreamNet 2009). Coho salmon appear to be restricted from migrating to this area by Cushing Falls, also known as Seufert's Falls, at about river mile 0.5. Riparian vegetation along the creek where the alternatives cross is plentiful, with substantial amounts of Oregon white oak and other deciduous trees and shrubs, which provide shade, cover, and large woody debris recruitment.

Columbia River. Behind The Dalles Dam, the Columbia River is a reservoir called Lake Celilo. This reach of the Columbia River is a migration corridor for fish moving to and from upriver spawning areas (StreamNet 2009; WDFW 2009), and is designated as critical habitat for several species of federally protected salmonids, including four salmon evolutionarily significant units (ESUs), three steelhead DPSs, and one bull trout DPS. Coho salmon use the Columbia River as a migration corridor as well (there is some uncertainty as to whether the Coho Lower Columbia River ESU occurs past Hood River). Pacific lamprey, river lamprey, leopard dace, and mountain sucker are all state-listed candidate or sensitive species that occur in the Columbia River. Each action alternative would cross the Columbia River (line miles W2–3 and ME7–8).

Table 3-24. Fish-Bearing Streams Crossed by the Action Alternatives

River/Stream	Special Status Fish Species Present	Protected Fish Unit or Segment[1]	Alternative
Columbia River (OR/WA)	Chinook Salmon (*Oncorhynchus tshawytscha*)	Upper Columbia River spring-run ESU[1] (E[1])	West, Middle, East
		Snake River spring/summer-run ESU (T[1])	West, Middle, East
		Snake River fall-run ESU (T)	West, Middle, East
	Sockeye Salmon (*Oncorhynchus nerka*)	Snake River ESU (E)	West, Middle, East
	Steelhead (*Oncorhynchus mykiss*)	Middle Columbia River DPS[1] (T)	West, Middle, East
		Snake River Basin DPS (T)	West, Middle, East
		Upper Columbia River DPS (T)	West, Middle, East
	Bull Trout (*Salvelinus confluentus*)	Columbia River DPS (T)	West, Middle, East
	Coho Salmon (*Oncorhynchus kisutch*)	Lower Columbia River ESU[2] (T)	West, Middle, East
	Pacific lamprey (*Lampetra tridentata*)	None	West, Middle, East
	River lamprey (*Lampetra ayresi*)	None	West, Middle, East
	Leopard dace (*Rhinichthys falcatus*)	None	West, Middle, East
	Mountain sucker (*Catostomus platyrhynchus*)	None	West, Middle, East
Fifteen Mile Creek (OR)	Steelhead (*Oncorhynchus mykiss*)	Middle Columbia River DPS (T)	West, Middle, East
	Chinook Salmon (*Oncorhynchus tshawytscha*)	None	West, Middle, East
Swale Creek (WA)	Steelhead (*Oncorhynchus mykiss*)	Middle Columbia River DPS (T)	West
Little Klickitat River (WA)	Steelhead (*Oncorhynchus mykiss*)	Middle Columbia River DPS (T)	West, Middle, East

[1] Federally protected species designated as threatened (T) or endangered (E) under the ESA. Unit refers to evolutionarily significant units (ESU), and segment refers to distinct population segments (DPS).

[2] There is some uncertainty as to whether the Coho lower Columbia River ESU occurs past Hood River; ORNHIC and StreamNet data show coho upstream of the John Day River, but no ESU has been designated.

Swale Creek. Swale Creek is an ephemeral stream with isolated pools of water present year round. During the summer, streamflow typically diminishes to less than 0.5 cfs, and temperatures may exceed 70˚F, effectively reducing the available habitat and precluding migration of juvenile salmonids through the area. Adult steelhead are found in Swale Creek to a point about 0.5 mile downstream of the intersection with the West Alternative (WDFW 2009), which is part of the creek designated as steelhead critical habitat. Juvenile steelhead could occur in this area, but would likely move out of the system before streamflows decline in summer months. Riparian vegetation where the West Alternative crosses Swale Creek includes deciduous trees, shrubs, grasses, and forbs. This riparian area provides shade and woody debris.

Neither the Middle nor East alternatives cross critical habitat for steelhead in Swale Creek. These two alternatives cross Swale Creek at different points, but in both locations the channel is shallow and does not appear to contain suitable habitat for steelhead. In addition, the riparian vegetation at these crossings is limited to small shrubs and agricultural crops, which do not contribute much value to fish habitat in Swale Creek.

Swale Creek is in Water Resource Inventory Area (WRIA) 30 in Klickitat County. Swale Creek discharges into the Klickitat River at river mile 17.2.

Little Klickitat River. The portion of the Little Klickitat River crossed by the action alternatives is designated as critical habitat for the Middle Columbia River steelhead DPS. The action alternatives cross the river at different locations; near line miles W19.5, M20, and E23. Chinook and coho salmon occur in the lower 0.25 mile of the Little Klickitat River, but this is about 5 miles downstream (or west) of the West Alternative (WDFW 2009). Riparian vegetation is Oregon white oak and other deciduous trees and shrubs as well as ponderosa pine.

The Little Klickitat River is in Water Resource Inventory Area (WRIA) 30 in Klickitat County and is a tributary to the Klickitat River. The Little Klickitat River is 303(d) listed under the Clean Water Act as a Category 5 water for exceedence of water temperature criteria (Ecology 2009a) (see Chapter 5 for more information about the Clean Water Act).

3.7.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Fish would be impacted if the water quality and habitat in which they live were changed. Impacts could be due to erosion, pollution, stream alterations, and riparian vegetation removal. Erosion could occur as a result of rain runoff from ground disturbed by construction activities, which could transport loose sediment to surface waters and subsequently increase turbidity and sedimentation of the river or stream bottom. Pollution could result from accidental oil or gas spills from construction vehicles. Removing riparian vegetation would remove the benefits it provides for fish, such as providing shade and decreasing water temperatures, filtering water and reducing turbidity and contaminants, increasing habitat complexity through large woody debris input to the stream, and helping stabilize the stream banks and controlling erosion.

None of the action alternatives would directly alter fish habitat or require culverts in fish-bearing streams. All tree removal would be upland from stream edges and would not impact shading on water surfaces.

Tower and road construction could result in erosion. Whether sediments reach fish habitat would be a function of the amount of soil disturbed, the terrain, how close construction sites are to water bodies and drainages, and mitigation measures used to limit off-site soil movement.

Some impacts on fish and fish habitat could result from new access roads that would cross smaller, intermittent streams, some of which could support fish seasonally, but most of which are dry for most of the year (based on stream typing from Washington's Interim Water Typing System [WAC 222-16-031]). None of these seasonal streams support sensitive fish species. Culverts needed within these intermittent streams would be designed (sized appropriately) and installed to ensure unobstructed water passage to minimize potential downstream effects to fish.

Detonating explosives adjacent to fish habitat could cause disturbance, injury, or mortality to fish, or salmonid eggs. To avoid impacts on fish, blasting should be avoided within 200 feet of fish-bearing streams.

Even low concentrations of petroleum entering streams can have toxic effects to fish and other aquatic organisms. BPA would require that stored fuel and vehicle refueling be done away from streams and drainages (see Section 3.7.3 Mitigation Measures). Other than unanticipated spills near water bodies, ***no*** impacts would occur on aquatic organisms from petroleum products.

Operations and line maintenance could require the periodic removal of tree saplings and possible herbicide use for saplings and noxious weeds, but only in upland areas. Herbicides may be toxic to fish and other aquatic organisms, depending on type used and concentration, should they enter streams (Tu et al. 2001). They can also reduce stream primary production by killing aquatic plants. Generally impacts on streams occur from overspray or drift (aerial applications) and additionally from leaching through soils into groundwater or by surface/subsurface runoff. BPA would use an integrated vegetation management strategy (BPA 2000a) to control vegetation along the transmission line corridor that may involve a number of different methods, including manual (hand-pulling, clippers, chainsaws), mechanical (rollerchoppers, brush-hogs), biological (insects or fungus for attacking noxious weeds), and the application of herbicides. If used, herbicide application would be limited to hand spraying at least 100 feet from all fish-bearing stream channels and only EPA-approved herbicides that are non-toxic to aquatic resources would be used (see Section 3.7.3 Mitigation Measures). Overall, there would be ***no-to-low*** potential operation and maintenance impacts on fish.

Big Eddy Substation is about 0.5 mile west of Fifteenmile Creek and about 1 mile south of the Columbia River. Because of the distance and limited construction area within the existing fenced electrical yard, Big Eddy Substation upgrades would have ***no*** impacts on fish or fish habitat.

West Alternative

The West Alternative would place about 25 new culverts in dry washes or seasonal, non–fish-bearing tributary streams (see Section 3.5 Water Resources and Wetlands). With proper sizing and erosion control measures, sedimentation would be limited and water flow would be maintained such that there would be no impacts on possible downstream fish-bearing streams.

The West Alternative would cross four fish-bearing streams, but towers would be placed well away from the water's edge (see Table 3-25), no culverts would be required, and no riparian trees would be removed. Of the four fish-bearing streams crossed, Fifteenmile Creek, the Columbia River, and the Little Klickitat River have special-status fish species present in the areas of the river crossings. Any construction work would be well away from these streams and there would be no impacts on these special-status fish. Overall, there would be ***no-to-low*** potential impacts on fish from the West Alternative.

Table 3-25. Approximate Tower Distances from Intersections with Fish-Bearing Streams

Stream Name	Alternative	Approximate Distance in Feet from North (N)[1] and South (S)[1] Sides of the Stream
Fifteen Mile Creek	West	1015 (N) and 1424 (S)
Fifteen Mile Creek	Middle, East (1st crossing)	1015 (N) and 692 (S)
Fifteen Mile Creek	Middle, East (2nd crossing)	1250 (N) and 926 (S)
Fifteen Mile Creek	Middle, East (3rd crossing)	1279 (N) and 680 (S)
Columbia River	West	300 (N) and 800 (S)
Columbia River	Middle, East	475 (N) and 926 (S)
Swale Creek	West	700 (N) and 400 (S)
Swale Creek	Middle	900 (N) and 500 (S)
Swale Creek	East	700 (N) and 100 (S)
Little Klickitat River	West	323 (N) and 526 (S)
Little Klickitat River	Middle	366 (N) and 850 (S)
Little Klickitat River	East	558 (N) and 879 (S)

[1] N = north; S = south

Middle Alternative

The Middle Alternative would place about 28 new culverts in dry washes or seasonal, non–fish-bearing tributary streams (see Section 3.5 Water Resources and Wetlands). With proper sizing and erosion control measures, sedimentation would be limited and water flow would be maintained so there would be no impacts on possible downstream fish-bearing streams.

The Middle Alternative would cross the four fish-bearing streams, but towers would be placed well away from the water's edge (see Table 3-25), no culverts would be required, and no riparian trees would be removed. Of the four fish-bearing streams crossed, Fifteenmile Creek, the Columbia River, and the Little Klickitat River have special-status fish species present in the areas of the river crossings. An existing BPA access road along Fifteenmile Creek would require upgrading; to ensure sediment would not reach the creek, mitigation measures would be required. Other construction work would be well away from these streams and there would be no impacts on special-status fish present in these water bodies. Overall, there would be ***no-to-low*** potential impacts on fish due to the Middle Alternative.

East Alternative

The East Alternative would place about 30 new culverts in dry washes or seasonal, non–fish-bearing tributary streams (see Section 3.5 Water Resources and Wetlands). With proper sizing and erosion control measures, sedimentation would be limited and water flow would be maintained so there would be no impacts on possible downstream fish-bearing streams.

As with the other alternatives, the East Alternative would cross the four fish-bearing streams, but towers would be placed well away from the water's edge (see Table 3-25), no culverts would be required on these streams, and no riparian trees would be removed. Of the four fish-bearing streams crossed, Fifteenmile Creek, the Columbia River, and the Little Klickitat River have special-status fish species present in the areas of the river crossings. As with the Middle Alternative, an existing BPA access road along Fifteenmile Creek would require upgrading; to ensure sediment would not reach the creek mitigation measures would be required. Other construction work would be well away from these streams and there would be no impacts on special-status fish present in these water bodies. Overall, there would be ***no-to-low*** potential impacts on fish due to the East Alternative.

Knight Substation Options

No fish-bearing streams are located in the vicinity of Knight Substation Sites 1 and 2, although a dry wash that is a tributary to Blockhouse Creek is located nearby. Blockhouse Creek is about 4 miles and 1 mile downstream of the Sites 1 and 2, respectively, and no fish occur in Blockhouse Creek in the vicinity of the confluence with the dry wash. Therefore, ground disturbance associated with the construction of Knight Substation at either site would have ***no*** impact on fish or fish habitat.

Fiber Optic Cable Options

For the Loop Back Option, ***no*** impacts on fish would occur other than those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential fish impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.7.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on fish.

- Minimize the project ground disturbance footprint, reseed disturbed areas, and install culverts during the dry season (see mitigation measures for Section 3.3 Vegetation and 3.5 Water Resources and Wetlands) to limit sedimentation affecting fish habitat.
- Prepare and implement a SWPPP and a Spill Prevention and Contingency Plan (see mitigation measures for Section 3.4 Geology and Soils and 3.5 Water Resources and Wetlands) to protect fish habitats.
- Avoid blasting within 200 feet of fish-bearing streams.

3.7.4 Unavoidable Impacts Remaining after Mitigation

No unavoidable impacts on fish or fish habitat have been identified associated with any of the alternatives.

3.7.5 No Action Alternative

The No Action Alternative would have no impact on fish because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.8 Cultural Resources

This section describes the cultural resources in and near the proposed project and how the project alternatives could affect these resources.

3.8.1 Affected Environment

Cultural resources are nonrenewable resources associated with human occupation or activity related to history, architecture, archaeology, engineering, and culture. Historic properties are a subset of cultural resources that are eligible for inclusion in the National Register of Historic Places (NRHP). They are defined as any district, site, building, structure, artifact, ruin, object, work of art, or natural feature important in human history at the national, state, or local level. Historic properties include both historic and pre-contact resources. Pre-contact resources are those that date to before direct or indirect contact between Euro-Americans and Native Americans.

Although the Action Alternatives vary slightly in length and location, they share several cultural resource elements. Each alternative begins in Oregon on an upland east of The Dalles, crosses the Columbia River, climbs over the Columbia Hills, and then extends across an arid plain in Washington (Washington Plateau). The Oregon portion of each alternative is small compared with the portion in Washington.

The probability of encountering cultural resources along any of the alternatives varies by the landforms crossed (resources are more common in flat areas and areas near water sources). Existing or potential cultural resources are not likely equally distributed on all alternatives because of specific landforms and water sources nearby. For example, relatively flat land next to a river with historic fish runs, or near a natural travel corridor where historic Indian place names are found, would have a greater likelihood of pre-contact cultural resources than a steep slope and upland away from the river. Sites next to the river are more likely to represent pre-contact villages and intense fishing activity, while uplands are more likely to represent pre-contact, scattered plant-gathering and hunting areas and temporary campsites. Post-contact sites are also more likely along the river and could include fishing and settlement sites, while those in the uplands are more likely to be associated with farming.

Known existing pre-contact and historic sites, buildings and structures were researched in the area. Accessible areas of each alternative were also walked to determine if any obvious sites or potential sites were along the alternatives. However, many areas were inaccessible. Total recorded and new sites within 1 mile of each alternative are in Table 3-26.

Table 3-26. Identified Cultural Resource Sites by Action Alternative

Cultural Resource Sites	West Alternative	Middle Alternative	East Alternative
Existing Sites	143	123	113
New Sites	14	10	10
Total	157	133	123

Note: About 62 percent of the West Alternative, 52 percent of the Middle Alternative, and 58 percent of the East Alternative were inventoried for cultural resources (i.e., where BPA obtained landowner permission to conduct fieldwork).

BPA has asked potentially affected Tribes to identify concerns about properties of religious and cultural significance (locations that may not contain cultural materials, but have cultural importance for their association with cultural traditions) within the project area.

In addition, many of BPA's existing lines in the project vicinity could be considered for eligibility for the NRHP because of their age and because they are part of BPA's master transmission grid (though many have been substantially altered over the years). Big Eddy Substation could be eligible for inclusion in the NRHP as part of an historic district.

The Columbia River and the Columbia River Gorge

The southern portion of the project area lies in a well-documented ethnohistoric region along the Columbia River between The Dalles to the west and the former Celilo Falls to the east (Murdock 1980). The Columbia River's once-prominent features in this area – including rapids, eddies and waterfalls – provided an excellent fishery and terraces along the river afforded a place for people to fish, live and trade. The area's oldest pre-contact fishery site, dating back nearly 10,000 years, was found at Fivemile Rapids (now inundated) near The Dalles (Caldwell 1956).

Native inhabitants of this area lived in villages on both sides of the river. Although many of these sites were inundated by Lake Celilo after construction of The Dalles Dam, the surrounding areas were traditionally used by local peoples for subsistence activities and cultural practices (Spier and Sapir 1930). Populations of specific villages would ebb and flow seasonally, as residents moved between winter and summer dwellings and traveled inland in search of roots and other plant materials, and as inland tribes came to fish and trade. The result was fluctuating groups of various Native American bands that interacted closely throughout the year and across the landscape (Boyd and Hajda 1987; Wernz et. al. 2003; Biddle 1926).

About 200 years ago, Europeans and Euro-Americans began to arrive. The earliest documented Euro-Americans to travel through the area were members of the Lewis and Clark Expedition in 1805. The journals of the Lewis and Clark expedition demonstrate that the expedition camped in three locations along the river in the project vicinity. These campsites were likely inundated following completion of The Dalles Dam. Many settlers followed, especially as the Oregon Trail – which transects the area – became established. Construction of railroads and other infrastructure, planting of fruit orchards and cultivated crops, and ranching heavily impacted native subsistence and trade networks (Schalk 1980).

In 1855, both the Warm Springs Reservation and Yakama Reservation were created and Tribes were forced to move from their traditional territories. Oregon Tribes in the area eventually became part of the Confederated Tribes of the Warm Springs Reservation. In Washington, the local Wishram Tribe eventually joined more than a dozen others to become the Confederated Tribes and Bands of the Yakama Nation.

By 1861, The Dalles-Celilo region was "thickly settled (by Euro-Americans) along Threemile, Fivemile, Eightmile and Fifteenmile creeks" in Oregon (L. Carter. 1861). By the early 1900s, railroad-building crew camps and settlements were appearing along both sides of the river, including the current location of Wishram. The region also had military importance as a strategic river-access control point; Fort Dalles was established there around 1850 to protect residents.

Pre-Contact and Historic Sites

Many sites and site types are present within or near the project alternatives. These sites include pre-contact villages, camps, fishing stations, rock images (petroglyphs and pictographs), burial areas, rock cairns and alignments, pre-contact lithic scatters, historic rock alignments, and historic trash scatters.

Most previously recorded sites are close to the Columbia River. Relative locations of the previously recorded sites reflect the cultural significance of Celilo Falls and the surrounding area, the Columbia River, the Columbia River Gorge and other water bodies.

The Celilo Bridge, located just east of the Middle and East alternatives' Columbia River crossings, was built in 1912 and was the only river crossing between Portland and Pasco, Washington. The bridge is historically significant due to its engineering and importance in developing the railroad system in the Pacific Northwest. The Maryhill Museum of Fine Art, located about 1/3 of a mile southeast of the East Alternative (line mile E14),was likely placed on the National Register of Historic Places due to it's architectural significance.

Sites also include properties of religious and cultural significance to Indian Tribes. These sites may possibly include pre-contact site as well as sites that have been historically used by Tribal members. Locations that have known Indian place names can also be considered culturally significant sites because the place names act as connections between Tribal peoples and the landscape.

The Homesteads of the Dalles Mountain Ranch Historic District consists of approximately 2,450 acres located on the southern slope of the Columbia Hills on property belonging to the Washington State Parks and Recreation Commission. This historic district consists of remnants of historic ranches from the late 19^{th} and early 20^{th} centuries. The historic district is eligible under criterion A of the National Register of Historic Places (36 CFR 60), due to its association with events and patterns important in our history, specifically homesteading and ranching.

Columbia Hills State Park which includes the previously mentioned Dalles Mountain Ranch as well as the Horsethief Lake area, is within the viewshed of at least one of the alternatives. Numerous cultural sites are within the park boundary as well as the surrounding area.

Oregon and Washington Uplands

Fewer sites are found in the upland portion of the action alternatives. However, this may be somewhat skewed by the lesser amount of past investigations to identify sites in this area relative to the Columbia River Gorge. Pre-contact cultural resource sites on the Oregon and Washington uplands show evidence of procurement of upland resources and, in some cases, religious or spiritual activities. All sites reflect seasonal activities. Sites include pre-contact lithic scatters, rock cairns and rock alignments, rock images (pictographs and petroglyphs), and camp sites.

Historical sites within the upland areas reflect homesteading, agricultural-, and transportation-related themes and include historic railroads, farmsteads, trash scatters, and a hydroelectric facility.

3.8.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Because the project transects areas significant to Columbia River Tribes and because the general area has a rich history, there is the potential for disturbing known cultural sites. Project construction (towers, counterpoise installation, pulling and tensioning sites, access roads) could also damage or destroy unidentified cultural resources. Besides direct physical impacts, the proposed project could introduce visual elements that alter the character or setting of sensitive cultural and spiritual resource sites.

Increased access to cultural resources due to project construction, operation, and maintenance could increase vandalism and looting.

In addition, if existing substations, transmission lines and towers eligible for listing on the NRHP are replaced as part of the project, there could be an adverse effect due to the historic nature of some of BPA's infrastructure. However, proposed work at Big Eddy Substation would occur within the existing, disturbed electrical yard and would have no adverse impact to the substation's eligibility for the NRHP.

BPA attempts to avoid known sites whenever possible and uses trained cultural resource monitors on large-scale projects to ensure unidentified sites are not inadvertently impacted. Sites have been and would continue to be identified by using a variety of methods, including archaeology, oral history, and history. Archaeological sites would be delineated both by surface observations and subsurface testing before construction to avoid physically impacting sites during construction. Appropriate mitigation procedures would be in place to stop construction activities and determine protective measures (e.g., avoidance) if artifacts are found (see Section 3.8.3 Mitigation). Impacts should not occur to unknown sites with these procedures in place.

Operation and maintenance of the proposed transmission line and substation would not impact cultural resources. Towers and access roads would be sited to avoid sensitive areas, so maintenance of towers or access roads would not affect known resources. Vegetation within the right-of-way is sparse, so it is not expected that any ground-disturbing mechanical vegetation clearing would be required. If any maintenance activities need to occur outside of tower locations or off access roads, a review of sensitive areas would be required to avoid impacting resources.

West Alternative

Because the Action Alternatives could have both physical and visual impacts on cultural resources, resources are discussed in two ways: those that could be located within 1 mile of each alternative and those that could be located in the right-of-way.

The West Alternative would pass within 1 mile of 157 separate cultural resource sites (see Table 3-26). Of these, 143 sites were previously recorded and 14 were recorded during the cultural resources survey for the alternative. These sites include the following types of pre-contact sites: cairns, isolated artifacts and scatters of artifacts, camps, village sites, burial locations, and rock images (pictographs and petroglyphs). They also include the following types of historic sites: rock alignments, trails, roads, refuse scatters, shack locations, a fishwheel location, and a hydroelectric facility. Most of these sites are far enough away from the right-of-way to avoid being disturbed physically.

The alternative would be near Columbia Hills State Park, and some new towers could be visible from this area. The alternative also crosses through Homesteads of the Dalles Mountain Ranch Historic District. Although a BPA transmission line currently traverses the historic district, the line consists of wood pole structures rather than the highly visible, new steel towers that would be necessary for the current project.

Eleven sites are within the West Alternative's potential right-of-way. These sites include scattered and isolated pre-contact artifacts, a pre-contact rock alignment, a pre-contact cairn, and an historic rock alignment.

The West Alternative would avoid all but one of the larger sites and all burial areas. Surveys completed before construction would help further identify sites that may be impacted if they could not be avoided. However, the West Alternative crosses or spans landforms and water bodies where there is a probability of encountering unknown resources during construction. Overall, the West Alternative's potential to impact cultural resources would be ***moderate***.

Middle Alternative

The Middle Alternative would pass within 1 mile of 133 cultural resource sites (see Table 3-26). Of those, 123 were previously recorded and 10 were recorded during a recent cultural resources survey. These sites mainly consist of pictographs and petroglyphs, burial locations, scatters of lithic artifacts and isolated pre-contact artifacts, pre-contact and historic rock alignments and cairns, an historic fishwheel location and historic trash dumps. Other sites consist of historic fence jacks and a pre-contact lithic quarry. These sites are far enough away from the right-of-way to avoid being disturbed physically.

Nine of the sites are within the Middle Alternative's potential right-of-way. These sites include three scatters of historic artifacts, two pre-contact isolated artifacts, an historic railroad grade, an historic rock alignment, and a large site consisting of pre-contact artifacts, pictographs, and burial sites. The Middle Alternative crosses over an Oregon Trail segment at two places due to a 90-degree bend where the line crosses the Columbia River. The trail route was not identified during fieldwork but has been identified from historical sources.

The most significant cultural site along the Middle Alternative's proposed right-of-way is separated by a vertical distance that would make it unlikely to be impacted by the line. Other sites within the right-of-way would be avoided during construction. While the Middle Alternative crosses or spans some landforms and water bodies where there is a probability of encountering unknown resources during construction, overall its potential to impact cultural resources would be ***low.***

East Alternative

The East Alternative would pass within 1 mile of 123 cultural resource sites (see Table 3-26). Of those, 113 were previously recorded and 10 were recorded during the recent cultural resources survey. Sites mainly consist of pictographs and petroglyphs, burial locations, scatters of lithic artifacts and isolated pre-contact artifacts, pre-contact and historic rock alignments and cairns, an historic fishwheel location, and historic trash dumps. Other sites include historic fence jacks and a pre-contact lithic quarry.

Ten sites are within the East Alternative's potential right-of-way. These sites include two scatters of historic artifacts, an historic railroad grade, pre-contact lithic artifact scatters, a pre-contact burial, an historic rock alignment, and a large site consisting of pre-contact artifacts, pictographs, and burial sites. Like the Middle Alternative, the East Alternative crosses over an Oregon Trail segment at two points. The trail route was not identified during fieldwork but has been identified from historical sources. The East Alternative straddles both identified segments and there would be no physical impact to either segment.

The most significant cultural site along the East Alternative's proposed right-of-way is separated by a vertical distance that would make it unlikely to be impacted by the line. Other sites within the right-of-way would be avoided during construction. However, the East Alternative crosses or spans some landforms and water bodies where there is a probability of encountering unknown resources during construction. Overall, the East Alternative's potential to impact cultural resources would be ***low.***

Big Eddy Substation

Although the overall Big Eddy Substation is likely eligible for inclusion in the National Register of Historic Places as part of an historic district, the 500-kV yard where the additions would take place is newer and additional electrical equipment would not affect eligibility of the district as a whole. Because work at the substation would occur within the existing electrical yard and control house, a previously disturbed area, there would be ***no*** impact on cultural resources.

Knight Substation Options

There are no known cultural resource sites near either proposed Knight Substation site. However, only limited cultural resource surveys have been conducted in the vicinity of either location in the past. BPA recently conducted limited archaeological testing of portions of Site 1; no cultural resources were identified. Because the substation would be located where there is a low likelihood of cultural resources, there would be ***no-to-low*** potential impact**.**

If an unknown site is discovered during construction, work would be stopped and mitigation measures implemented.

Fiber Optic Cable Options

For the Loop Back Option, ***no*** impacts on cultural resources would occur other than those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential cultural resource impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.8.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts by the Action Alternatives on cultural resources:

- Locate transmission line towers and access roads to avoid cultural resources, where possible.
- Use existing access roads where possible to limit possibility of new disturbances.
- Consult with the Washington DAHP or Oregon State Historic Preservation Office (SHPO), as applicable, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation, state agencies (if sites found on state lands), and the USFS (if sites found on USFS land or within the National Scenic Area) regarding NRHP eligibility of cultural resources.
- Develop an Inadvertent Discovery Plan that details crew member responsibilities for reporting in the event of a discovery during construction. This plan should include directives to stop work immediately and notify local law enforcement officials (if appropriate), appropriate BPA personnel, Tribes, USFS (if appropriate) and the Washington DAHP or Oregon SHPO if cultural resources are discovered.
- Ensure cultural resource monitors are present during construction in the area of known cultural resources to monitor sites during excavation and to prevent unauthorized collection of cultural materials.
- Prepare a mitigation plan to protect sites if final placement of project elements results in unavoidable adverse impacts to a significant cultural resource.

3.8.4 Unavoidable Impacts Remaining after Mitigation

Some effects of the project may not be physical or direct in nature. The new transmission line could impact the viewshed of nearby sites or culturally significant areas. While these effects could be partially mitigated by various construction methods, including double-circuiting, they cannot be eliminated completely. BPA is still conducting studies and consulting with appropriate entities identify resources and the effects that could result from each alternative.

3.8.5 No Action Alternative

The No Action Alternative would have no impact on cultural resources in the project area because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.9 Socioeconomics

This section describes social, economic, and public facility resources and how the project alternatives could affect these resources.

3.9.1 Affected Environment

Population

The proposed project area is located in Wasco and Klickitat counties. All action alternatives originate near The Dalles, which is the county seat for Wasco County and the largest city in the area with a population of about 13,447 (City-Data 2007). All action alternatives end at Knight Substation about 4 miles from Goldendale, Washington, which has a population of about 3,742 (City-Data 2009). The Middle and East alternatives also come close to the residential communities of Wishram and Centerville, Washington, with respective populations of about 324 and 120 (U.S. Census Bureau 2000a).

The population densities for both Klickitat and Wasco counties as of 2007 were both about 10 people per square mile (City-Data 2007a), which is low compared to more populated areas of western Oregon and Washington. The 2007 population estimate for Klickitat County was 20,377, an increase of 6.3 percent from 2000, which is less than the overall state increase of 11.1 percent (U.S. Census Bureau 2007a). The 2007 estimated county population for Wasco County was 23,593, a decrease of 0.8 percent from 2000, which is less than the overall state average population increase of 7.8 percent (U.S. Census Bureau 2007b). As of 2007, Klickitat County had a more rural population than Wasco County. In Klickitat County, 59 percent of people lived in rural settings compared to 34 percent in Wasco County (City-Data 2007).

Federal agencies are required to consider impacts on minority and low-income populations (see Chapter 5 Consultation, Review, and Permit Requirements). Demographic data at the county level is further partitioned into section tracts and then block groups, which are defined with local input and are designed to represent relatively homogenous neighborhoods. The proportions of minority populations in Klickitat and Wasco counties are similar to those in Washington and Oregon as a whole (U.S. Census Bureau 2000a, 2000d). Minority populations in three of the five census survey areas intersected by the action alternatives are lower than the county and state averages. The central portion of the project area in Oregon (crossed by all action alternatives) has higher proportions of people of American Indian descent than Klickitat County or Washington state. Minority populations in the southern portion of the project area (crossed briefly by all action alternatives) have a higher proportion of people of Hispanic descent than both Klickitat County and the state of Washington. However, in all of these cases, minority populations make up no more than 17 percent of the total population in the block group.

Klickitat County residents with income levels reported below the poverty level in 2000 accounted for about 4 percent of the population, compared to a Washington state average of about 7 percent. Wasco County residents with income levels reported below the poverty level accounted for about 3 percent of the population, compared to an Oregon state average of 8 percent. In the project area, populations below the poverty level were higher than both county averages (U.S. Census Bureau 2000a, 2000b, and 2000c). The proportion of the populations with an income below the poverty level was less than 20 percent.

Local Economy

Agriculture is a dominant force in the local economy for both Wasco and Klickitat counties, generating about $90 million in commodity value in Wasco County and about $57 million in Klickitat County in 2007 (NASS 2007). Lumber production; health care; manufacturing; professional, technical, and scientific services; arts, entertainment, and recreation; electrical power generation; mining, accommodation and food services; and retail also play major roles in the local economy, with retail generating the greatest revenue listed at about $382 million for Wasco County and $66 million for Klickitat County (U.S. Census Bureau 2007a, 2007b). For instance, Impact Analysis for Planning (IMPLAN)[2] estimates that 88 percent of purchases from the "other nonresidential construction" sector are supplied by sources in Klickitat and Wasco counties, and 12 percent are imported from other counties. Formerly, aluminum production was economically important, but a global price drop in aluminum forced several local smelters to close. Another important element of the local economy comes from tourism. Recreation resources supporting tourism are discussed in greater detail in Section 3.1 Land Use and Recreation.

Real estate has been experiencing some recent changes, particularly in the northern portion of the area along the Middle and West alternatives, and near Knight Substation Sites 1 and 2, where parcels are being sold as 20-acre rural residential lots, many with a view of Mt. Adams. While this area remains mostly undeveloped, home sites are currently for sale, and the number of residences may increase over the next several years.

Wind energy is rapidly developing within the region and contributes to the local economy through lease payments to landowners, jobs associated with each wind energy facility, and tax payments to the county and state. Klickitat County has designated an area that includes most of the project area as part of its Energy Overlay Zone, which promotes construction of wind power generation and associated transmission infrastructure. Several wind farms have been built near the action alternatives and several others are planned. The largest wind power project in the area is Windy Flats, which will eventually include up to 95 wind turbines and is crossed by the East Alternative (line mile E15–16) (Hardke 2009). The Windy Flats Westerly Expansion Area is in the southern portion of the project area abutting the Columbia Hills between the West and Middle alternatives. This area is proposed for wind farm expansion in the near future (Hardke 2009).

Taxes

The retail sales tax is Washington’s principal single source of tax revenue. Together with the related use tax, over $5.8 billion in state revenue was realized during fiscal year 2002, the latest information available. This represented nearly 50 percent of state taxes deposited in the general fund during that year (Washington State Department of Revenue, October 2003). The state use tax rate is 6.5 percent and the use tax rate for unincorporated portions of Klickitat County is 0.05 percent, for a total use tax rate of 7 percent (Washington Department of Revenue 2010). Federal agencies such as BPA are exempt from paying sales tax on goods purchased in Washington for in-state use. However, goods purchased by BPA outside of Washington for use in Washington are subject to the state use tax, which has the same local rates as the sales tax. Oregon has no sales or use tax.

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[2] IMPLAN is an input-output model commonly used in this type of application. The IMPLAN system adjusts national level data to fit the economic composition and estimated trade balance of a chosen region and can be used to construct county models. The multipliers used in this analysis are based on IMPLAN data for Klickitat and Wasco counties (Minnesota IMPLAN Group 2007).

Property taxes help support local government services such as police, fire and schools, and are levied on real property (land and improvements) unless either the land or improvements are tax exempt. The local property tax, which varies by local taxing district, is assessed at a rate around $3 per thousand dollars of evaluation. BPA, a federal agency, is exempt from this tax on land that it owns in fee (RCW 84.36.010).

Employment

In 2000, the unemployment rates in Klickitat and Wasco counties were 6.3 and 4.8 percent, respectively (U.S. Census Bureau 2000b, 2000c; City-Data 2007). With the recent national economic recession, unemployment rates for both counties have increased to about 9 and 10 percent, respectively, in 2009 (U.S. Census Bureau 2009). These are similar to the 2009 unemployment rates in their respective states, with Washington at about 9 percent, and Oregon at about 12 percent.

Per capita income is a widely accepted statistical indicator of the economic well being of an area. The per capita income for the project area was lower than both the state and national averages in 2000. The national per capita income for the United States was $21,587. The per capita incomes for the state of Washington and Klickitat County for the same year were $22,973 and $16,502, respectively. The per capita incomes for Oregon and Wasco County were $20,940 and $17,195, respectively (U.S. Census Bureau 2000b, 2000c).

The three sectors employing the most people in both counties in 2000 were the agriculture, forestry, fishing and hunting, and mining sector; the retail sector; and the manufacturing sector. The sector accounting for the most employment in Klickitat County was the agriculture, forestry, fishing and hunting, and mining sector at about 13 percent, while in Wasco County the top sector was retail trade at about 16 percent (U.S. Census Bureau 2000c).

State Trust Lands

Several parcels of publically owned property along the action alternatives are Washington State Trust Lands (State Trust Lands) managed by DNR. State Trust Lands are held in trust by the state and leased to private farmers either on a cash rent or sharecrop basis (McKay 2010), or to a wind developer (i.e., Windy Flats). Of the State Trust Lands crossed, the West Alternative crosses range land and the East Alternative crosses wind development land that may also be used for range land. All action alternatives cross DNR-leased crop land if the routes head to Substation Site 2. Cash rents for agricultural land range from $30 to $40 per acre, per year (acre·year). Sharecrop returns to DNR range from 30 to 35 percent of the crop, which results in $10 to $70 per acre·year, while rangelands lease at about $2/acre·year. Wind development is a much higher rate. The primary beneficiaries of State Trust Lands are public schools (kindergarten through 12th grade), which receive over 78 percent of the funds. In 2009, over 5.6 million acres were in State Trust Lands, and provided over $192 million in state revenues (DNR 2010). The West and East alternatives cross State Trust Land; all action alternatives cross a portion of a State Trust Land heading to Substation Site 2; Substation Site 2 is on State Trust Lands (see Map 3-1).

Community Values

The local area has a strong farming tradition, with many rural communities linked closely with agriculture, and fourth and fifth generation farms and ranches operating. Residents strongly identify with this tradition and with the social values and culture with which it is associated. The Dalles, where all action alternatives begin, was once crossed by the Oregon Trail and has been an economic hub in the

Pacific Northwest, linking major transportation routes within the region. It is viewed as offering a more rural way of life, but with easy access to Portland (City of The Dalles 2009a). East of The Dalles, the Middle and East alternatives come close to the rural center of Wishram (line miles ME9). The Middle Alternative then splits north to cross the Garner Family Trust (line miles M12–14), a fifth generation farm representative of other homesteads in the Centerville Valley. It then continues north near the rural community of Centerville, Washington, located between the Middle and East alternatives near line miles M16 and E19. The community consists of mostly single-family residences, agricultural-related commercial and industrial development, and a school. Near line mile WM20, both the West and Middle alternatives pass the Divers Ranch, a fourth-generation cattle ranch also representative of other multi-generational holdings in the area. The West and Middle alternatives cross the Old Settler Road and a Divers family burial site (Divers 2009).

High-quality environmental, recreational, and historical resources are also well represented in the area. Residential use, recreation, research, and environmental and historical preservation are important activities occurring in many specially designated places in the area. All action alternatives cross the Columbia River and the Lewis and Clark Historic Trail, run through the National Scenic Area, and cross over the Columbia Hills. The West Alternative runs for about 2 miles through both the Columbia Hills State Park and Columbia Hills Natural Area Preserve, across the Klickitat Trail, and then north to follow about 2 miles of the Little Klickitat River. The Middle Alternative also runs along the Little Klickitat River for about 1 mile, and, along with the East Alternative, crosses portions of the Oregon Trail.

Construction of weekend or retirement homes, and wind farm development have brought some change to local communities recently.

Some members of the community welcome a new transmission line as step to increased energy development, while others do not want such growth or intrusion. Few landowners (private or public) want a transmission line to cross their property, and sentiments range from “build public facilities on public lands” to “don’t impact public lands that protect species and benefit all citizens of the state.”

Housing and Lodging

In 2007, there were 9,180 housing units in Klickitat County, of which about 11 percent were vacant (U.S. Census Bureau 2007a). In comparison, there were 10,733 housing units available in Wasco County, of which about 16 percent were vacant (U.S. Census Bureau 2007b). The combined vacancy rate in the local area in 2007 was about 14 percent. Vacancy rates from 5 to 7 percent are typically considered low, 7 to 10 percent are considered moderate, and a vacancy rate of 10 percent or higher is typically considered high. Therefore, this is higher than the national vacancy rate of owner-occupied housing of about 2 to 3 percent and the national rental vacancy rate of 8 to 10 percent (CalculatedRisk 2009).

There are 19 hotels or motels with over 900 rooms in the local area. The hotels and motels are primarily in The Dalles and Goldendale. Occupancy rates are as high as 100 percent in the summer and as low as 30 percent in the winter. There are also many campgrounds within about 20 miles of the project, although many are closed during winter. RV hookups are available at Celilo Park (about 8 sites with RV hookups); Maryhill State Park, Goldendale, Washington (more than 50 RV sites); Rufus RV Park in Rufus, Oregon (58 RV sites); Sherman County RV park in Moro, Oregon (33 RV sites); and Sunset RV Park (12 RV sites), Cottonwood RV Park (about 35 RV sites), and Peach Beach Campark (82 RV sites) in Goldendale, Washington.

Public Services

Hospitals and Schools

There are three hospitals in the project vicinity. Klickitat Valley Hospital in Goldendale serves all of central and eastern Klickitat County. Skyline Hospital in White Salmon serves western Klickitat and eastern Skamania Counties. The Mid-Columbia Medical Center in The Dalles serves northern Wasco County and southern Klickitat County.

There are 32 schools, both public and private, in the area: 20 schools in Klickitat County and 12 in Wasco County. About 7,000 students are enrolled (Schooltree 2009).

Law Enforcement and Fire Protection

The Klickitat County Sheriff Department provides law enforcement to all of unincorporated Klickitat County and the Goldendale Police Department provides enforcement in Goldendale.

The Wasco County Sheriff's office provides law enforcement to all of Wasco County except for The Dalles. The City of The Dalles Police Department provides law enforcement for The Dalles incorporated area.

Washington and Oregon state patrols provide patrol officers on the state highways in the area.

The local area is a high fire danger zone, a result of the seasonally hot and dry climate, urban/wildland interface, and abundant available fuels. Both Wasco and Klickitat counties have community wildfire protection plans (Klickitat and Skamania County Steering Committee 2006; Hubert 2005). Fire protection is provided primarily through 27 fire districts, including 16 in Klickitat County (Alderdale, Appleton, Bickleton, Centerville, Dallesport, Glenwood, Goldendale, High Prairie, Husum/Cherry Lane, Klickitat, Lyle, Roosevelt, Trout Lake, Underwood, White Salmon, and Wishram), and 11 in Wasco County (Mosier, The Dalles, Dufur, Tygh Valley, Pine Grove, Juniper Flats, Maupin, Columbia Rural, Sportsman Park, Pine Hollow, and Shaniko). Additional fire suppression agencies that provide service include DNR, the NPS, the USFS, the Goldendale volunteer fire department, and The Dalles fire department. In the event of major fires, all fire protection providers provide cooperative fire-fighting support.

Airports

There are multiple airports in Klickitat and Wasco counties. The Columbia Gorge Regional Airport west of U.S. 197 near Dallesport, and the Goldendale Airport near Goldendale are publically owned facilities operated by WSDOT (see Map 3-1). Piper Canyon Airport near line mile WM19.5 and Warwick Airport between the West and Middle alternatives at about line miles W11 and M14 are small, private airports.

Transmission Lines

Several BPA transmission lines cross the project area (see Chapter 2). Klickitat County PUD (Public Utility District) provides electrical service in Klickitat County, and Northern Wasco County PUD and Wasco Electric Cooperative provide service in Wasco County.

3.9.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Environmental Justice Considerations

In the project area, some populations have higher proportions of minority groups than in the county and/or state as a whole. These proportions are still much lower than half of the population. Therefore, the project would not result in any minority populations being disproportionately affected compared to other races or ethnicities.

Low income populations also occur at higher percentages in the project area than in the county. Again, however, these percentages are low relative to the total population and do not result in disproportionate effects. There would be ***no*** disproportionate environmental impacts from any of the action alternatives.

Community Values

The proposed project would impact private farms, ranches, and residences and potentially recreational use lands. The potential routes would not result in the loss of large amounts of land from any single property or change the social capacity of any communities in the area. However, the proposed project has created some conflict about energy development and whose lands should be impacted, concerns about property values, and could potentially create a sense of loss of the agrarian, cultural, and natural resource aesthetic in the area. (For additional impact analysis on these issues, see Sections 3.1 Land Use and Recreation, 3.2 Visual Resources, 3.3 Vegetation, 3.6 Wildlife, and 3.8 Cultural Resources).

Population, Housing, and Lodging

The project would not result in any permanent population increase or the construction of new housing. Project -related demand for lodging would be temporary due to the presence of construction workers in the area, but no additional employees would be needed for operations. With more than 900 hotel rooms in the area, and an average annual occupancy rate of about 75 percent, there are typically 225 available rooms at any given time. With a maximum construction workforce of about 100, with fewer workers at various times over about a 20-month construction period, existing hotels have adequate capacity. Existing campgrounds and RV parks would also be an option for construction workers to the extent that space is available. Construction workers' need for lodging would have a ***low*** temporary impact on the population and housing for all action alternatives.

Taxes

The proposed project would result in an estimated $30 to $40 million in purchases of construction materials for use in Washington, with nearly all purchases originating out-of-state. The state use tax rate is 6.5 percent and the use tax rate for unincorporated portions of Klickitat County is 0.05 percent, for a total use tax rate of 7 percent (Washington Department of Revenue 2010). Assuming the proposed project construction results in out-of-state materials purchases totaling $30 million, use tax revenues of $1.95 million and $150,000 would accrue to Washington and Klickitat County, respectively.

The proposed project could result in the purchase and removal from the Klickitat County property tax rolls of 72 acres of private nonirrigated farmland for use as a substation. Nonirrigated cropland in Klickitat County is assessed for property taxes at about $230 per acre and generates about $2 per acre in property tax annually (McBride pers. comm.). The proposed land purchase would reduce Klickitat County property tax revenue by about $142 annually.

The proposed project would remove no land from property tax rolls in Wasco County, Oregon.

Employment

The action alternatives would have a temporary, ***low*** positive impact on employment and most sectors of the local economy during project construction through the hiring of local construction workers; local procurement of supplies and equipment such as gravel and fuel for vehicles, equipment rentals, staging area rentals, and other incidental materials and supplies; and food, lodging and other expenditures by workers. These direct expenditures would generate economic activity in other parts of the economy through what is known as the multiplier effect, with direct spending generating indirect and induced economic impacts. Indirect impacts consist of spending on goods and services by industries that produce the items purchased as part of the project. Induced impacts include expenditures made by workers' households involved either directly or indirectly in the construction process.

BPA would hire a contractor to build the line, and a combination of contractors and BPA staff would be responsible for engineering design, land acquisition, surveys, environmental analysis and monitoring, and obtaining construction materials, including the transmission towers. These expenditures would likely not be made locally.

Based on estimates from the IMPLAN[3] model, the project would result in about 70 temporary direct, indirect, and induced jobs (Minnesota IMPLAN Group 2007). The direct employment impact would be about 50 jobs, which could fluctuate throughout the construction period. The indirect employment impact would be about 10 jobs, and the induced employment impact would be about 15 jobs. Indirect impacts could result from purchases made by businesses that are directly affected by the project, including those supplying goods related to engineering, automotive repairs, wholesale trade, and truck transport. Induced impacts would result from purchases made by people who spend income received as a result of the project and would be dispersed among more than 100 sectors. Thirty to 80 percent of these jobs would likely be filled by local workers. The remaining workers would be expected to temporarily relocate from outside the area. Construction workers would be separated into different crews stationed at various locations along the transmission line right-of-way. These individuals would purchase meals and other items locally and likely seek temporary accommodations in local hotels, RV parks, or apartment and rental houses.

Agriculture

Individual farms and related businesses in the agricultural sector could experience long-term lost revenue and income through the conversion of farmland to transmission line rights-of-way or access roads, the amount of which varies slightly among the different action alternatives. Average annual per-acre crop production values for the area were estimated at $205 for nonirrigated (grain) crops, $308 for irrigated (grain) crops, $550 for alfalfa, and $30 for rangeland based on information obtained from the Klickitat County Assessor's Office (McBride 2010). In addition, there could be a permanent increase in pest-control costs if aerial spraying is disrupted by transmission lines, and a possible temporary cost associated with the reconfiguration of irrigation equipment to accommodate transmission towers and access roads. One-time compensation payments to landowners would be made for easements and reconfiguration of irrigation equipment, if needed. Farms could also experience temporary losses of

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[3] IMPLAN is an input-output model commonly used in this type of application. The IMPLAN system adjusts national level data to fit the economic composition and estimated trade balance of a chosen region and can be used to construct county models for any region in the United States. The multipliers used in this analysis are based on IMPLAN data for Klickitat and Wasco counties.

crops or forage during construction. Landowners would be compensated at market value for any reduced yield of crops and forage caused by construction activities for that season.

IMPLAN was used to estimate both the direct effects of the project on farms as well as the total effects on the economies of Klickitat and Wasco counties. Total effects from displacing or idling farmlands could include reduced output by grain elevators; feedlots; food processors, wholesalers, and retailers; and other sectors. Impacts are given for each action alternative. Estimated economic losses include both permanent and temporary agricultural output (revenue from products) and labor income.

State Trust Lands

State Trust Lands would experience small losses of revenue through the conversion of farmland to transmission line towers or access roads. Although each action alternative would affect State Trust Lands slightly differently, the amount of DNR revenue lost to towers and access roads would be negligible, ranging from $0 per year (Middle Alternative) to $12 per year (West Alternative), based on cash rents for the land. If any of the alternatives connect to Substation Site 2, they would impact additional State Trust Lands by about $210 per year. The amount of revenue impact of any of the alternatives would be small compared to 2009 revenues from State Trust Lands of about $192 million (DNR 2010). Therefore, permanent impacts would be ***low*** for all action alternatives. (See the Knight Substation Options section for a discussion of potential losses to State Trust Lands from Knight Substation Site 2). Crops lost to temporary construction activity would result in at most $273 annually during construction for the action alternatives. This amount would be compensated, resulting in ***no*** financial impacts to DNR from construction activities. If any of the land is held in CRP, federal payments made to the state would be affected if all or a portion of the land had to be taken out of CRP. Placement of transmission lines would not necessarily affect CRP status and no loss in value from construction activities would be expected for CRP land. Because the East Alternative would be routed to avoid conflicts with existing wind turbines already developed on DNR State Trust Land, there would be no additional wind development revenue loss expected.

General Property Impacts and Compensation

BPA would need to acquire new right-of-way and access road easements across both private and public properties in varying amounts for each action alternative to enable the construction and maintenance of the proposed transmission line (see Section 3.1 Land Use and Recreation for acreages). BPA would pay market value to nonfederal landowners, as established through the appraisal process, for any new land rights required for this project.

Where the right-of-way would cross over a property, the impact would vary depending on the placement of the right-of-way in relation to a property's size, shape, and the location of existing improvements. A right-of-way could diminish the utility of a portion of property if the line effectively severs this area from the remaining property (called "severance damage"). The appraisal process takes all factors affecting value into consideration—including those mentioned above, as well as any other elements unique to the property—in determining property value, including the loss in value within the easement area, as well as outside the easement area in cases of severance. The appraisals may reference studies conducted on similar properties to support their conclusions. The strength of any appraisal depends on the individual analysis of the property, using neighborhood-specific market data in order to determine market value.

The easements required may encumber the right-of-way area with land use limitations. Each transmission line easement would specify the present and future right to clear the right-of-way and to keep the same clear of all trees, whether natural or cultivated, and all structure supported crops, other structures, trees, brush, vegetation, fire and electrical hazards. Non-structure supported agricultural crops less than 10 feet tall could be grown. Specific agreements with landowners would be required in order to vary from these limitations.

Where BPA needs to acquire easements on roads that already exist and the landowner is the only other user, market compensation is generally 50 percent of full fee value. If other landowners share the access road, compensation is usually something less than 50 percent. For fully improved roads, the appraiser may prepare a cost analysis to identify the value of the access road easement. If BPA acquires an easement for the right to construct a new access road and the landowner has equal benefit and need of the access road, market compensation is generally 50 percent of full fee value; if the landowner has little or no use for the new access road, market compensation for the easement is generally close to full fee value.

As a government agency, BPA has the power of eminent domain, or the power to condemn land rights needed to support its projects. If, after good faith negotiations, BPA and a landowner are not able to agree on terms of a purchase, BPA would ask the U.S. Department of Justice to begin condemnation proceedings in the U.S. District Court on its behalf. As part of these proceedings, BPA would pay just compensation in the form of fair market value for the land that is condemned, with this value determined through appraisals and considering all other relevant factors. A landowner may request that the condemnation process be used if they do not want to negotiate.

Property Value Impacts

The proposed transmission line is not expected to have long-term impacts on property values in the area. Whenever land uses change, the concern is often raised about the effect the change may have on property values nearby. Zoning is the primary means by which most local governments protect property values. By allowing some uses and disallowing others, or permitting them only as conditional uses, conflicting uses are avoided. Some residents consider transmission lines to be an incompatible use adjacent to residential areas. Nonetheless, the presence of transmission lines in residential areas is fairly common.

The question of whether nearby transmission lines can affect residential property values has been studied many times in the United States and Canada over the last 20 years or so, with mixed results. In the 1990s, BPA contributed to the research when it looked at the sale of 296 pairs of residential properties in the Portland, Oregon and Vancouver, Washington, metropolitan areas and in King County, Washington. The study evaluated properties adjoining 16 BPA high-voltage transmission lines (subjects) and compared them with similar property sales located away from transmission lines (comps). All of the sales were in 1990 and 1991 and adjustments were made for time and other factors. Study results showed that the subjects in King County were worth about 1 percent less than their matched comps, while the Portland/Vancouver area subjects were worth almost 1.5 percent more (Cowger et al. 1996).

BPA updated this study in 2000 using 1994-95 sales data. The sales of 260 pairs of residential properties in the King County and Portland/Vancouver metropolitan areas were reviewed. The residential sales analysis identified a small but negative impact of from 0 to 2 percent for those properties adjacent to the transmission lines as compared to those where no transmission lines were present. Although this study identified a negative effect, the results are similar to the earlier study and the differences are relatively small (Bottemiller et al. 2000). Other studies include “High-Voltage Transmission Lines: Proximity, Visibility, and Encumbrances Effects,” by James A. Chalmers and Frank A. Voorvaart, published in The Appraisal Journal, summer 2009. The most recently published BPA article titled, “Further Analysis of Transmission Line Impact on Residential Property Values,” by Marvin L. Wolverton, PhD, MAI, and Steven C. Bottemiller, MAI, provides references to other studies conducted independent of BPA's influence. This article was published in The Appraisal Journal, July 2003.

Studies of impacts during periods of physical change, such as new transmission line construction or structural rebuilds, generally have revealed greater short-term than long-term impacts. However, most studies have concluded that other factors, such as general location, size of property, improvements, condition, amenities, and supply and demand factors in a specific market area are far more important criteria than the presence or absence of transmission lines in determining the value of residential real estate.

Whether a transmission line introduces a negative visual impact on property owners depends on the placement of a line and its proximity, as well as each individual landowner's perception of what is visually acceptable or unacceptable. (Potential visual impacts are evaluated in Section 3.2 Visual Resources).

The new transmission line would cross over or near some current and potentially future residential areas (see Section 3.1 Land Use and Recreation). Some ***low*** temporary negative impacts on property values (and salability) might occur on an individual basis as a result of the new transmission line for these and potentially for nearby properties along all action alternatives. However, these impacts would be highly variable, individualized, and unpredictable. Constructing the transmission line is not expected to cause long-term negative impacts on property values along the proposed routes or in the general vicinity. Non-project impacts, along with other general market factors, are already reflected in the market value of properties in the area. These conditions are not expected to change appreciably.

Public Services

The project would have ***no*** impacts on hospitals, schools, and law enforcement because the project would not cause an increase in the permanent population. Project construction and maintenance activities have the potential to introduce a fire risk in a high-fire danger zone, primarily dry grassland and agricultural fields that are susceptible to wildfire and sparsely populated. Representatives from the Centerville Fire Department with jurisdiction over portions of the project area have stated that alternatives that are easier to access and less rugged terrain would be preferable. Lack of roads and steep terrain increases the difficulty of accessing and fighting fires. Best management practices would be followed by construction and maintenance workers to reduce the risk of fires. ***Low*** permanent impacts on local or regional fire fighting services would be expected for all action alternatives.

The proximity of the rights-of-way to airports could have impacts on airport operations and aircraft flight patterns. If a decision is made to build the project, BPA would work with WDOT and the FAA to coordinate construction and design to minimize impacts and ensure aircraft safety. (See Section 3.1 Land Use and Recreation for details on impacts and mitigation for each alternative).

Operations and Maintenance

Helicopter inspection of the line would occur twice a year, and vehicle ground inspections annually. Maintenance vehicles would use access roads where established and maintenance workers would walk through agricultural fields when able to avoid damage to crops. If work is required on towers located within fields, vehicles and equipment would need to drive through fields and they could cause damage to crops, vegetation, and other property. BPA would mitigate impacts to compensate landowners and restore land use function (see Mitigation Measures in this section and in Section 3.1 Land Use and Recreation). Maintenance work could present a low fire risk for all action alternatives (see Public

Services subsection). Other than potential low impacts to fire fighting services, operations and maintenance would have ***no*** impacts on socioeconomics resources for any of the action alternatives.

Project construction would occur within the existing Big Eddy Substation footprint and would have ***no*** impact on socioeconomic resources.

West Alternative

Most agricultural economic impacts along the West Alternative would occur in rangelands and nonirrigated cropland (see Section 3.1 Land Use and Recreation). The maximum permanent reduction in direct agricultural output would be about $5,845, of which about $631 would be labor income (see Table 3-27). Associated with these losses would be indirect reductions in earnings by other sectors associated with agriculture, totaling about $9,580 in output for Klickitat and Wasco counties, $1,615 of which would be labor income. Temporary reductions in output and labor income due to construction activities would be similar. In 2007, grain farming and cattle ranching and farming accounted for an estimated $50 million in economic output in Klickitat and Wasco counties, so permanent displacements and temporary disruptions in farm production resulting from the proposed project would each amount to less than 0.02 percent of the direct output of these two crop types (Minnesota IMPLAN Group 2008). Relative impacts on the labor income earned in the two-county region would be comparably small. Because of this small impact and with mitigation payments to landowners, the project would have ***low*** permanent and temporary impacts on the local and regional economy.

Table 3-27. Reductions in Output[1] and Labor Income[2] Resulting from Farmland Displacement and Disturbance along the Action Alternatives

	Permanent Reductions (yearly)[3]				Temporary Reductions[3]			
	Direct Effect[4]		Total Effect[5]		Direct Effect[4]		Total Effect[5]	
	Output	Labor Income	Output	Labor Income	Output	Labor Income	Output	Labor Income
West Alternative	$5,845	$631	$9,580	$1,615	$6,215	$634	$9,757	$1,600
Middle Alternative	$8,280	$835	$12,237	$1,996	$7,380	$714	$10,491	$1,674
East Alternative	$7,380	$785	$11,303	$1,893	$9,775	$877	$13,957	$2,143

[1] Output is the value of the farm product (in this case, nonirrigated grain, irrigated alfalfa, and/or animal product).

[2] Labor income is the ***portion of output*** earned by farmers and farm workers.

[3] Permanent losses are earnings that would no longer occur on an annual basis. Temporary losses are those that only occur during the period of construction. Temporary direct effects would be reimbursable.

[4] Direct Effects are changes in crop and livestock production and the associated labor income that could result from the proposed project.

[5] Total Effect is the sum of the direct effects (see footnote 4), the indirect effects (i.e., changes in purchases from other sectors by the affected business), and the induced effects (i.e., changes in personal consumption purchases from other sectors by affected farmers and farm workers).

Note: Estimates are based on potential maximum losses from the range of tower options available for each alternative.

Sources: McBride 2010; Minnesota IMPLAN Group 2007

The West Alternative tower option that would include permanently removing the Chenoweth-Goldendale line (line miles W6.0–22) could affect Klickitat County PUD. The PUD uses this line as a back-up to Goldendale Substation when other lines are down for maintenance. Other means for back-up would need to be found as needed. Impacts would be ***moderate***.

Middle Alternative

Similar to the West Alternative, most agricultural economic impacts along the Middle Alternative would occur in rangelands and nonirrigated croplands, although relatively more cropland would be impacted, including some irrigated alfalfa. The maximum permanent reduction in direct agricultural output would be about $8,280, of which about $835 would be labor income (see Table 3-27). Associated with these losses are indirect reductions in earnings by other sectors associated with agriculture, totaling about $12,237 in output for Klickitat and Wasco counties, $1,996 of which would be labor income. Temporary reductions in output and labor income due to construction activities would be slightly lower. Based on county earnings for 2007 (see West Alternative discussion), permanent displacements and temporary disruptions in farm production resulting from the proposed project would each amount to closer to 0.02 percent of the direct output of the affected agricultural products (Minnesota IMPLAN Group 2008). Relative impacts on the labor income earned in the two-county region would be comparably small. Because of this small impact and with mitigation payments to landowners, the project would have ***low*** permanent and temporary impacts on the local and regional economy.

The Middle Alternative has a tower option that would include removing portions of the existing Harvalum-Big Eddy Line and rebuilding the line on double-circuit towers to carry both the existing and proposed line in areas where they would share right-of-way. The Harvalum-Big Eddy Line would be temporarily taken out of service for removal and rebuild. Construction would have to be timed such that electric loads were relatively light on the existing line and could be redirected to other transmission lines in the area so as to not disrupt transmission service. There would be ***no*** impacts to service with proper scheduling.

East Alternative

As for the other action alternatives, most agricultural economic impacts along the East Alternative would occur in rangelands and nonirrigated croplands, although relatively more cropland would be impacted than along the West Alternative, including some irrigated alfalfa. The maximum permanent reduction in direct agricultural output would be about $7,380, of which about $785 would be labor income (see Table 3-27). Associated with these losses are indirect reductions in earnings by other sectors associated with agriculture, totaling at most $11,303 in output for Klickitat and Wasco counties, $1,893 of which would be labor income. Temporary reductions in output and labor income due to construction activities would be slightly higher. Based on county earnings for 2007 (see West Alternative discussion), permanent displacements and temporary disruptions in farm production resulting from the proposed project would each amount to closer to 0.02 percent of the direct output of the affected agricultural products (Minnesota IMPLAN Group 2008). Relative impacts on the labor income earned in the two-county region would be comparably small. Because of this small impact and with mitigation payments to landowners, the project would have ***low*** permanent and temporary impacts on the local and regional economy.

The East Alternative has a tower option that would include removing portions of the existing Harvalum-Big Eddy Line and portions of the existing McNary-Ross Line in areas where the proposed line and the existing lines share a right-of-way. The lines would be rebuilt on double-circuit towers to carry both the existing and proposed line. The Harvalum-Big Eddy and the McNary-Ross lines would have to be taken out of service during removal and rebuild. Construction would have to be timed such that electric loads were relatively light on the existing lines and could be redirected to other transmission lines in the area so as to not disrupt transmission service. There would be ***no*** impacts to service with proper scheduling.

Knight Substation Options

Knight Substation Site 1

Substation Site 1 is privately owned property. Locating Knight Substation at Site 1 could permanently remove 80 acres of nonirrigated cropland from production (see discussion in Section 3.1 Land Use and Recreation). This would result in a total reduction in economic output of about $20,984/year for Klickitat and Wasco counties, and a reduction in total labor income of about $2,937/year (see Table 3-28). The direct effects to the individual landowner would be slightly smaller. However, the landowner would be compensated by purchase of the property by BPA, and 50–70 acres could potentially be leased out for cultivation at some point in the future. Placing this privately-owned land into federal ownership would also remove it from the county tax base, for a loss of about $142 annually to the county in property taxes. These losses altogether would be considered a permanent ***low*** impact.

Table 3-28. Reductions in Output[1] and Labor Income[2] from Farmland Displacement and Disturbance at Knight Substation

	Direct Effect[3]		Total Effect[4]	
	Output	Labor Income	Output	Labor Income
Knight Substation Site 1	$16,394	$1,261	$20,984	$2,937
Knight Substation Site 2	$6,156	$473	$7,880	$1,103

[1] Output is the value of the farm product (in this case, nonirrigated grain).

[2] Labor income is the ***portion of output*** earned by farmers and farm workers.

[3] Direct Effects are changes in grain production and the associated labor income that could result from the proposed project.

[4] Total Effect is the sum of the direct effects (see footnote 3 above), the indirect effects (i.e., changes in purchases from other sectors by the affected business), and the induced effects (i.e., changes in personal consumption purchases from other sectors by affected farmers and farm workers).

Note: Estimates are based on potential maximum losses from the range of tower options available for each alternative.

Sources: McBride 2010; Minnesota IMPLAN Group 2007

Knight Substation Site 2

Substation Site 2 is DNR State Trust Land leased for crop production. The substation would permanently remove about 30 acres of nonirrigated cropland from a 544-acre property owned by DNR. This would result in a total permanent reduction in regional economic output of about $7,880/year for Klickitat and Wasco counties, and a reduction in total labor income of about $1,103/year (see Table 3-28). Direct effects, which would impact DNR lessees or sharecroppers as well as DNR, would be slightly less. Lessees and sharecroppers would not be compensated for these losses. Revenues to DNR would be reduced by about $900–2,100 per year, about a thousandth of a percent of the revenues in 2009 from State Trust Lands. DNR would be compensated by purchase of the land rights, and since the state does not pay property tax, this would have ***no*** impact on the county tax base. Given the relatively small reductions in revenue and economic output, the permanent conversion of nonirrigated cropland to a transmission facility would result in a ***low*** permanent impact on the local economy as well as on State Trust Lands.

Construction of Knight Substation at either Site 1 or 2 would require both the existing Wautoma-Ostrander and the North Bonneville-Midway lines to briefly be taken out of service as they would be looped into the substation. Construction would have to be timed such that electric loads were relatively light on the existing lines and could be redirected to other transmission lines in the area so as to not disrupt transmission service. There would be ***no*** impacts on service with proper scheduling.

Fiber Optic Cable Options

For the Loop Back Option, no impacts on socioeconomics would occur other than those already described for each action alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential socioeconomic impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.9.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on socioeconomic resources.

- Compensate landowners at market value for any new land rights for right-of-way or access road easements.
- Compensate landowners for damage to property or crops during construction or operation and maintenance activities.
- Compensate landowners for irrigation systems that must be reconfigured to accommodate new transmission infrastructure.
- Consult with the NRCS and the Farm Service Agency to mitigate impacts to CRP land to maintain existing CRP status of lands and federal payments to landowners, where practicable.
- Prepare for fire management (see mitigation measures in Section 3.3 Vegetation).

3.9.4 Unavoidable Impacts Remaining after Mitigation

The project would permanently remove some areas from agricultural production, and environmental and recreational resources. Modest economic benefits could include increased employment in the area, local purchase of goods and services, and increased service capacity on the BPA transmission grid.

3.9.5 No Action Alternative

With the No Action Alternative, the positive economic impact due to construction expenditures would not occur. The low impacts to agricultural output and the county tax base would also not occur.

In addition, with the No Action Alternative, BPA would be unable to provide the full amount of firm transmission service that has been requested. Congestion on the existing lines moving power east to west through the area would limit the ability to transfer additional power through the Columbia River Gorge and could make it more difficult for existing or new generation facilities (including wind facilities) to sell their power. Some or all of those who have requested firm transmission service would need to accept other types of transmission service from BPA, pursue transmission service on other lines (if any capacity is available), or fund their own high-voltage lines and substations. For any firm transmission service requested for new generation, the lack of additional firm transmission capacity under the No Action Alternative also could lead some developers to ultimately modify or even cancel their projects if alternative transmission service could not be found.

3.10 Transportation

This section discusses transportation issues related to the project. For additional discussion of project access roads and scenic byways, see Sections 3.1 Land Use and Recreation and 3.2 Visual Resources.

3.10.1 Affected Environment

The transportation system in the project area includes highways and roads, railroads, airports, and the Columbia River.

Most of the roads in the project area are rural county roads (see Map 3-1). Direct road access to the immediate project vicinity is primarily provided by Klickitat and Wasco county roads and existing BPA access roads, although some access may come more directly off SR-14 (Washington). Regional highway access to the area is provided by I-5, I-90, I-84, US-197, US-97, and US-395. Highways and local roads are mostly two lanes in the vicinity, except I-84/US-30, which is a four-lane divided highway. The average daily traffic volumes of these major access highways are shown in Table 3-29.

Table 3-29. Average Daily Traffic for Primary Roads in the Project Area

Road	Average Daily Traffic (vehicles/day)
SR-142	990
SR-14	4,300
US-97	5,000
US-197	8,400
I-84	15,500

Source: WSDOT 2009a; ODOT 2009

Railroads in the area include the Burlington Northern Santa Fe Railway and the Union Pacific Railroad. These railroads parallel both sides of the Columbia River through the area. Amtrak's Empire Builder train travels through the Columbia Gorge on the north side of the Columbia River as it travels to and from Chicago, Illinois. The railroad tracks used by these railroads are crossed by all action alternatives (see Map 3-1).

Federal Aviation Administration (FAA)-certified aviation facilities in the project area include two public airports—The Columbia Gorge Regional/The Dalles Municipal (hereafter referred to as The Columbia Gorge Regional) and Goldendale airports, and two private airports, Piper Canyon and Warwick (see Map 3-1). There are also various private airstrips primarily used for agricultural operations in the area.

The Columbia River is used to transport grain and other commodities produced in the region.

3.10.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Impacts to transportation would include increased traffic and possible delays along transportation corridors due to construction activities, improvements to small segments of county roads, development of BPA access roads, and affects on air traffic safety.

Intermittent disruptions to traffic flow on roads would occur during the 20-month construction period. During construction, light and heavy vehicles would access the corridor, and equipment and components would be transported to the project site via semi-trucks. Staging areas would be set up along or near the corridor for construction crews to store materials and trucks. A relatively low increase in daily traffic volume on highways would occur, with a maximum of 16 vehicles per day to deliver materials and equipment to construction sites. The addition of the construction traffic to the main roads in the area would result in a small change to existing volume to capacity ratios.

Construction vehicles could interrupt or slow traffic for brief periods of time as they enter or exit access roads, due to blasting near a road (to protect cars from flying debris), or while the conductor is being strung across the roadway by helicopter. A traffic control plan would be developed for submittal to the appropriate highway departments. Crossings of railroads would be timed to avoid interrupting train service; appropriate coordination and crossing permits would be obtained from the affected railroad. BPA would coordinate with ship traffic control for stringing the conductor across the Columbia River.

Trucks carrying heavy construction materials and equipment could damage existing roadways. All loads transported on state and county roads would be within legal size and load limits, or have valid oversize and/or weight permits. Any damage to existing roads would be repaired following construction. Project vehicles could track dust, soils and other materials from construction sites onto public roads. Erosion control measures would include stabilization of construction entrances and exits to prevent sediments from being transported onto adjacent roadways.

Overall impacts to transportation from construction would be ***low*** because increased traffic on roads would be short-term and roads can absorb the relatively small increase in vehicle use; time needed for conductor stringing over, highways, railroads, and the Columbia River would be brief and scheduled to create minimal or no delays; and measures would be taken to repair damage to existing roads and prevent erosion onto adjacent roadways.

Operation and maintenance traffic over the life of the line would be only a few maintenance vehicles once a year, and helicopters twice a year, which would create ***no*** impact on transportation.

Development of access roads would include upgrading existing BPA access roads, upgrading existing county roads, building new access roads, and constructing and removing temporary access roads to tower sites within agricultural fields. Improvements to existing roads could involve clearing brush, grading and laying down gravel, widening roads, smoothing-out curves, and adding culverts, ditches, rolling-dips and/or water bars. Specific miles of access roads required are discussed for each alternative. Road-related impacts to other resources such as land use, visual resources, vegetation, wildlife, fish, soils, water resources, and cultural resources are discussed in the resource specific sections elsewhere in this EIS. See Section 3.1 Land Use and Recreation for a discussion about possible unauthorized access and use of BPA roads.

Where transmission lines run near airports and where towers and/or wires are above a certain height, airplane safety must be determine by the FAA. The FAA requires that designs be submitted for approval if a proposed structure or conductor/ground-wire is 200 feet or more above the ground or water, or if any part of the proposed transmission line is within a prescribed distance of a public airport (Melzer 2010a). Structures that the FAA deems as obstructions to aircraft may be made safe by marking with special lighting, paint, and/or marker balls, as directed by the FAA. Possible marking requirements could include 36-inch marker balls along the uppermost wire of a transmission line, red and white paint on a tower, white/red strobe lines placed at the top of a structure, and red steadily burning lights halfway up a tower (Melzer 2010a,b). For all route alternatives, towers in the vicinity of the Columbia Gorge Regional Airport would need review by the FAA. Towers proposed near the Goldendale airport have already been reviewed and cleared by the FAA (FAA 2010a–d). The Warwick Airport would not be impacted by any route alternative. There would be impacts on the Piper Canyon Airport by the West and Middle alternatives, as discussed for each alternative; however, since this airport is not regulated by the FAA, structure marking would not be determined by the FAA. (For more details on FAA requirements pertaining to airport size and proximity to the project, see the Transportation section in Chapter 5).

Construction work at Big Eddy Substation may disrupt traffic on Columbia View Drive and Fifteenmile Road as equipment and trucks enter or exit the substation. However, the substation work at Big Eddy would be minimal, and disruptions would be brief. Impacts to transportation would be ***low***.

West Alternative

The West Alternative would require about 21 miles of new access road, 11 miles of existing road upgrades, 3 miles of temporary roads, and 5 miles of county road upgrades. The county roads that would require upgrades include Ahola Ridge Road (from Horseshoe Bend Road south to Finn Ridge Road), Finn Ridge Road (from Harms Road to Ahola Ridge Road), and Palomino Drive (from Horseshoe Bend Road north). See Table 2-3 and Map 3-1.

The West Alternative passes within 3 miles of the Columbia Gorge Regional Airport. A number of towers and wires would be reviewed by the FAA and possibly marked for aircraft safety; these are primarily in the Columbia Gorge. About 11 towers within the first 5 miles from Big Eddy Substation would exceed 220 feet and would be reviewed by the FAA to determine the need for lighting. In addition, wires on towers between line miles W1–11 (though the Columbia Gorge) and at W19 (Little Klickitat River crossing) would need review for marker balls because they span deep ravines and the wire would be over 200 feet from the ground or water. As with all the route alternatives, the towers on either side of the Columbia River would require lighting; the topmost wire that would cross the river would require marker balls; and lights that would point to the wires would be needed on the towers.

The West Alternative would pass about 600 feet to the south of the Piper Canyon Airport, paralleling the airstrip for about 2,000 feet. Although the FAA doesn't regulate obstructions to private-use airports, the owner of the airport would be consulted by BPA, and lighting or marking would be considered for aircraft safety and the security of the line.

The West Alternative would require the most new access roads of the route alternatives, and would pass relatively close to two airports, and although airport impacts would be mitigated with appropriate tower and line marking, the line would create some risk to air traffic safety. Therefore, overall impacts to the West Alternative on transportation would be considered ***low-to-moderate***.

West Option 1 would have the least potential risk impact on air traffic because the single-circuit towers would be shorter and fewer towers would have to be marked. Options 2 thru 6 would have similar tower marking requirements and therefore similar potential impacts.

Middle Alternative

The Middle Alternative would require about 19 miles of new access road, 15 miles of existing road upgrades, and 3 miles of temporary roads. No county roads would require upgrades.

The Middle Alternative would have about 5 towers that would exceed 200 feet and that would be reviewed by the FAA and possibly marked for aircraft safety. These towers would be where the line would cross Fifteenmile Creek, the Columbia River, and steep terrain heading north over the Columbia Hills. In addition, numerous wires between line miles M1–11 (though the Columbia Gorge) and at M19 (Little Klickitat River crossing) would be reviewed for marker balls because they span deep ravines and they would be over 200 feet from the ground or water. As with all the route alternatives, the towers on either side of the Columbia River would require lighting; the topmost wire that would cross the river would require marker balls; and lights that would point to the wires would be needed on the towers.

Given that mitigation measures should be able to minimize impacts on airport operations and aircraft safety, the permanent transportation impacts on air transportation would be ***low*** for the Middle Alternative.

Middle Option 1 would have the least potential risk of impact on air traffic because the single-circuit towers would be shorter and fewer towers would be marked. Options 2 and 3 would have similar tower marking requirements and therefore similar potential impacts.

East Alternative

The East Alternative would require about 16 miles of new access road, 16 miles of existing road upgrades, and 5 miles of temporary roads. No county roads would require upgrades.

The East Alternative would have about 8 towers that would exceed 200 feet and that would be reviewed by the FAA and possibly marked for aircraft safety. These towers would be located where the line would cross Fifteenmile Creek, the Columbia River, and rolling terrain along the Columbia Hills. In addition, numerous wires between line miles E1–15 (through the Columbia Gorge) would need review for marker balls as they span deep ravines. As with all the route alternatives, the towers on either side of the Columbia River would require lighting; the topmost wire that would cross the river would require marker balls; and lights that would point to the wires would be needed on the towers.

Given that mitigation measures should be able to minimize impacts on airport operations and aircraft safety, the permanent transportation impacts on air transportation would be ***low*** for the East Alternative.

East Option 1 would have the least potential risk impact on air traffic as the single-circuit towers would be shorter and fewer towers would have to be marked. Options 2 and 3 would have similar tower marking requirements and therefore similar potential impacts.

Knight Substation Options

Construction at Substation Site 1 would require temporary road access, likely off Hill Road from the west, Butts Road from the south, or from Pine Forest Road from the north. These county roads would likely require upgrading to accommodate the equipment loads for the substation. Construction traffic would be noticed mostly on Knight Road, but would be dispersed along one of the roads mentioned above. Permanent access to Site 1 for operations would likely be from Knight Road.

Substation Site 2 would be accessed directly from Knight Road to the east. Construction traffic would be noticed on Knight Road with potential short-term delays as trucks and equipment enter or exit the site.

Knight Substation would be remotely controlled, with personnel visiting periodically, so traffic due to substation operations and maintenance would be minimal.

Overall substation impacts to transportation would be ***low***, because traffic disruptions would be minimal both during construction and substation operations and maintenance.

Fiber Optic Cable Options

For the Loop Back Option, no impacts on transportation would occur other than those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential transportation impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.10.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts on transportation.

- Coordinate with Klickitat County roads department for upgrades of county roads.
- Coordinate routing and scheduling of construction traffic with state and county road staff, Columbia River operators, and railroad operators.
- Employ traffic control flaggers and post signs warning of construction activity and merging traffic, when necessary for short interruptions of traffic.
- Conduct regular maintenance on access roads and gates within and leading to the corridor.
- Prepare and implement a SWPPP (see mitigation measures in Section 3.4 Geology and Soils) to prevent sediments from being transported onto adjacent roadways.
- Limit tracking of soil onto paved roads (see mitigation measures in Section 3.4 Geology and Soils).
- Design roads to limit erosion (see mitigation measures in Section 3.4 Geology and Soils).
- Restore public roadways to preconstruction conditions upon completion of project construction activities.
- Coordinate with the WSDOT Aviation Division and comply with FAA regulations for marking or lighting (including painting and/or lighting towers and installing marker balls on overhead ground wires in specific locations).
- Consult with the owner of Piper Canyon Airport to ensure aircraft safety at Piper Canyon Airport.

3.10.4 Unavoidable Impacts Remaining after Mitigation

During construction, unavoidable transportation impacts would consist of minor delays and interruptions to local traffic.

3.10.5 No Action Alternative

The No Action Alternative would have no impact on transportation because no new transmission lines, towers, or substations would be constructed. Existing transportation resources would remain the same, and impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.11 Noise

This section describes noise that may be created by the construction, operation and maintenance of the proposed project.

3.11.1 Affected Environment

Noise is commonly defined as unwanted sound that disrupts normal human activities or diminishes the quality of the human environment. Transient noise sources, such as passing aircraft or motor vehicles, produce noise usually of short duration. Stationary sources such as a power lines, transformers or substations can emit noise over a longer period. Ambient noise is all noise generated in the vicinity of a site by typical noise sources such as traffic, neighboring businesses or industries and weather (wind or rain). Ambient noise level is a typical mix of noise from near and distant sources.

Noise is usually measured in decibels on the A-weighted scale (dBA), which corresponds to how humans hear sound. Table 3-30 shows typical noise levels for common sources expressed in dBA. Noise exposure depends on how much time an individual spends near the source.

Table 3-30. Common Noise Levels

Noise Source or Effect	Sound Level (dBA[1])
Rock-and-roll band	110
Truck at 50 feet (15.2 meters)	80
Gas lawnmower at 100 feet (30 meters)	70
Normal conversation indoors	60
Moderate rainfall on foliage	50
Refrigerator	40
Bedroom at night	25

[1] Decibels (A-weighted)
Source: DOE 1986

Along the action alternatives, existing noise levels vary with proximity to existing transmission lines, traffic (particularly near highways), agricultural activities, aircraft and wind levels (which can sometimes be high in the Columbia River Gorge). While each alternative crosses or parallels busy highways in the southern portion of the project area, most of the land crossed is agricultural along with some recreational land. Ambient noise levels can be intermittently high next to highways and consistently moderate to high during sustained winds in the Columbia River Gorge, but generally low elsewhere.

Transmission line noise is associated with corona. Corona is the partial electrical breakdown of the insulating properties of air around the conductors of a transmission line. Corona-generated noise is usually heard as a hissing or crackling sound accompanied by a hum under certain conditions.

The conductors of high-voltage transmission lines are designed to be corona-free under ideal conditions. Noise from transmission lines generally occurs only when conductors are wet during foul weather (periods of rain, fog, snow, or icing). Based on several years' meteorological records from Moro, Oregon, and Kennewick, Washington, foul weather conditions occur infrequently (less than 1 percent of the time) in the project area (NOAA 2010). However, for a few months after construction, residual grease or oil can cause water to bead up on the surface of conductors, producing temporarily higher levels of audible noise. Also, during fair weather, insects and dust on conductors can serve as occasional corona sources.

Substations also generate noise, which comes mostly from transformer equipment that creates a 120-Hz (less than 50 dBA) hum. Circuit breakers also create noise when opening or closing, but those activities are rare.

The EPA has established a guideline of 55 dBA for an average day-night noise level (L_{dn}) and 45 dBA for night-time noise levels (between 10 p.m. and 7 a.m.) in outdoor areas (EPA 1978). The state of Washington has similar guidelines of maximum permissible noise levels of 60 dBA (L_{dn}) and 50 dBA (night-time) to intrude into residential property (Washington State 1975). These levels apply to transmission lines that operate continuously. BPA has established a transmission-line design criterion for corona-generated noise (L_{50}, foul weather) of 50 dBA at the edge of the right-of-way (DOE 2006). Likewise, BPA's design criterion for substation noise is 50 dBA at a substation property line. Besides meeting Washington's guidelines, these criteria have been interpreted by the state of Oregon and BPA to meet Oregon Noise Control Regulations (Perry 1982).

3.11.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

Construction Noise

Construction of the transmission line and Knight Substation would generate temporary noise that could affect nearby residences, business owners and recreationists. Although daytime construction activities are excluded from noise regulations and line construction activities would be temporary, BPA did evaluate these noise impacts. The project would be built primarily using conventional construction equipment. Table 3-31 summarizes maximum noise levels (from 50 feet away) produced by such equipment. Construction activities that would create noise include access road grading, excavation for tower footings, assembling and lifting towers into place, helicopter assistance during tower installation and stringing of conductors, blasting in bedrock (when needed), and use of implosive fittings for conductor splicing.

When determining noise levels, an equivalent sound level (L_{eq}) is generally accepted as the average sound level. The overall noise caused by conventional construction equipment is estimated to be 89 dBA L_{eq} at 50 feet, dissipating with distance. Table 3-32 shows estimated construction noise levels at various distances from a construction site.

Table 3-31. Construction Equipment Noise Levels

Type of Equipment	Maximum dBA[1] at 50 Feet
Road Grader	85
Bulldozers	85
Heavy Trucks	88
Backhoe	80
Pneumatic Tools	85
Crane	85
Combined Equipment	89

[1] Decibels (A-weighted)
Source: Thalheimer 1996

A helicopter may be used to assist with tower installation. A loaded cargo helicopter flying 250 feet away produces roughly 95 dBA, which is the same amount of noise produced by a diesel locomotive 100 feet away (Helicopter Association International 1993). If a helicopter is used, towers would be preassembled at one or more central staging areas and then transferred by helicopter to tower sites. The helicopter would hover at central staging areas for two to five minutes per tower as it picked up each tower section, and would then hover at each tower site for two to 10 minutes during a one-hour period while the tower sections are placed on the foundation. Assuming helicopters were used to erect about 130 towers, between 10 and 30 hours of hover time would be required, spread over several weeks along the transmission line route.

Table 3-32. Construction Equipment Noise Levels by Distance

Distance from Construction Site (feet)	Hourly L_{eq} (dBA[1])
50	89
100	83 (similar to truck at 50 feet)
200	77
400	71 (similar to gas lawnmower at 100 feet)
800	65
1,600	59 (similar to indoor conversation)

[1] Decibels (A-weighted)
Assumptions: Equipment used was one each – grader, bulldozer, heavy truck, backhoe, pneumatic tools, concrete pump, crane. Reference noise level of 89 dBA (L_{eq}). Distance for the reference noise level: 50 feet. Noise attenuation rate: 6 dBA/doubling of distance. This calculation does not include the effects, if any, of local shielding or atmospheric attenuation.

Blasting could be required in rocky areas where conventional excavation of tower footings would not be practical. Where blasting might occur, the explosion would produce a short noise like a thunderclap that could be audible for half a mile or more. Implosive fittings could also be used to connect conductors together. Implosive fittings make a sound like a shotgun. The fittings would be required about every 3 miles. On single-circuit towers, the conductor would require nine fittings per splice location; for double-circuit towers, 18 fittings would be required. These disturbances would be short-lived and infrequent.

Noise generated by construction activity at Big Eddy Substation would occur for all alternatives and could have a ***moderate*** temporary noise impact on a few nearby residents. If bedrock blasting is required, this could be a ***high*** temporary noise impact on a few residents, and a lesser temporary impact on residents and visitors within a mile or two of the substation.

Noise from Big Eddy Substation's existing equipment (primarily transformers) and nearby transmission lines would remain the primary source of environmental noise at the site even if the proposed project was built and operating. Additions at Big Eddy Substation would have ***no*** permanent noise impacts.

Additional noise impacts are discussed under each alternative later in this section.

Transmission Line Operations and Maintenance Noise

Maximum potential corona noise levels for the action alternatives are estimated to range from 40 to 49 dBA at the edge of the right-of-way during foul weather (L_{50}). This level is comparable to, or less, than those from existing 500-kV lines in Oregon and Washington (see Appendix E). The highest levels would generally occur where the new 500-kV circuit is at the minimum distance of 75 feet from the right-of-way edge. Noise from new conductors would be less than existing transmission lines in some places because BPA designs new lines to minimize potential corona.

The highest potential noise level of 49 dBA during foul weather would meet BPA's design criterion and Oregon and Washington regulations. This would be well below the 55 dBA level that can interfere with speech outdoors and would not intrude on indoor noise levels (EPA 1974). During the area's fair weather, which helps minimize the occurrence of corona, noise levels at the edge of the right-of-way would not exceed 29 dBA and would likely be masked by ambient noise. For all action alternatives, there would be ***low*** noise impact from operations. The only exception would be potentially higher noise impacts on one home in Wishram that, depending on tower configuration, could be as close as 71 feet to the centerline of the Middle or East alternatives.

Occasional maintenance activities would generate temporary noise sources. Each tower and line would be inspected by field crews at least once annually. In addition, twice a year a helicopter would patrol the transmission line corridor to look for any problems. If repairs are needed, field vehicles would be dispatched to access trouble spots. For all action alternatives, line maintenance would have temporary ***low*** noise impacts.

West Alternative

Ten houses would be within 500 feet of the West Alternative, depending on the line configuration. Four homes would be within 300 feet, the closest about 200 feet from the centerline (see Table 3-33; also Appendix B for a map showing house locations). Homes along the route are scattered throughout the project area, including two just north of Big Eddy Substation in Oregon and nine in rural Klickitat County (near line miles W12-13, 17, 18, 21, and 25). Construction could have temporary ***moderate-to-high*** noise impacts for these residents.

Table 3-33. Houses/Businesses near the Action Alternatives

	Single Circuit			Double Circuit[1]		
Primary Configuration	**West Alternative**	**Middle Alternative**	**East Alternative**	**West Alternative**	**Middle Alternative**	**East Alternative**
Houses/Businesses < 300 ft	4	3	3	4	5	5
Houses/Businesses < 500 ft	10	12	12	10	11	10
Range of Distances from Centerline, feet	203–486	71–425	71–484	203–486	191–495	191–495

[1] Double circuit counts include houses from single-circuit segments E-4, E-27 and M-5, where no double circuit is planned. (See Figure 1 in Appendix E for information on segments.)

Middle Alternative

Eleven to 12 homes and businesses (one business total) would be within 500 feet of the proposed Middle Alternative, depending on line configuration. Three to five of those would be within 300 feet (see Table 3-33). The homes along the route include five between Big Eddy Substation and the Columbia River crossing (near line miles M3 and M7), and three in Wishram (one of the Wishram residences is within 71 feet of the centerline of the proposed single-circuit right-of-way). The others are farther north near line miles M17, 20, and 25 in rural Klickitat County. For these residents, construction could have temporary ***moderate-to-high*** noise impacts.

East Alternative

Ten to 12 homes and businesses (three businesses total) would be within 500 feet of the East Alternative depending on line configuration. Three to five of those would be within 300 feet, depending on configuration (see Table 3-33). Along the first 9 miles, the East Alternative would affect the same Oregon and Washington homes as the Middle Alternative. In addition, it would run close to a cluster of homes and businesses near line mile E22 and a home near line mile E27, west of Goldendale. Construction could have temporary ***moderate-to-high*** noise impacts on these residents.

Knight Substation Options

Because there are no residences within 800 feet of Knight Substation Sites 1 and 2, construction activities would have temporary ***low-to-moderate*** noise impacts. If bedrock blasting is required, this could have a temporary ***moderate*** noise impact on residents within a mile or two of the substation site.

Substation operations noise is mainly made by equipment like transformers, reactors and other wire-wound equipment, which can produce a hum. No transformer would be installed at Knight Substation. Any equipment installed would be required to meet BPA’s noise level criterion of 50 dBA at the edge of the property. This would ensure that all applicable federal, state, and local noise regulations are met. The substation would create ***no-to-low*** permanent noise impacts.

Fiber Optic Cable Options

For the Loop Back Option, no noise impacts would occur beyond those already described for each alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential noise impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.11.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse noise impacts by the action alternatives:

- Ensure standard sound-control devices, including mufflers, are on all construction equipment and vehicles.
- Limit construction activities to daytime hours.
- Notify landowners located along the corridor prior to construction activities, including blasting.

3.11.4 Unavoidable Impacts Remaining after Mitigation

Temporary noise impacts would occur during construction. Some corona noise may also be heard along the line (but not from homes), especially in wet or foggy weather.

3.11.5 No Action Alternative

Under the No Action Alternative, current noise levels at the edges of existing rights-of-way would continue to range from ambient to 48 dBA. The existing McNary–Ross 345-kV and parallel Big Eddy–Harvalum 230-kV lines currently produce the highest noise levels when corona is present.

3.12 Public Health and Safety

This section describes public health and safety issues associated with the proposed project, including electric and magnetic field levels.

3.12.1 Affected Environment

Throughout the local area, existing transmission facilities provide electricity for heating, lighting and other services essential for the health and safety of residents, farmers and business owners. If not constructed and operated properly, however, transmission facilities could pose risks to area dwellers and visitors – including fire or electric shock hazards or interference with aircraft safety. Transmission facilities meet safety requirements to prevent or reduce these risks. These include maintaining proper clearances between power lines and the ground, roadways and treetops; preventing accidental use of rights-of-way; and minimizing EMF as much as possible. (Airport locations/impacts and FAA tower marking requirements are discussed in Sections 3.1 Land Use and Recreation, and 3.2 Visual Resources.)

Electric and Magnetic Fields

Transmission lines, like all electric devices, produce EMF. Current, the flow of electric charge in a wire, produces the magnetic field. Voltage, the force that drives the current, is the source of the electric field. The strength of EMF depends on the design of an electrical line and distance from it. EMF is found around any electrical wiring, including household wiring, and electrical appliances and equipment.

Electric fields are measured in volts per meter (V/m) or kilovolts per meter (kV/m). Throughout a home, the average electric field strength from wiring and appliances is typically less than 0.01 kV/m. Electric-field levels in public buildings such as shops, offices, and malls are comparable with residential levels. Outdoor electric fields in publicly accessible places can vary widely from less than .01 kV/m to 12 kV/m; the higher fields are present only in limited areas along high-voltage transmission line rights-of-way (see Appendix E). Electric field strength is reduced by intervening objects such as walls and vegetation.

The International Committee on Electromagnetic Safety (ICES) has established exposure guidelines of 5 kV/m for electric fields, except on power line rights-of-way where the limit is 10 kV/m. However, there are no national guidelines or standards for electric fields from transmission lines, and the state of Washington has no electric field limit. Oregon's Facility Siting Council has established a limit of 9 kV/m within the right-of-way (no edge of right-of-way limit). BPA has guidelines for its transmission lines and designs new transmission lines to meet its electric-field guideline of 9 kV/m maximum on the right-of-way and 5 kV/m maximum at the edge of the right-of-way.

Magnetic fields are measured in units of gauss (G) or milligauss (mG). Average magnetic field strength in most homes (away from electrical appliances and wiring) is typically less than 2 mG. However, appliances carrying high current or with high-torque motors, such as microwave ovens, vacuum cleaners or electric shavers, may generate fields of tens or hundreds of milligauss directly around them (see Table 3-34). Office workers are exposed to similar fluctuating magnetic fields, while equipment or machine workers or those working for electric utilities are generally exposed to slightly higher level fields. Outdoor magnetic fields in publicly accessible places can range from less than a few milligauss to 300 mG or more, depending on proximity to power lines and their voltage (see Appendix E).

Like electric fields, magnetic fields fall off with distance from the source. Unlike electric fields, however, magnetic field strength is not reduced by intervening objects such as walls. Consequently, while appliances can produce the highest localized magnetic fields, power lines serving neighborhoods and distribution lines and transformers serving individual homes or businesses are a common source of longer-term magnetic field exposure.

Table 3-34. Typical Magnetic Field Levels

Appliance	Magnetic Field Range (mG)[1]
Can Opener	40–300
Vacuum Cleaner	20–200
Microwave Oven	1–200
Electric Shaver	0–100
Hairdryer	0.1–70
Power Drill	20–40
Television	0–20
Computer Monitor	2–6

[1] At a distance of 1 foot.
Source: NIEHS 2002

There are no national guidelines or standards for magnetic fields, and Oregon, Washington and BPA do not have magnetic field limits for transmission lines. Guidelines that do exist for public and occupational magnetic-field exposures are based on demonstrated responses to short-term exposures and include appropriate safety factors. For example, ICES has established exposure guidelines of 9,040 mG for magnetic fields (ICES 2002).

Some studies have been conducted on longer-term exposure, but have been inconclusive (see Appendix F).

3.12.2 Environmental Consequences

General impacts that would occur for all action alternatives are discussed below, followed by impacts unique to each alternative.

Common Impacts

General Safety Issues

During construction of towers and installation of conductors and ground wires, heavy equipment, cranes, helicopters, fuels, and blasting materials would be used. These could pose risks of fire and injury. In addition, there are potential safety issues to the public from more traffic on highways and roads in the area during construction. By following all on-site safety requirements and mitigation practices, however, these risks would be minimized for workers and the public. The public would not be allowed in construction areas and would not be at risk of injury. Typical safety standards, such as using flaggers, and properly handling fuels or other hazardous materials, would reduce potential impacts. Construction of the action alternative would pose ***low*** general safety impacts.

During operations and maintenance of the line, there could be additional risks for fire or injuries as workers, vehicles and helicopters travel along the corridor to perform required tasks. Historically, however, on existing lines these activities have posed ***no-to-low*** safety impacts.

Electric and Magnetic Fields

The possible effects of EMF on people near a transmission line right-of-way fall into two categories: short-term electric field effects that can cause shocks, and possible long-term health effects associated with magnetic fields. Each is discussed in this section.

Electric Fields

Power lines, like electrical wiring, can cause serious electric shocks if certain precautions are not taken. All BPA lines are designed and built to meet the National Electrical Safety Code. The NESC specifies the minimum allowable distance between conductors and the ground or other objects. These requirements determine the edge of the right-of-way and the height of the line, that is, the closest point that houses, other buildings, and vehicles are allowed to the line. These clearances are specified to prevent harmful shocks to workers and the public. The electric field analysis for the three transmission line alternatives is discussed in more detail in Appendix E.

BPA also does not permit any uses within rights-of-way that are unsafe or might interfere with constructing, operating, or maintaining the transmission facilities. These restrictions are part of the legal rights BPA acquires for its transmission line easements.

However, people working or living near transmission lines must also take certain precautions. For example, it is important never to bring conductive materials – including TV antennas, irrigation pipes or water streams from an irrigation sprinkler – too close to the conductors. Also, vehicles should not be refueled under or near the conductors. BPA provides a free booklet that describes safety precautions for people who live or work near transmission lines (see Appendix A).

Besides serious shocks, transmission lines can also cause nuisance shocks when a grounded person touches an ungrounded object under or near a line or when an ungrounded person touches a grounded object. BPA takes additional precautions to prevent nuisance shocks. Fences and other metal structures on and near the right-of-way would be grounded during construction. After construction, BPA would respond to any complaints and install or repair grounding as needed. (Nuisance shocks from mobile objects that cannot be grounded permanently are minimized by conductor clearance codes and design practices, such as BPA's 5 kV/m electric field requirement for road crossings.)

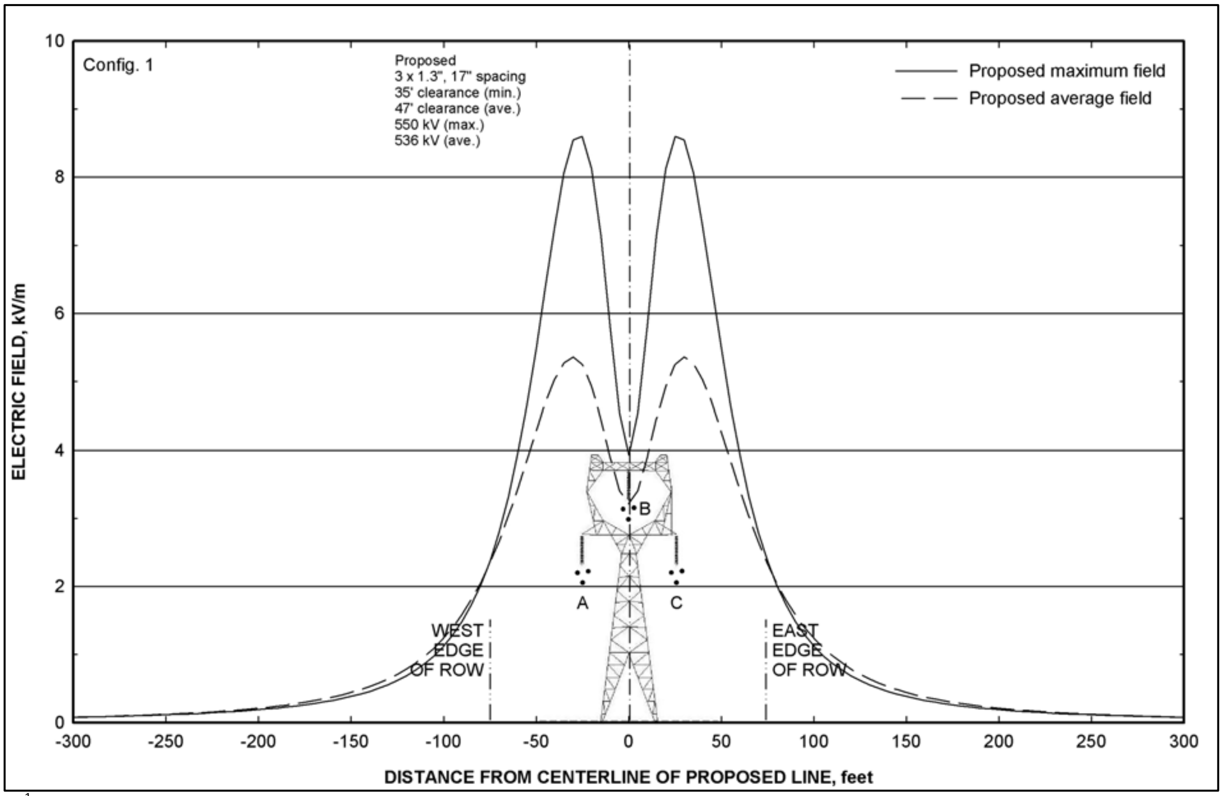
The calculated maximum electric field expected on the rights-of-way of the action alternatives (where conductors are closest to the ground) would range from 7.0 to 8.8 kV/m, depending on the tower option and line configuration. This is below Oregon's limit for peak electric fields of 9 kV/m. For average conductor heights, peak fields would range from 4.2 to 5.8 kV/m. Peak values would be present only directly under the conductors and are based on the assumption of maximum current and voltage. (See Figure 3-12 for a visual example of electric fields around one tower configuration.) These calculated peaks are rarely reached under real-life conditions, because actual line height is generally above the minimum value used in the computer model, actual voltage is generally below the maximum value used in the model, and vegetation within and near the edge of the right-of-way tends to shield the field at ground level.

Both maximum and average values expected at the edge of the right-of-way would range from less than 0.1 to 2.4 kV/m, well under BPA's guidelines of 5 kV/m. These electric field levels would be comparable to or less than those from existing 500-kV lines in the area and elsewhere.

For all action alternatives, shock risks for nearby residents and passers-by would be minimal. There would be ***no-to-low*** electric field impacts. Electric fields would remain the same at Big Eddy Substation;

facilities added to accommodate any alternative would not incrementally increase electric fields already present.

Figure 3-12. Electric Fields around Single-Circuit Configuration 1[1]



[1] Maximum field is computed using maximum voltage at minimum conductor clearance. Average field is computed using maximum voltage at average clearance. Electric field examples for all single- and double-circuit tower configurations can be found in Appendix E.

[2] ROW is an acronym for right-of-way.

Magnetic Fields

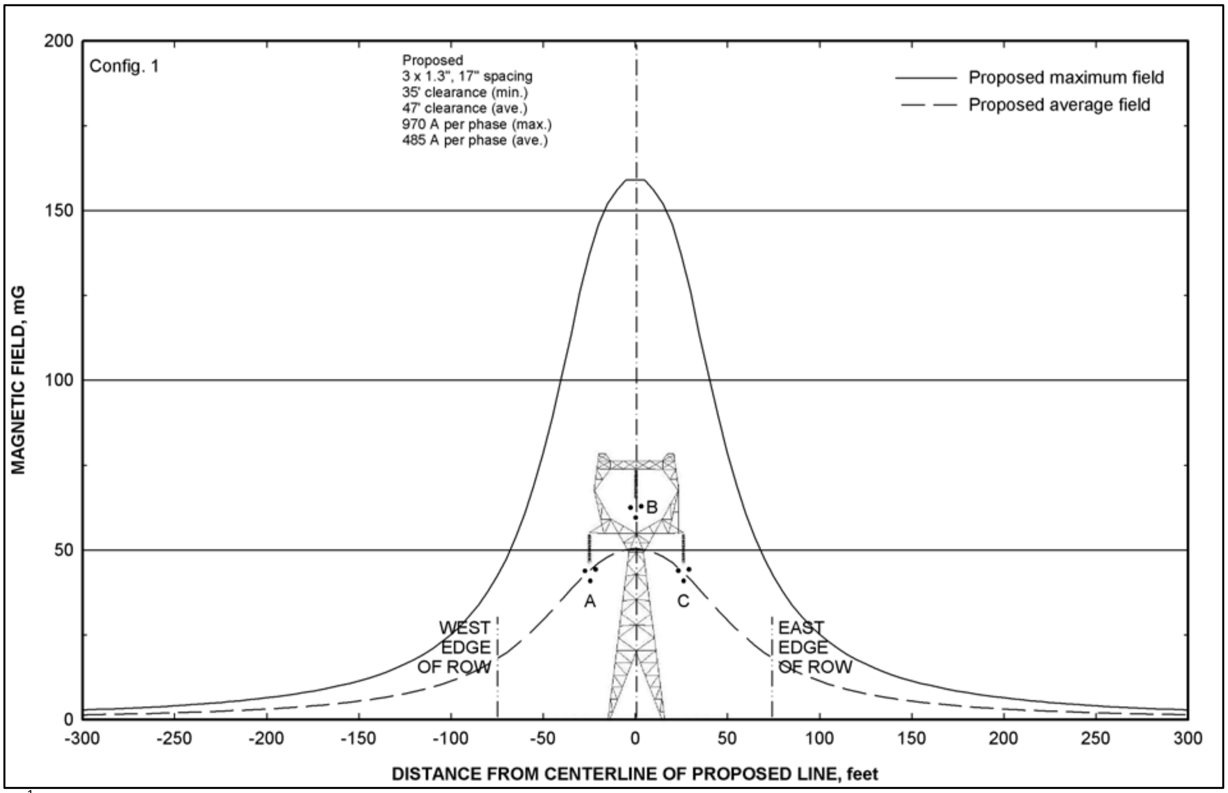
Although there have been decades of research, whether there are long-term health effects associated with transmission line fields remains inconclusive. Magnetic fields are most in question as possible sources of long-term effects, although studies sometimes lump both electric and magnetic fields together. In recent years, considerable research on possible biological effects of EMF has been conducted. A review of these studies and their implications for health-related effects is provided in Appendix F.

In summary, scientific reviews of EMF health effects research have found there is insufficient evidence to conclude that EMF exposures lead to long-term health effects, such as adult cancer, or adverse effects on reproduction, pregnancy, or growth and development of an embryo. However, uncertainties remain about possible links between childhood leukemia and childhood magnetic field exposures at levels greater than 4 mG. There are also suggestions that short-term exposures to magnetic fields greater than 16 mG may be related to an increased risk of miscarriage. Animal and cellular studies provide little support for the idea that any statistical associations reflect a causal relationship, i.e., that magnetic-field exposure increases the risk of childhood cancer or miscarriage.

An increase in public exposure to magnetic fields could occur if the proposed project results in field level increases and if residences or other structures draw people to these areas. The predicted field levels discussed in this section are only indicators of how the proposed project may affect the magnetic-field environment. They are not measures of risk or impacts on health.

Maximum magnetic fields expected for the action alternatives would range from 60 to 219 mG for the different tower and conductor configurations; average peak fields range from 17 to 65 mG. Maximum magnetic fields occur on rights-of-way directly under power lines where conductors are closest to the ground. At the edge of rights-of-way, peak magnetic fields would range from less than 1 to 82 mG, and average fields from less than 1 to 31 mG. (See Figure 3-13 for a visual example of magnetic fields for one tower configuration.)

Figure 3-13. Magnetic Fields for Single-Circuit Configuration 1[1]



[1] Maximum field is computed using maximum possible current at minimum conductor clearance. Average field is computed using average current at average clearance. Magnetic field examples of all single- and double-circuit tower configurations can be found in Appendix E.

Actual day-to-day magnetic-field levels would be lower. They would vary as currents change daily and seasonally, and as clearances change with ambient temperature.

Beyond the edge of rights-of-way, magnetic fields fall off rapidly. For example, at a distance of 200 feet from centerline, a single-circuit transmission line with maximum current would produce a peak field of 6 mG and average field of about 2 mG. For a double-circuit tower with split-phase (or phase-optimization) configuration, the maximum and average fields would be less than 2 mG. This means that beyond a few hundred feet, transmission line magnetic fields approach common ambient levels.

These calculations take into consideration that portions of the action alternatives would share rights-of-way with existing lines, or in some cases could replace those lines. In other words, they represent the total projected magnetic fields along the rights-of-way, but not net gains or losses in fields. Because of the way new transmission lines are designed (discussed later in this section), magnetic fields in certain locations could end up lower that what currently exists.

Magnetic fields would remain unchanged at Big Eddy Substation. Beyond the perimeter of the substation yard, magnetic fields would continue to be determined by fields from transmission lines entering the substation. The addition of a new 500-kV line would not incrementally increase fields.

Potential magnetic field impacts on residents living closest to the action alternatives are discussed under each alternative later in this section. For all action alternatives, motorists passing near or under the line would be exposed only briefly to magnetic fields, which would be required to meet BPA standards at street crossings.

Implanted Medical Devices

Because EMF from various sources (including automobile ignitions, appliances and possibly transmission lines) can interfere with implanted cardiac pacemakers, manufacturers are now designing devices to be immune from such interference. However, research has found these efforts only partly successful and a few models of older pacemakers still in use could be affected by EMF from transmission lines. (There are also many models of pacemakers not affected by fields larger than those found under transmission lines.)

Because of the known potential for interference with pacemakers, EMF field limits for pacemaker wearers have been established by the American Conference of Governmental Industrial Hygienists (ACGIH). It recommends that, if unsure about their pacemakers, wearers of these and similar medical-assist devices should limit their exposure to electric fields of 1 kV/m or less and to magnetic fields of 1,000 mG or less (ACGIH 2008). For additional discussion about interference with implanted devices, see Appendix E.

Electric fields from the proposed 500-kV line would generally meet ACGIH standards at the edge of rights-of-way and beyond. Still, wearers of pacemakers and similar medical-assist devices are discouraged from unshielded right-of-way use. (A passenger in an automobile under the line would be shielded from the electric field.) Magnetic fields would be well below ACGIH limits.

Electromagnetic Interference

If corona is present at the surface of transmission line conductors, it can sometimes cause interference with broadcast radio and television signals close to the right-of-way. This affects only conventional broadcast radio and television receivers operating at lower frequencies (AM radio and TV channels 2-6). Satellite and cable TV systems are not affected, nor are FM radio signals.

The bundle of three conductors used for each phase of the proposed 500-kV line would minimize corona generation and should keep radio and television interference levels at acceptable levels. If complaints arise, measures would be taken under BPA's mitigation program to restore reception to the same or better quality.

Magnetic fields from transmission and distribution facilities can also interfere with other electronic equipment, such as distorting images on older tvs and computer monitors with cathode ray tubes. While unlikely to occur at the magnetic field levels found near the proposed line, such interference is easily remedied by shielding the affected device or moving it to another location. Contemporary display devices using flat-panel technologies, such as liquid-crystal or plasma displays, are not affected.

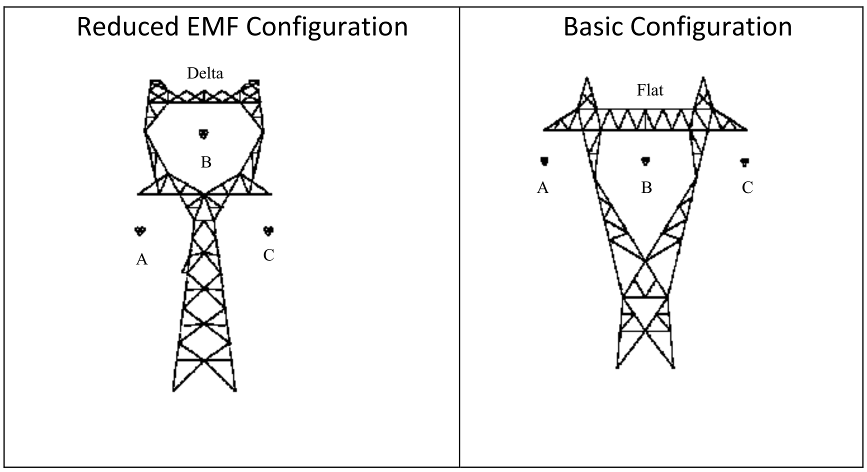
With the exception of one home that could be located very close to the Middle or East alternatives (discussed under those alternatives), none of the alternatives is anticipated to create electromagnetic interference in nearby homes.

Designing Lines to Reduce EMF

When BPA builds new high-voltage 500-kV transmission lines, the agency designs them using "EMF-mitigation" techniques to keep EMF exposure as low as reasonably achievable while maintaining system reliability.

For example, BPA uses "delta configuration" tower designs for single-circuit lines, where the three phase conductor bundles (called A, B, and C) are positioned in a triangular shape (two on the bottom, one on top) (see Figure 3-14). This configuration provides for more EMF cancellation effects than the more traditional "flat configuration," where the three phase conductor bundles are arranged horizontally and all are at the same height above ground.

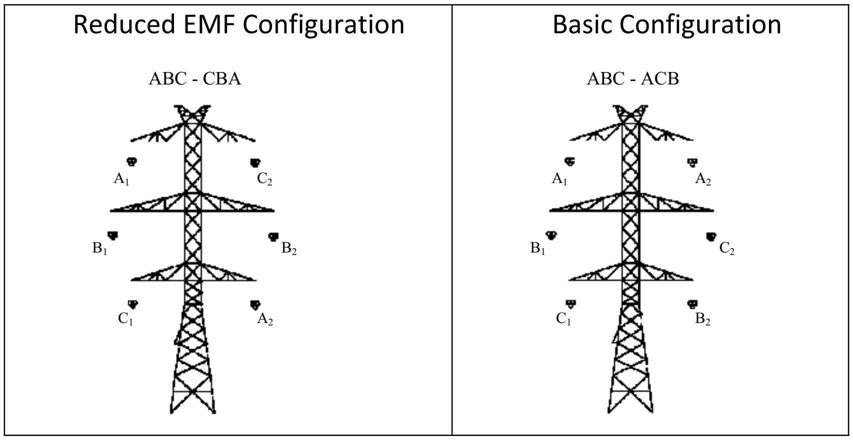
Figure 3-14. Single-Circuit Tower Design to Mitigate EMF



For double-circuit lines (two transmission line circuits on the same tower; six phase conductor bundles instead of three), BPA uses a "phase-optimization" approach to minimize EMF levels, when feasible. Generally, three phase conductor bundles of one line circuit are placed vertically on the left side of the tower while the three phase conductor bundles of the other circuit are placed vertically on the right side (see Figure 3-15).

Such phasing arrangements result in some EMF cancellation, with actual offset rates depending on the power flow (direction) and magnitude (kilovolts) of the transmission line circuits.

Figure 3-15. Double-Circuit Tower Design to Mitigate EMF



West Alternative

For the West Alternative, the transmission line would travel through a sparsely populated area where existing lines are of lower voltage, very distant or absent. Therefore the magnetic fields near local houses would generally increase from existing levels to the ranges of levels discussed in this section. The amount of increase would depend on distance from the proposed line and whether other lines are present.

For the 10 homes closest to (within 300-500 feet of) the West Alternative, average magnetic fields would range from 0.1 to 3.5 mG, depending on whether single- or double-circuit towers are used (see Table 3-35). Maximum magnetic fields would range from 0.2 to 7 mG. These magnetic field levels are comparable to typical ambient levels and would be far less than those encountered near common household appliances or directly under the line.

Table 3-35. Magnetic Field Levels at Houses/Business near the Action Alternatives

	Single Circuit			Double Circuit[1]		
Primary Configuration	**West Alternative**	**Middle Alternative**	**East Alternative**	**West Alternative**	**Middle Alternative**	**East Alternative**
Houses/Businesses < 300 ft	4	3	3	4	5	5
Houses/Businesses < 500 ft	10	12	12	10	11	10
Range of Distances from Centerline, ft	203–486	71–425	71–484	203–486	191–495	191–495
Range of Avg. Magnetic Field, mG	0.5–3.1	0.7–22.3	0.5–22.3	0.1–3.5	0.1–1.8	0.3–1.8
Range of Max. Magnetic Field, mG	1.1–6.2	1.4–45	1.1–45	0.2–7	0.2–4.5	0.7–4.6

[1] Double-circuit counts include houses from single-circuit segments E4, E27 and M5, where no double-circuit is planned. See Figure 1 in Appendix E for more information on segments.

Middle Alternative

For the 11 to 12 homes and businesses closest to the Middle Alternative, average magnetic fields would range from 0.1 to 22.3 mG, depending on whether single- or double-circuit towers are used (see Table 3-35). Maximum magnetic fields would range from 0.2 to 45 mG. (The highest potential fields would exist near the Wishram residence closest to the proposed single-circuit line.) For all but the closest home, these magnetic field levels are comparable to ambient levels.

For the closest Wishram home, magnetic fields could be elevated over ambient levels, although the maximum level of 45 mG is below international guidelines (800–9,000 mG). If double-circuit towers were used in this area (proposed and existing lines were placed on the same towers), field levels at this home would be substantially lower (4.5 mG vs. 45 mG) because towers would be farther from the house and the conductors would be closer together, lessening overall field strengths. For this alternative, in all locations where the proposed line would parallel existing lines, magnetic field levels would be below existing levels if double-circuit towers were used.

East Alternative

For the 10 to 12 homes and businesses closest to the East Alternative, average magnetic fields would range from 0.3 to 22.3 mG, depending on whether single- or double-circuit towers are used (see Table 3-35). Maximum magnetic fields would range from 0.7 to 45 mG. (The highest potential fields would exist near the one closest Wishram residence.) For all but the closest home, these magnetic field levels are comparable to ambient levels.

As with the Middle Alternative, magnetic fields could be elevated over ambient levels for the closest Wishram home, but the maximum level of 45 mG would be below international guidelines. If double-circuit towers are used in this area, magnetic fields would be below ambient levels at this house. As with the Middle Alternative, in all locations where the proposed line would parallel existing lines, magnetic field levels would be below existing levels if double-circuit towers were used.

Knight Substation Options

EMF at the perimeter of the Knight Substation yard, regardless of location, would reflect fields generated by the new 500-kV line. The magnitudes and impacts would be similar to those for the transmission lines alone. Within a few hundred feet, these fields would dissipate to ambient levels. Since there are no residences near either substation site, there would be ***no*** EMF impacts.

Fiber Optic Cable Options

For the Loop Back Option, no impacts to public health and safety would occur beyond those already described for each action alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential public health and safety impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.12.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse impacts by the action alternatives on public health and safety:

- Notify landowners located along the corridor prior to construction activities, including blasting.
- If blasting is required, take appropriate safety measures and follow all state and local codes and regulations. Lock up or remove all explosives from work sites at the end of the workday.
- Hold crew safety meetings at the start of each construction workday to review potential safety issues.
- Prepare and implement a Spill Prevention, Control and Countermeasure Plan (see mitigation measures in Section 3.5 Water Resources and Wetlands) to manage hazardous materials and respond to emergency situations.
- Prepare and maintain an on-site safety plan in compliance with state requirements.
- Prepare for fire control (see mitigation measures in Section 3.3 Vegetation).
- Fuel all highway-authorized vehicles off-site to minimize the risk of fire. Fueling of construction equipment that is transported to the site via truck and is not highway authorized will be done in accordance with regulated construction practices and state and local laws. Helicopters will be fueled and housed at local airfields or at staging areas.
- Secure the site at the end of each workday to protect equipment and the general public.
- Ensure that BPA contractors flying helicopters prioritize public safety during flights. For example, establish flight paths to avoid populated areas or schools (Helicopter Association International 1993).
- Implement appropriate airport safety measures (see mitigation measures in Section 3.1 Land Use and Recreation).
- Clear vegetation according to BPA standards to avoid contact with transmission lines.
- Report possible hazardous materials, toxic substances, or petroleum products discovered along the transmission line route that would pose an immediate threat to human health or the environment, including large dump sites, drums of unknown substances, suspicious odors, stained soil, etc.).
- Adhere to appropriate specifications for grounding fences and other objects on and near existing and proposed rights-of-way.
- Construct and operate the new transmission line according to the NESC.
- Restore reception quality if radio or television interference occurs as a result of constructing the transmission line so that reception is as good as or better than before the interference.

3.12.4 Unavoidable Impacts Remaining after Mitigation

Once built, the proposed line could also cause accidental injury from electric shock if someone were to bring conductive material too close to the lines within the right-of-way. Electric fields on the right-of-way also have the potential to interfere with implanted cardiac pacemakers worn by persons walking (or otherwise not shielded) under the line.

EMF levels directly under the lines and in the rights-of-way could be higher than ambient levels, but would meet all applicable regulations and standards and would dissipate rapidly beyond the transmission line right-of-way. Fields could increase at homes within several hundred feet of the line (10 to 12 homes) for certain tower options.

3.12.5 No Action Alternative

The No Action Alternative would have no impact on public health and safety because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.13 Air Quality

3.13.1 Affected Environment

There are no major industrial facilities along the action alternatives or substation sites and no significant existing air quality problems in these portions of Wasco and Klickitat counties. Local air pollutant emissions are limited mainly to windblown dust from agricultural operations and tailpipe emissions from traffic along state highways and local roads. The nearest air quality monitoring station is in The Dalles. The area has been designated as having attainment status.

The Department of Environmental Quality Eastern Regional Office in Bend, Oregon regulates air quality in Wasco County. Air quality in Klickitat County is regulated by the Washington Department of Ecology Central Regional Office, in Yakima County by the Yakima Regional Clean Air Agency, and in Benton County by the Benton Clean Air Agency.

Based on available data from the monitoring station in The Dalles, Oregon Department of Environmental Quality (DEQ), and Ecology acknowledge that air quality along the action alternatives complies with all regulatory limits for ambient air concentrations. Yakima and Benton counties had no air quality concerns about the proposed project.

Air quality has a direct effect on visibility. Section 106 of the Clean Air Act and its amendments require that air quality be preserved, protected, and enhanced in any specific area of national or regional natural, recreational, scenic or historic value. Congress designated 156 national parks and wilderness areas as "mandatory federal Class 1 areas" where visibility is especially important (Ecology 2010). Washington has eight Class 1 areas, totaling more than 3.3 million acres. In these areas, there are restrictions on the use of the land and resources in order to avoid damaging visibility, plants, and other resources. There are no Class I areas in the project area.

3.13.2 Environmental Consequences

Common Impacts

Construction

Construction and vegetation removal activities would affect air quality. Heavy equipment creates dust and emits pollutants. The primary type of air pollution created during construction would be particulate matter, including fugitive dust from disturbed soils becoming airborne, and combustion pollutants from equipment exhaust.

Several construction crews (foundation crews, assembly crews, wire stringing crews and framing crews) would most likely be working simultaneously on separate sections of the line. This type of transmission line construction crew (up to 100 workers) could construct about 10 miles of line in 4 months. Construction equipment would consist of about 20 vehicles (pickups, vans), three bucket trucks, one conductor reel machine, two small cranes (20 to 30 ton) and one large crane (90 ton), three large excavators (bulldozers, backhoes), road construction equipment (dump trucks, rollers, road bladers), one line tensioner, 1 puller, 1 reel trailer and two helicopters (small helicopter and skycrane). One construction crew would work on Big Eddy Substation and construct Knight Substation. Construction of the Knight Substation would occur over about a 20-month period.

Construction activities that could create dust include road building and grading, on-site travel on unpaved surfaces, work area clearing and preparation, and soil disturbing operations. Wind erosion of disturbed areas would also contribute to fugitive dust. Air quality impacts are expected to be short term, and mitigation measures would be implemented to minimize impacts.

Soils in the area are mostly fine-grained, wind-blown silt and clayey silt soils (loess). Several other soil types are either very rocky, or are very thin over bedrock. Proposed construction would take place over 20 months. Gravel would be used as surface material on unpaved access roads to minimize particulate matter from being released into the air.

Tree removal, as well as the potential removal of existing towers, would create fugitive dust. Most of the vegetation is cultivated croplands, grasslands and rangelands; additional clearing of tall-growing vegetation within the right-of-way would be minimal. Erosion control measures and reseeding would be used on disturbed areas.

Clearing of tall brush and low-growing trees and vegetation can produce debris that would need to be disposed of by lop and scatter, chipping, wood waste recycling, or removal to land fill. No burning would occur.

Heavy equipment and vehicles, including those with diesel internal combustion engines, would emit pollutants such as carbon monoxide, carbon dioxide, sulfur oxides, PM-2.5, oxides of nitrogen, volatile organic hydrocarbons, aldehydes, and polycyclic aromatic hydrocarbons. All equipment is required to have acceptable air filtration systems.

The amount of pollutants emitted from construction vehicles and equipment would be relatively small and comparable to current conditions with the operation of agricultural equipment in the project vicinity. Such short-term emissions from construction sites are exempt from air quality permitting requirements.

Air quality impacts from construction of the proposed project would be ***no-to-low*** for all alternatives.

Operation and Maintenance

Operation and maintenance vehicles would mainly use access roads with native or rocked surfaces, causing fugitive dust to be stirred up. Quantities of potential emissions would be very small, temporary, and localized.

The transmission lines themselves would cause limited air emissions. The high electric field strength of transmission lines causes a breakdown of air at the surface of the conductors called corona. Corona has a popping sound that is most easily heard during rainstorms. When corona occurs, small amounts of ozone and nitrogen oxides are released in such small quantities that they are generally too small to be measured or to have any significant effect on humans, plants, or animals (see Sections 3.11 Noise and 3.12 Public Health and Safety for more detailed information).

There would be ***no-to-low*** impacts on air quality during operation and maintenance of the proposed project**.**

Fiber Optic Cable Options

For the Loop Back Option, no impacts on air quality would occur other than those already described for each action alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential air quality impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.13.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate adverse air quality impacts.

- Prepare and implement a SWPPP (see mitigation measures in Section 3.4 Geology and Soils) to limit erosion and dust generation.
- Control windblown dust (see mitigation measures in Section 3.4 Geology and Soils).
- Reseed disturbed areas (see mitigation measures in Section 3.3 Vegetation) to prevent dust from erosion.
- Shut down idling construction equipment, if feasible.
- Ensure all vehicles are in compliance with applicable federal and state air quality regulations for tailpipe emissions. Certification that vehicles meet applicable regulations will be provided by contractors to BPA in writing.
- Maintain and certify in writing that all construction equipment is in proper working condition according to manufacturer's specifications.
- Obtain rock and concrete from sources with appropriate environmental permits.

3.13.4 Unavoidable Impacts Remaining after Mitigation

Uunavoidable impacts on air quality would include fugitive dust and vehicle emissions.

3.13.5 No Action Alternative

The No Action Alternative would have no impact on air quality because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.14 Greenhouse Gases

3.14.1 Affected Environment

Greenhouse gases (GHG) are chemical compounds found in the earth's atmosphere that absorb and trap infrared radiation, or heat, re-radiated from the surface of the earth. The trapping and build-up of heat in the atmosphere increases the earth's temperature, warming the planet and creating a greenhouse-like effect (EIA 2009b). Anthropogenic activities (caused or produced by humans) are increasing atmospheric concentrations to levels that could increase the earth's temperature up to 7.2 degrees F by the end of the twenty-first century (EPA 2010b).

The principal greenhouse gases emitted into the atmosphere through human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), and fluorinated gases (EPA 2010b). Of these four gases, CO_2 is the major greenhouse gas emitted (EPA 2010b; Houghton 2010). For example, carbon dioxide emissions from the combustion of coal, oil, and gas constitute 81 percent of all U.S. greenhouse gas emissions (EIA 2009a). Carbon dioxide enters the atmosphere primarily through the burning of fossil fuels such as coal, natural gas and oil, and wood products; as a result of land use changes; and the manufacturing of cement. Prior to the industrial revolution, concentrations were roughly stable at 280 parts per million (ppm), but have increased 36 percent to 379 ppm in 2005, all of which is attributed to human activities (Intergovernmental Panel on Climate Change [IPCC] 2007).

Of the remaining three principal greenhouse gases, methane is emitted during the production and transport of fossil fuels, through intensive animal farming, and by the decay of organic waste in landfills. Methane concentrations have increased 148 percent above pre-industrial levels (EPA 2010b). Nitrous oxide is emitted during agricultural and industrial activities, and during the combustion of fossil fuels and solid waste. Nitrous oxide atmospheric levels have increased 18 percent since the beginning of industrial activities (EPA 2010b, 2010). Fluorinated gases, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), are synthetic compounds emitted through industrial processes and now are being used to replace ozone-depleting compounds such as chlorofluorocarbons in insulating foams, refrigeration, and air conditioning. Although they are emitted in small quantities, these gases have the ability to trap more heat than CO_2 and are considered high global-warming potential gases. Atmospheric concentrations of fluorinated gases have been increasing over the last two decades and are expected to continue to increase (EPA 2010b).

The Clean Air Act is a federal law that establishes regulations to control emissions from large generation sources such as power plants. The EPA has issued a Final Mandatory Reporting of Greenhouse Gases Rule that requires reporting of greenhouse gas emissions from large sources. Under the rule, suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of greenhouse gases, are required to submit annual reports to the EPA (EPA 2010a). Executive Orders 13423 and 13514 require federal agencies to measure, manage, and reduce greenhouse gas emissions by agency-defined target amounts and dates. In the state of Washington, Executive Orders 07-02 and 09-05 direct state agencies to work with western states and Canadian provinces to develop a regional emissions reduction program designed to reduce greenhouse gas emissions to 1990 levels by 2020 (Ecology 2010). In the state of Oregon, House Bill 3543 from 2007 (codified at Oregon Revised Statutes [ORS] 468A.205), directs state and local governments, businesses, nonprofit organizations and individual residents to reduce greenhouse gas emissions in Oregon; by 2010, arrest growth of greenhouse gas emissions; by 2020 begin to reduce greenhouse gas levels to

10 percent below 1990 levels; and by 2050 achieve greenhouse gas levels at least 75 percent below 1990 levels (Oregon Global Warming Commission 2010).

Global atmospheric greenhouse gas concentrations are a product of emissions and removal over time. Soils store carbon in the form of decomposing plant materials and constitute the largest carbon reservoir on land. Through the process of photosynthesis, atmospheric carbon is also captured and stored as biomass in vegetation, especially forests. To better understand the relevance tree removal may have on the environment, one must first consider the carbon cycle. The carbon cycle consists of two phases: gaseous carbon (i.e., carbon dioxide) and solid carbon (i.e., sugars). Photosynthesis is the process plants such as trees use to sequester carbon dioxide from the air and subsequently manufacture solid, organic mass (i.e., sugars). Consequently, as trees grow and increase in mass, carbon is removed from the atmosphere. Inversely, as trees decay or are burned, carbon is emitted into the atmosphere.

Based on the carbon cycle, it is reasonable to conceptualize trees as merely a temporary carbon reservoir. In a natural environment, a tree seed would grow (sequester carbon), the tree would die and decay (release gaseous carbon), and subsequently a new tree would presumably grow in its place. Such a cyclical pattern can be visualized by a sine wave graph. Essentially, the quantity of carbon stored in solid, organic mass is dependent on the current phase of the carbon cycle. Peak solid carbon storage occurs when a tree is fully mature, and minimum solid carbon storage occurs immediately after the tree has decomposed or burned. Alternatively, minimum solid carbon storage may occur when a forested area is permanently converted to a non-forested area, such as grasslands.

Stored carbon can be released back into the atmosphere when biomass is burned (ESA 2008). In addition, CO_2, N_20, and CH_4 emissions increase in areas where soil disturbance occurs (Kessavalou et al. 1998). Models predict atmospheric concentrations of all greenhouse gases are to increase over the next century, but the extent and rate of change is difficult to predict, especially on a global scale.

3.14.2 Environmental Consequences

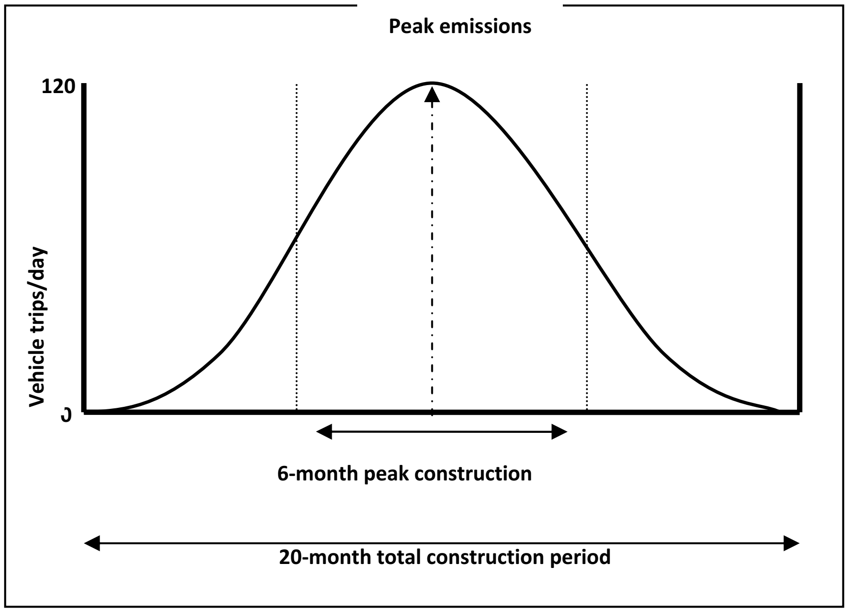
Common Impacts

Potential impacts related to greenhouse gases would generally be the same under all action alternatives. Implementation of any of the action alternatives would contribute to greenhouse gas concentrations in several different ways. Carbon dioxide, methane, and nitrous oxide emission levels would incrementally increase as vegetation and soils are removed and/or disturbed during construction of the transmission line (Kessavalou et al. 1998) and through the operation of construction-related vehicles during the construction period. Emissions would also occur during operation and maintenance of the transmission line.

Emissions from construction, operations, and maintenance-related vehicles on and off the project right-of-way also would impact atmospheric greenhouse gas concentrations incrementally because construction equipment and vehicles would be fueled by gasoline and diesel combustion motors.

Greenhouse gas emissions were estimated for all action alternatives based on the approximate number of vehicles to be used during project construction and the approximate distance those vehicles would travel during the construction period. For the proposed project, an estimated 16 vehicle round trips per day would occur during the peak construction period for all action alternatives. (Construction would take about 20 months, with peak construction activity occurring during a 6-month period see Figure 3-16.) During the 6-month peak construction period, road and tower pad construction usually takes about 3-5 months including close-out repairs of any roads damaged during construction. Non-peak construction activities would include acquisition of easements, work to connect the new line and other existing lines into the substations, and tower site restoration work (see Chapter 2 Proposed Action Alternatives for the proposed construction schedule).

Figure 3-16. Project Construction Schedule with Peak Emissions



To provide a conservative analysis and ensure that the proposed project's potential contributions to greenhouse gas concentrations are adequately considered, greenhouse gas emissions were calculated for the 6-month peak construction period using the estimate of 16 vehicle round trips per day. A round trip on the proposed project was considered to be from The Dalles to Knight Substation and back to The Dalles (about 80 miles). The greenhouse gas emission estimates are, therefore, artificially high to ensure that potential greenhouse gas emissions are fully described.

Figure 3-16 displays the estimated greenhouse gas emissions for the 6-month peak construction period. While all emissions of greenhouse gases are significant in that they contribute to global greenhouse gas concentrations and climate change, the total CO_2 emissions from the proposed project would be very low compared to emissions from other contributors. To provide context for these emission rates, EPA's mandatory reporting threshold for annual CO_2 emissions is 25,000 metric tons of $C0_{2e}$. This threshold is roughly the amount of CO_2 generated by 4,336 passenger vehicles per year. This threshold requires federal reporting of greenhouse gas emissions, but does not require any other action (EPA 40 Code of Federal Regulations [CFR] Parts 86, 87, 89 et al.).

As shown in Table 3-36, construction would result in an estimated 409 metric tons of CO_2 emissions, and an estimated 409 metric tons of CO_{2e} emissions per year. The project's estimated CO_{2e} emissions translate roughly to the annual CO_2 emissions of 78 passenger vehicles. This emission rate is about 61 times lower than what is required to trigger EPA emissions reporting. Given this extremely low amount of contribution, the project's impact on greenhouse gas concentrations during construction would be ***low***.

Table 3-36. Estimated Greenhouse Gas Emissions from the Action Alternatives

Estimated GHG Emissions of the Action Alternatives per Year	CO_2 Emissions in Metric Tons per Year	CH_4 (CO_2e[1] Emissions in Metric Tons per Year)	N_2O (CO_2e Emissions in Metric Tons per Year)	Total CO_2e Emissions in Metric Tons per Year
From Construction	409	0.03	0.4	**409**
From Operation and Maintenance	0.7	0.001	0.03	0.7

[1] CH_4 and N_2O emissions have been converted into units of CO_{2e} equivalent using the IPCC global warming potential (GWP) factors of 21 GWP for CH_4 and 310 GWP for N_2O.

Note: See Appendix G for calculations used in determining emissions.

During operation and maintenance of the transmission line, a helicopter would be used twice a year for aerial inspections and about 1 vehicle would travel round trip per year. Emergency trips were estimated at about 2 each year. The helicopter and vehicles would most likely access the transmission line corridor from The Dalles. A round trip would be from The Dalles to the project and back again, a flying distance of about 60 miles and a driving distance of about 80 miles. All full-grown trees would already have been removed during construction, but tree saplings would be removed during regular maintenance for the life of the line.

Table 3-36 displays the estimated annual greenhouse gas emissions that would be expected during operation and maintenance of the transmission line. As shown in this table, operation and maintenance would result in about 0.7 metric tons of CO_{2e} emissions per year, which translate to the annual CO_2 emissions of less than 0.1 passenger vehicle. This emission rate is about 0.003 percent of the rate required to trigger EPA emissions reporting.

Though recognized as a contribution to overall green house gas emissions, measurement of emissions from soil disturbance is difficult. However, research has shown that emissions as a result of soil disturbance are short-lived and return to background levels within several hours (Kessavalou et al. 1998). Based on the conservative methodology used to estimate vehicle emissions, the emissions related to soil disruption and annual vegetation decay are accounted for in the overall construction emission rates. Carbon that would be stored in removed vegetation would be offset in time by the growth and accumulation of carbon in soils and new vegetation.

Some trees would be removed as part of the proposed project and soil disturbance would occur. The West Alternative could remove about 93 to 130 trees, the Middle Alternative could remove about 14 to 26 trees and the East Alternative could remove about 16 trees.

The nature of tree removal is to permanently convert land (i.e., proposed BPA right of way) to a non-forested area. Therefore, this action can be characterized as permanently maintaining the proposed BPA right-of-way at the minimum level of solid carbon storage. It is the objective of this analysis to fully account for this loss of potential solid carbon storage in the context of GHG emissions.

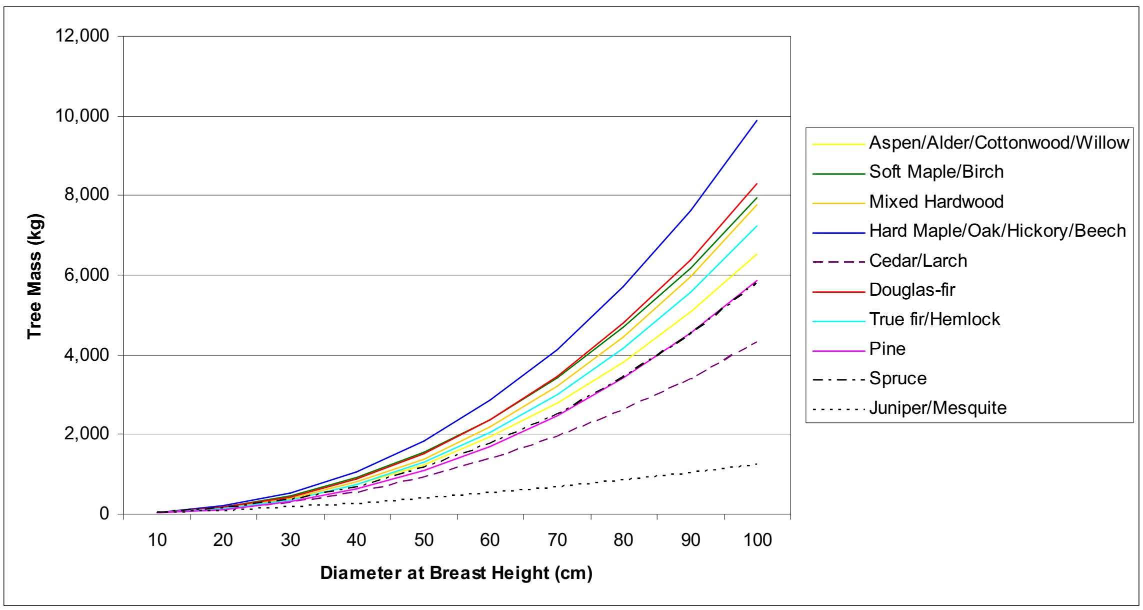
The GHG emissions from tree removal can be broken down further into three segments: the carbon that has potential to be released from the existing trees, the loss of future carbon sequestration that would have occurred if each tree continued to grow, and the energy consumed while removing the trees from the soil. The intention of this analysis was to quantify the maximum potential of GHG emissions associated with the tree removal. Within subsequent qualitative analysis, this conservative estimation can serve as a baseline to compare with other GHG emitting processes.

The estimation of the amount of carbon that may be released after harvesting a tree requires some assumptions:

- the average moisture content of a green tree assumed to be 30 percent (Simpson 1993); about 30 percent of a trees biomass is below ground (IPCC 2006);
- about 50 percent of a tree's dry-mass is comprised of carbon (IPCC 2006);
- 100 percent of the carbon will eventually be oxidized into carbon dioxide and emitted into the atmosphere; and,
- based on Figure 3-17, an average tree with dbh of 50 to 60-cm contains about 2,000-kg of above ground biomass.

In summary, the removal of a 50 to 60-cm dbh tree would emit about 3.3 metric tons- carbon dioxide equivalent (CO_2e) per tree.

Figure 3-16. Estimated Total Above Ground Biomass for Typical Trees in the United States



Source: Jenkins et al. 2004

Tree growth and future carbon sequestration rates are highly variable and depend on several factors including the species of tree, age of tree, climate, forest density, and soil conditions. As an alternative to estimating tree growth rates, a simple method to estimate the loss of future carbon sequestration is via mass balance. As stated above, the average current above ground mass for the trees to be removed is about 2,000 kg. Using Figure 3-17, the average, fully mature tree would not likely exceed 10,000 kg of above ground mass. Again, assuming that the average moisture content of a green tree is 30 percent, about 30 percent of a tree's biomass is below ground, and 50 percent of a tree's dry-mass is comprised of carbon, about 13 metric tons-CO_2e per tree could have been sequestered.

Removal and disposal of each tree is an energy-consuming process that results in GHG emissions via fuel combustion. This component of GHG emissions, however, was accounted for above in terms of transmission line construction.

The net carbon footprint associated with tree removal on the action alternatives will vary from 266 metric tons-CO_2e on the East Alternative to 2162 metric tons-CO_2e on the West Alternative (see Table 3-37).

Table 3-37. Net Carbon Footprint Associated with the Removal of Trees by Action Alternative

	Carbon Released from Harvesting Trees (metric tons-CO_2e)	Loss of Future Carbon Sequestration (metric tons-CO_2e)	Total (metric tons-CO_2e)
West Alternative	430	1,690	2,122
Middle Alternative	86	338	424
East Alternative	53	208	261

Note: See Appendix G for assumptions used in determining emissions.

Given this extremely low amount of contribution, the project's impact on greenhouse gas concentrations during operation and maintenance would be **low**.

Fiber Optic Cable Options

For the Loop Back Option, no greenhouse gas impacts would occur other than those already described for each action alternative because this option would place the fiber optic cable on the same towers as the proposed transmission line. Potential greenhouse gas impacts of the Wautoma Option are described in Section 3.15 Fiber Optic Cable Options.

3.14.3 Mitigation Measures

The following mitigation measures have been identified to reduce or eliminate greenhouse gas emissions.

- Implement vehicle idling and equipment emissions measures (see mitigation measures in Section 3.13 Air Quality).
- Encourage carpooling and the use of shuttle vans among construction workers to minimize construction-related traffic and associated emissions.
- Locate all staging areas as close to construction sites as practicable to minimize driving distances between staging areas and construction sites.
- Locate staging areas in previously disturbed or graveled areas to minimize soil and vegetation disturbance where practicable.
- Use the proper size of equipment for the job.
- Use alternative fuels for generators at construction sites such as propane or solar, or use electrical power where practicable.
- Reduce electricity use in the construction office by using compact fluorescent bulbs, and powering off computers every night.
- Submit a plan for approval to recycle or salvage non-hazardous construction and demolition debris.
- Submit a plan for approval to dispose of wood poles locally where practicable.
- Use locally sourced rock for road construction.

3.14.4 Unavoidable Impacts Remaining after Mitigation

Unavoidable impacts would include slight increases in greenhouse gas releases.

3.14.5 No Action Alternative

The No Action Alternative would have no greenhouse gases impacts because no new transmission lines, towers, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.

3.15 Fiber Optic Cable Options

As part of the proposed project, BPA is proposing to string new fiber optic cable to enhance communications among BPA substations in the area. All action alternatives would require installation of this fiber optic cable. Two options have been identified for routing the proposed cable – a Loop Back Option and a Wautoma Option. This section summarizes these options (see Chapter 2 for more detailed descriptions) and discusses the affected environment for each option and how resources would be impacted by each option (see Map 3-8).

3.15.1 Summary of Options

Loop Back Option

In this option, the fiber optic cable would be strung on the new towers from BPA's Big Eddy Substation north to Knight Substation, then the cable would loop back on the same towers to Big Eddy Substation. The affected environment for this option would be the same as discussed for the transmission line alternatives in this chapter.

Wautoma Option

For this option, the fiber optic cable would also be strung on the new towers from BPA's Big Eddy Substation north to Knight Substation, but would then continue northeast for 72 miles and carried on the existing towers that support BPA's Wautoma-Ostrander transmission line. The cable would cross Klickitat and Yakima counties and the Yakama Indian Reservation, ending at BPA's existing Wautoma Substation in northwest Benton County, Washington. Every 3 to 5 miles a splice box would be installed and a reeling site established to string and put tension on the cable. About 16 splice boxes would be placed on the transmission towers or in the ground next to the towers. At each site, about 0.25 acre of ground in line with the conductors within the existing right-of-way would be temporarily disturbed by a reeling truck and tensioning equipment.

Equipment used along the route would be primarily standard utility equipment, such as bucket trucks, light duty trucks, cranes, four-wheel drive pickup trucks, a line truck with pulling and tensioning reel, helicopter, and all-terrain vehicles. Use of helicopters and/or loud equipment would be minimized before 8 a.m. or after dusk to avoid noise that would disturb landowners. All equipment would stay within the right-of-way and use existing access roads. There would be no staging areas.

Because the fiber optic cable under this option would be installed on existing towers, cable installation would be expected to proceed relatively quickly. Typically, fiber optic crews can install about 5 to 10 miles of cable per week, depending on terrain. Installation of the cable under the Wautoma Option would be expected to take from 2 to 4 months, with most installation activities at a given location along the line completed in about a day.

Some work would also take place at local substations. Outside the yard at each of the Knight and Wautoma substations, two concrete vault boxes (4 feet x 4 feet x 4 feet) would be installed. Other fiber optic equipment needed as part of the communications network would also be installed within existing substation yards.

3.15.2 Affected Environment

Loop Back Option

The affected environment would be the same as discussed for the action alternatives earlier in this chapter.

Wautoma Option

The Wautoma Option is located entirely in Washington (18.3 miles in Klickitat County, 51.3 miles in Yakima County and 2.0 miles in Benton County) and about half of the project crosses the Yakama Indian Reservation. Other land crossed is mostly privately owned with some federal (Bureau of Land Management [BLM]) and state (DNR and Parks) land, including Brooks Memorial State Park. Generally, the route is sparsely populated.

Table 3-38. Fish-Bearing Streams Crossed by the Wautoma Option

Stream/ Creek Name	Fish Species Present										
	Bull Trout	Coho Salmon	Eastern Brook Trout	Rain-bow Trout	Steel-head Trout	Chinook Salmon	Large-mouth Bass	Small-mouth Bass	Mountain Whitefish	Walleye	Brown Trout
Butler Creek	X										
Dry Creek	X	X	X	X	X						
East Prong Little Klickitat River	X										
Kusshi Creek		X		X	X						
Logy Creek		X	X	X	X	X					
North Fork Dry Creek					X						
Satus Creek		X	X	X	X						
Shinando Creek				X							
Toppenish Creek		X	X	X	X	X	X	X			
West Prong Little Klickitat River	X			X	X						
Yakima River	X	X		X	X	X	X	X	X	X	X

The existing transmission line crosses mostly shrublands and grasslands. Soils consist primarily of different types of silty loams. The existing line crosses the following streams and creeks: Butler Creek, Cozy Nook Creek, Dry Creek, East Prong Little Klickitat River, Granger Drain, Jenkins Creek, Kusshi Creek, Logy Creek, Satus Creek, Shinando Creek, Toppenish Creek, West Prong Little Klickitat River, and the Yakima River. A list of fish-bearing streams can be found in Table 3-38.

The Washington state database has identified priority habitats occurring in the project area: shrub-steppe and riparian zones. Priority habitats are those habitat types "with unique or significant value to a diverse assemblage of species" and that are used in guiding conservation and management priorities (WDFW 2008, 2010b). Special-status species in the project vicinity include wild turkey (*Melegris gallopavo*), mule and black-tailed deer (*Odocoileus hemionus*), and Western gray squirrel (*Sciurus griseus*), a Washington state-listed threatened species.

In addition to various county and other rural roads in the vicinity, the Wautoma Option crosses SR-97 and I-82. The historic Northern Pacific Railroad grade also passes under the existing Wautoma-Ostrander line.

3.15.3 Environmental Consequences

Loop Back Option

In the Loop Back Option, the cable would be strung on the proposed new transmission towers. There would be no new impacts beyond those already discussed for the action alternatives in this chapter.

Wautoma Option

For the Wautoma Option, temporary land use impacts would occur from installation of the cable on or under the existing towers. Impacts would be limited to splice box locations and related pulling and tensioning sites. These activities could damage some crops. Land use impacts would be ***low****.*

Construction activities would create some temporary visual and noise impacts for nearby private landowners, as well as recreationists in the state park area. Because these impacts would be temporary (depending on terrain, a crew can install 5–10 miles of fiber in a week) and would occur in a relatively isolated area, impacts would be ***low***.

There would also be ***no-to-low*** impacts on vegetation, because vegetation that would be disturbed would be next to existing towers legs and the vegetation has been previously disturbed and is not comprised of trees or special status species.

Temporary impacts to soils would occur, primarily soil compaction at pulling and tensioning sites. Erosion could occur where there would be digging required for the buried splice boxes. However, with mitigation, there would be *no-to-low* soil impacts.

Existing streams, rivers and wetlands crossed by the existing Wautoma-Ostrander line would be avoided, and there would be ***no*** impacts.

Stringing the fiber optic cable is not expected to have any impacts on federal threatened or endangered wildlife species. Other species, including state-list species, could be impacted by construction activities or collisions with lines.

Fiber optic cable installation would cause temporary wildlife displacement in some areas. Temporary displacement caused by construction activities would have a ***low*** impact on wildlife species in grassland/shrub-steppe habitats. Impacts could be ***moderate*** if construction took place during breeding or nesting seasons for western gray squirrel and migratory birds. For these and other species for which displacement does not adversely affect the breeding season, construction impacts would be ***low***.

Most collisions with power lines occur during flights in areas used daily by a relatively large number of birds. Waterfowl, shorebirds, and other waterbirds such as egrets and cranes appear to be more susceptible to collision where lines span river valleys, wetland areas, and lakes. Important factors in determining the risk of collisions for a bird species include body size, maneuverability, age of the bird, and the height at which the bird flies (Crowder and Rhodes 1999). Although bats can be susceptible near wind turbines, bats do not tend to collide with transmission lines that are stationary.

The main areas of concern for the Wautoma Option would be the fiber optic cable crossing over the Yakima River. Bird diverters hung on fiber optic cables help birds avoid collisions. Bird diverters would be installed on the fiber optic cable spanning open water or other areas of high bird use to reduce collisions.

The likelihood of affecting cultural resources is ***low*** because new ground disturbance would be minimal, and the fiber optic cable would be constructed on an existing transmission line that may have already impacted visual resources, including traditional cultural properties. BPA is surveying the areas that might be impacted for preexisting cultural sites to ascertain any areas that might be especially sensitive where construction activities may be modified or curtailed. In addition, BPA has consulted with the Washington Department of Archaeology and Historic Preservation as well as the Confederated Tribes and Bands of the Yakama Nation Tribal Historic Preservation Officer and representatives from the Confederated Bands and Tribes of the Yakama Nation Cultural Resources Program.

Project construction would occur within the existing right-of-way and would have ***no*** impact on socioeconomic resources.

BPA would use standard utility vehicles and existing access roads to access the Wautoma-Ostrander line right-of-way for installation of the fiber optic cable, so there would be ***no*** transportation-related impacts. The use of vehicles and equipment to install the cable would have ***low-to-moderate*** temporary noise impacts during the brief installation period at any one location.

There would be ***no*** impact on public health and safety, air quality or greenhouse gases.

3.15.4 Mitigation Measures

In general, all applicable mitigation measures identified for each resource earlier in this chapter would be taken to reduce or eliminate adverse impacts by fiber optic cable installation.

3.15.5 Unavoidable Impacts Remaining after Mitigation

Even with mitigation, there would be some temporary construction impacts, but there would be no unavoidable permanent impacts.

3.15.6 No Action Alternative

The No Action Alternative would have no impact on resources because no new fiber optic cable would be strung on new or existing towers. Impacts from operation and maintenance of existing towers, conductors, and substations would continue unchanged.

3.16 Intentional Destructive Acts

Intentional destructive acts, that is, acts of sabotage, terrorism, vandalism, and theft, sometimes occur at power utility facilities. Vandalism and thefts are most common, especially of metal and other materials that can be sold. BPA has seen a significant increase in metal theft from its facilities over the past few years when the price of metal is high on the salvage market. There were more than 50 burglaries at BPA substations in 2006 alone. The conservative estimate of damages for these crimes is $150,000, but the actual amount is likely much higher since this number does not factor in all the labor-related costs associated with repairing the damage.

The impacts from vandalism and theft, though expensive, do not generally cause a disruption of service to the area. Stealing equipment from electrical substations, however, can be extremely dangerous. In fact, nationwide, many would-be thieves have been electrocuted while attempting to steal equipment from energized facilities. On Oct. 11, 2006, a man in La Center, Washington, was electrocuted while apparently attempting to steal copper from an electrical substation.

Federal and other utilities use physical deterrents such as fencing, cameras, warning signs, rewards, etc., to help deter theft, vandalism and unauthorized access to facilities. In addition, through its Crime Witness Program, BPA offers up to $25,000 for information that leads to the arrest and conviction of individuals committing crimes against BPA facilities. Anyone having such information can call BPA's Crime Witness Hotline at (800) 437-2744. The line is confidential, and rewards are issued in such a way that the caller's identity remains confidential.

Acts of sabotage or terrorism on electrical facilities in the Pacific Northwest are rare, though some have occurred. These acts generally focused on attempts to destroy large transmission line steel towers. For example, in 1999, a large transmission line steel tower in Bend, Oregon, was toppled.

Depending on the size and voltage of the line, destroying towers or other equipment could cause electrical service to be disrupted to utility customers and end-users. The effects of these acts would be as varied as those from the occasional sudden storm, accident or blackout, and would depend on the particular configuration of the transmission system in the area. While in some situations these acts would have no noticeable effect on electrical service, in other situations, service could be disrupted in the local area, or if the damaged equipment was part of the main transmission system, a much larger area could be left without power.

When a loss of electricity occurs, all services provided by electrical energy cease. Illumination is lost. Lighting used by residential, commercial, industrial and municipal customers for safe locomotion and security is affected. Residential consumers lose heat. Electricity for cooking and refrigeration is also lost, so residential, commercial, and industrial customers cannot prepare or preserve food and perishables. Residential, commercial, and industrial customers experience comfort/safety and temperature impacts, increases in smoke and pollen, and changes in humidity, due to loss of ventilation. Mechanical drives stop, causing impacts as elevators, food preparation machines, and appliances for cleaning, hygiene, and grooming are unavailable to residential customers. Commercial and industrial customers also lose service for elevators, food preparation, cleaning, office equipment, heavy equipment, and fuel pumps, unless they have heavy-duty backup generators.

In addition, roadways experience gridlock where traffic signals fail to operate. Mass transit that depends on electricity, such as light rail systems, can be impacted. Sewage transportation and treatment can be disrupted.

Overhead transmission conductors and the towers that carry them are mostly on unfenced utility rights-of-way. The conductors use the air as insulation. The towers and tension between conductors make sure they are high enough above ground to meet safety standards. Towers are constructed on footings in the ground and are difficult to dislodge.

While the likelihood for sabotage or terrorist acts on the proposed project is difficult to predict given the characteristics of the project, it is unlikely that such acts would occur. If such an act did occur, the problem area would be isolated quickly and electricity rerouted as much as possible to keep the system functioning. The Department of Energy, public and private utilities, and energy resource developers use security measures to help prevent such acts and to respond quickly if human or natural disasters occur.

3.17 Irreversible or Irretrievable Commitment of Resources

Irreversible commitments of resources occur when a nonrenewable resource such as minerals or petroleum-based fuels is used for the construction or operation of a proposed project. Irretrievable commitments of resources cause the lost production or use of renewable resources such as timber or rangeland.

The proposed project would consume aluminum, steel, other metals, wood, gravel, sand, plastics, and various forms of petroleum products in the construction of the transmission line, substation and development and improvement of access roads. Most of these materials are not renewable and could potentially be irreversible commitments of resources if not recycled (metals and glass) or reused (sand and gravel) at the end of the life of the project. The amount of land taken out of production for Knight Substation would also be irreversible.

Irretrievable commitments include small amounts of land lost to grazing and crop production. These commitments are irretrievable rather than irreversible because management direction could change and allow these uses in the future.

3.18 Relationship between Short-Term Uses of the Environment and Long-Term Productivity

The proposed action alternatives would not pose impacts that would significantly alter the long-term productivity of the affected environment. Within the project area, soils and vegetation that were disturbed in the 1950s and 1970s during construction of the existing transmission lines have largely recovered. While there is never complete recovery, long-term productivity of the affected environment has not been significantly altered because revegetation of the area's predominant grasslands and crop production continues. Similar impacts followed by recovery of productivity would occur for the proposed transmission line.

Chapter 4
Cumulative Impacts

The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act require the assessment of cumulative impacts in the decision-making process for proposed federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). As stated in the CEQ handbook, "Considering Cumulative Effects under the National Environmental Policy Act" (CEQ 1997), cumulative impacts should be analyzed in terms of the specific resource, ecosystem, and human community being affected and should focus on effects that are truly meaningful.

This chapter provides an analysis of potential cumulative impacts related to the Proposed Action. The analysis of cumulative impacts was accomplished using four steps summarized below. The first three steps are addressed in Section 4.1, and the fourth step is addressed in Section 4.2.

Step 1 — Identify Potentially Affected Resources

In this step, each resource that could be cumulatively affected by the Proposed Action, in combination with other actions, was identified.

Step 2 — Establish Boundaries

In order to identify the past, present, and reasonably foreseeable actions to consider in the cumulative impact analysis, specific spatial (i.e., location) and temporal (i.e., time) boundaries were identified for each affected resource.

Step 3 — Identify Potentially Cumulative Actions

In this step, other past, present, and reasonably foreseeable future actions to be included in the impact analysis for each specific affected resource were identified. These actions fall within the spatial and temporal boundaries established in Step 2.

Step 4 — Analyze Cumulative Impacts

This final step involves the analysis of the impacts of the actions identified in Step 3 in addition to the impacts of the Proposed Action. This analysis identifies the total cumulative impact related to each resource.

4.1 Affected Resources, Resource Boundaries, and Cumulative Actions

In considering the resources that could be cumulatively affected by the Proposed Action and other actions (Step 1), BPA determined that the same resources described in the affected resource sections in Chapter 3 of this EIS should be considered in the cumulative analysis. For each resource, BPA then established reasonable boundaries for the consideration of other past, present, and reasonably foreseeable future actions (Step 2). These boundaries are in terms of where the other actions are located (i.e., spatial boundaries), and when in time these actions took place or will take place (i.e., temporal boundaries). Accordingly, for each resource, the spatial boundary is the area where other past, present, and reasonably future actions have, are, or could take place and result in cumulative impacts to the affected resource when combined with the impacts of the Proposed Action. The temporal boundary describes how far into the past, and forward into the future, other actions should be considered in the cumulative impact analysis. Appropriate spatial and temporal boundaries may vary for each resource.

The determination of what past, present, and reasonably foreseeable future actions to consider in the cumulative impact analysis is based on the resources being affected. Guidance on determining what actions to consider in the cumulative impact analysis comes from a variety of sources, including the CEQ Cumulative Effects Handbook referenced above.

For past projects, CEQ has issued a guidance memo entitled "Guidance on Consideration of Past Actions in Cumulative Effects Analysis." This document states that consideration of past actions is only necessary in so far as it informs agency decision-making. Typically the only types of past actions considered are those that continue to have present effects on the affected resources. This present effect will dictate how far in the past actions are considered, and the impacts of these past actions are largely captured in the discussion of the affected environment chapter for each resource. The guidance states that "[a]gencies are not required to list or analyze the effects of individual past actions unless such information is necessary to describe the cumulative effect of all past actions." Agencies are allowed to aggregate the effects of past actions without "delving into the historical details of individual past actions."

Present actions are those that are currently occurring and also result in impacts to the same resources as would be affected by the Proposed Action. Reasonably foreseeable future actions are those actions that are likely to occur and affect the same resource as the Proposed Action. The determination of what future actions should be considered requires a level of certainty that they will occur. This level of certainty is typically met by the completion of a permit application, approved proposals or planning documents, or other similar evidence.

Determining how far into the future to consider other cumulative actions is informed by the duration of the impact of the Proposed Action. For the purposes of this EIS, the future actions being considered are those that could occur over the life of a transmission line, which is about 50 years. However, though a 50-year time frame was examined, only those actions that are reasonably foreseeable were considered (see Table 4-1 for a summary of actions).

Table 4-1. Catalogue of Past, Present, and Reasonably Foreseeable Future Actions by Affected Resource

Affected Resource	Spatial Boundary	Temporal Boundary	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Land Use and Recreation	Klickitat and Wasco counties in and adjacent to the project area, including areas of the Columbia River Gorge National Scenic Area	Based on planning timeframes of the affected counties	Construction/operation of The Dalles Dam; agricultural activities; highway and railroad construction; construction and operation of existing BPA transmission lines and Big Eddy Substation; Scenic Act designation; wind energy development; commercial and residential development; and airport construction and operation.	Agricultural activities and other ongoing land uses and practices; residential and commercial development; existing wind energy facilities; and airport operation.	Ongoing agricultural activities and other land uses; airport operation; Knight Substation expansion; residential and commercial development; pipeline construction; and development of wind energy and other power generation facilities and transmission infrastructure.
Transportation	Affected roads in Klickitat and Wasco counties	Based on construction period	Construction and operation of The Dalles Dam; agricultural activities; highway and railroad construction; construction and operation of existing BPA transmission lines and Big Eddy Substation; wind energy development; commercial and residential development; airport construction and operation.	Agricultural activities; residential and commercial development; highway improvements; existing wind energy facilities; airport operation.	Ongoing agricultural activities; airport operation; residential and commercial development; highway improvements; pipeline construction; and development of wind energy and other power generation facilities and transmission infrastructure.
Visual Resources	Based on a viewshed analysis conducted for the EIS (See Section 3.2 Visual Resources and Appendix C)	Back to the period of large scale agricultural conversion and Scenic Area designation, and through the life of the line (about 50 years).	Residential and commercial development; road and railway construction; transmission construction and operation; construction and operation of wind energy and the Goldendale power plant; The Dalles Dam construction; airport construction and operation.	Residential and commercial construction, sand and gravel operations, dam and power plant operations; existing wind energy facilities; and airport operation.	Residential and commercial development; sand and gravel operations; dam operation; power plant operation; marine terminal; expansion of Knight Substation and transmission line construction and operation; development of wind energy facilities and power transmission infrastructure; and airport operation.

Affected Resource	Spatial Boundary	Temporal Boundary	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Vegetation	The project corridor (the proposed rights-of-way and new access roads).	Back to the period of large scale agricultural conversion and Scenic Area designation, and through the life of the project (though most cumulative impacts occurring up to 3 years past construction while species re-establish).	Agricultural activities; residential and commercial development; road and railway construction; wind project development; conservation and park designations.	Agricultural activities; commercial and residential development; roadway construction and maintenance; and maintenance and operation of existing wind energy facilities.	Same as present actions; and expansion of Knight Substation and transmission infrastructure.
Geology and Soils	The project corridor (the proposed rights-of-way and new access roads for the action alternatives).	Back to the period of large scale agricultural conversion through the life of the project (though most cumulative impacts occurring in first year past construction).	Agricultural activities; road and railroad construction; commercial and residential development.	Agricultural activities; residential development; and maintenance of roads and existing wind energy facilities.	Same as present actions; and expansion of Knight Substation and transmission infrastructure.
Water Resources and Wetlands	Includes the Swale Creek, Little Klickitat River, Five Mile Creek, Three Mile Creek, and Eight Mile Creek drainages west of US-97. No water or wetland impacts expected to occur in Oregon.	Back to the period of large scale agricultural conversion through the life of the project.	Agricultural activities; road construction and maintenance; residential and commercial development; wind energy development and operation; park designation and conservation lands; stream restoration projects; transmission line construction.	Same as past actions	Same as past actions and expansion of Knight Substation and transmission infrastructure.

Affected Resource	Spatial Boundary	Temporal Boundary	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Wildlife	The project corridor (the proposed rights-of-way and new access roads for the action alternatives).	Back to the period of large scale agricultural conversion through the life of the project.	Agricultural activities; road construction/maintenance; residential and commercial development; wind energy facility development; conservation and restoration projects; and hunting and fishing.	Same as past actions	Same as past actions; and expansion of Knight Substation and transmission infrastructure.
Fish	Includes the Swale Creek, Little Klickitat River, Five Mile Creek, Three Mile Creek, and Eight Mile Creek drainages west of US-97. No water or wetland impacts expected to occur in Oregon.	Back to the period of large scale agricultural conversion through the life of the project.	Agricultural activities; road construction and maintenance; residential and commercial development; wind energy development and operation; park designation and conservation lands; stream restoration projects; transmission line construction.	Same as past actions	Same as past actions and expansion of Knight Substation and transmission infrastructure.
Cultural Resources	Based on a viewshed analysis conducted for the EIS (See Section 3.2 Visual Resources and Appendix C)	Back to the period of large scale agricultural conversion through the life of the project.	Residential and commercial development; road and railway construction; transmission construction and operation; construction and operation of wind energy and the Goldendale power plant; The Dalles Dam construction; airport construction and operation.	Residential and commercial construction, sand and gravel operations, dam and power plant operations; existing wind energy facilities; and airport operation.	Residential/commercial development; sand/gravel operations; dam operation; power plant operation; marine terminal; expansion of Knight Substation and transmission line construction/operation; development of wind energy facilities and power transmission infrastructure; airport operation.

Affected Resource	Spatial Boundary	Temporal Boundary	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Socioeconomics	Wasco and Klickitat counties	Back to the period of large scale agricultural conversion through 1 year following completion of construction.	Agricultural activities; highway/railroad construction; construction/operation of existing BPA transmission lines; commercial/residential development; road/railroad construction/maintenance; airport construction/operation; Scenic Area designation and tourism development; and wind energy facility development/operation.	Same as past actions; and new wind energy facility development	Same as present actions; power generation facilities and transmission infrastructure; marine terminal; pipeline construction; and expansion of Knight Substation and transmission infrastructure
Noise	Wasco and Klickitat counties, including areas of the Columbia River Gorge National Scenic Area	Back to the period of large scale agricultural conversion through the life of the project.	Road and railroad construction and maintenance; agricultural activities; residential and commercial development; wind energy development; airport construction and use; construction and operation of The Dalles Dam and BPA transmission lines.	Same as past actions	Same as past actions
Public Health and Safety	Wasco and Klickitat counties	Back to the period of large scale agricultural conversion through the life of the project.	Agricultural activities, burning of wood/ yard debris; residential/commercial development; road and railway construction/maintenance; transmission construction/operation; construction/operation of wind energy and the Goldendale power plant; The Dalles Dam construction; and airport construction.	Same as past actions	Same as past actions

Affected Resource	Spatial Boundary	Temporal Boundary	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Air Quality	Wasco and Klickitat counties, including areas of the Columbia River Gorge National Scenic Area	Back to the period of large scale agricultural conversion through the construction of the project.	Agricultural activities, burning of wood/yard debris; residential and commercial development; road and railway construction and maintenance; transmission construction/operation; construction and operation of wind energy and the Goldendale power plant; The Dalles Dam construction; and airport construction.	Agricultural activities, burning of wood/yard debris; residential and commercial development; road and railway construction and maintenance; construction/operation of wind energy and the Goldendale power plant	Same as present actions; and construction of new wind and other energy development.
Greenhouse Gases	Given the nature and extent of greenhouse gas emissions the appropriate boundary is global.	Greenhouse gases have been, and will continue accumulating in the atmosphere. The distant past through the life of the project.	Burning of fossil fuels and wood products; land clearing, agriculture and development.	Burning of fossil fuels and wood products; land clearing, agriculture and development; carbon sequestration initiatives; international efforts such as the Kyoto Treaty.	Burning of fossil fuels and wood products; land clearing, agriculture and development; carbon sequestration initiatives; international efforts such as the Kyoto Treaty.

[1] Past actions described are those past actions continuing to have present effects. Otherwise, they would not contribute to the cumulative impact of the Proposed Action when considering past, present and reasonably foreseeable future actions.

Some actions listed in Table 4-1 are further explained below.

Past and Present Actions

- Construction and operation of The Dalles Dam—while construction of the dam is a past action, operation of the dam would be considered present and reasonably foreseeable actions.
- Agricultural use—much of the land in the project area has been converted from native grasslands and shrub-steppe to agriculture and pasture. This conversion has all but ceased, as more land is subdivided for residential development.
- Commercial and residential development—Commercial and residential development would be considered present and reasonably foreseeable actions as well as past actions. There is active land subdividing and residential construction in the northern area of the transmission construction portion of the Proposed Action. Most of the lots being sold are marketed as having views of Mount Adams. There is some commercial development occurring in The Dalles, Oregon.
- Road and railroad construction—Construction of local and state highways (e.g., I-84, US 97, and SR 14) and the railroads bisected native grasslands, shrub-steppe habitat, riparian areas, and agricultural lands. Additional construction and maintenance of the road system would be considered present and reasonably foreseeable actions. One rail system has been removed creating the Klickitat Trail; however, there is still active railroad use along the Columbia River.
- Transmission line construction—would be considered present and reasonably foreseeable actions as well as past actions. There are a number of BPA and non-BPA transmission and distribution lines throughout the project area. Upon completion and future expansion of Knight Substation, additional transmission would be constructed.
- Wind Energy Development—Windy Point Wind Energy Project, with 52 turbines, was developed about 6 miles southeast of Goldendale, Washington.
- Airport Construction and Operation—two airports are in the general project area. One is located in Dallesport (Columbia Gorge Regional Airport, serving The Dalles), and the other is near the proposed location of Knight Substation.

Reasonably Foreseeable Future Actions:

- Knight Substation Expansion—although the project description proposes a specific size for Knight Substation, the substation is being designed to accommodate possible future expansion as energy requests warrant the need. BPA would purchase sufficient land to allow for expansion as part of possible future projects. Although the expansion would likely involve additional transmission construction, the locations of those projects are unknown as the energy development has not yet occurred.
- New wind energy projects and transmission infrastructure—there are a number of wind projects proposed in Klickitat and Wasco counties. Many of the proposed projects in Klickitat County would be southeast of Goldendale. These projects include: Juniper Canyon, Windy Flats, Linden Ranch, Windtricity, Imrie Wind, and Windy Point II. Other projects proposed in Klickitat County include the Miller North Wind Project and the School Section Wind Project. In addition, the Summit Ridge Wind project has been proposed for an area east of Dufur, Oregon.

- Natural gas pipeline construction—The Blue Ridge gas line is proposed to traverse Klickitat County as it would transport natural gas to Olympia and Seattle, Washington. A second pipeline project—the Palomar Pipeline— is proposed for southern Wasco County.
- Marine terminal in The Dalles—The Port of The Dalles is planning to develop a marine terminal, which will include cargo cranes and docks. This facility will allow for cruise ship and other watercraft access and options for shipping cargo.
- Commercial and residential development—Land is currently being subdivided and developed for residential use in the northern portion of the project area. In addition, commercial development has been proposed in or near the project area. The Sundoon Destination Resort is proposed for Klickitat County east of Dallesport. It would include a golf course and 400 visitor units. There is also a proposal to develop a business park at the Columbia Gorge Regional Airport in Dallesport.

4.2 Cumulative Impacts Analysis

This section provides the analysis of cumulative impacts when potential impacts from the proposed project are combined with past, present, and reasonably foreseeable actions listed in Table 4-1 and described in Section 4.1. The following analysis describes these potential cumulative impacts, in the order that the affected resources are presented in Chapter 3 of this EIS. For some resources, cumulative impacts would be approximately the same across all action alternatives. For other resources, cumulative impacts would vary by alternative. For these resources, general cumulative impacts are discussed first, followed by discussions of cumulative impacts specific to each alternative.

Land Use and Recreation

Land use in the project vicinity has incrementally changed due to cumulative past and present development, and this trend would be expected to continue with the cumulative future development identified in Section 4.1. Past and present actions have cumulatively established the current land use patterns in Wasco and Klickitat counties. These actions have introduced predominantly agricultural (mainly crops and livestock grazing) and rural residential uses throughout the area, with commercial and residential uses along the Columbia River. More recently, there has been a trend to converting agricultural land over to large-lot residential uses in some areas, for example near the Little Klickitat River. Assuming this trend continues, this land conversion could cumulatively reduce the amount of land used for agricultural purposes, although this reduction likely would be considered negligible given the extremely small portion of total agricultural lands in the general area that would be converted.

Land use in the area also has been cumulatively affected by development of transportation and utility infrastructure throughout the area. In addition to numerous roads, railroads pipelines, and transmission lines that are present in the area, development of wind energy projects has occurred and is expected to continue. Table 4-2 identifies the many wind projects that have been permitted, or are in the process of seeking permits, in the general project vicinity. These wind projects tend to be located in open areas, such as agricultural lands and undeveloped areas, where a good wind resource is present. Construction of these wind projects can involve temporary land use disturbance from the installation of wind facilities and temporary interruption of agricultural activities in areas where these facilities are being installed. In general, because developers of wind projects are required through their siting permits and land agreements to restore all temporarily disturbed areas to their original condition following construction, the temporary impact on agriculture from development of wind facilities would not cumulatively affect these land uses in the area. However, the wind turbines, transmission lines, substations, and roads that would be in place for these facilities would result in the permanent conversion of thousands of acres of mainly agricultural land to an energy production use. While agricultural uses could largely continue in areas around individual wind project components, this conversion to wind generation facilities is a significant cumulative change in land use in the project vicinity.

Table 4-2. Permitted and Permit-Pending Wind Projects in Southern Klickitat and Northern Wasco Counties.

Name	Megawatts (MW)	Status
Big Horn	250 MW	Permitted and constructed
Harvest Wind	100 MW	Permitted and constructed
Hoctor Ridge	60 MW	Permitted and some constructed
Imrie EOZ (formerly Goodnoe II)	34 MW	Permitted
Juniper Canyon (Phase 1)	151.2 MW	Permitted
Juniper Canyon (Phase 2)	98.8 MW	Permit pending
Linden Ranch Wind Farm	58 MW	Permitted and some constructed
Miller North	150 MW	Permits pending
Miller Ranch Wind Farm	98 MW	Permitted and some constructed
School Section	20 MW	Permits pending
White Creek	206 MW	Permitted and constructed
Windtricity (Imrie CUP)	100 MW	Permitted and some constructed
Windtricity (Mariah)	12 MW	Permitted
Windy Flats 190 MW Permitted and constructed	190 MW	Permitted and constructed
Windy Flats West	67 MW	Pending
Windy Point I	242.50 MW	Permitted and some constructed
Windy Point II	130 MW	Permitted and some constructed
Summit Ridge (Wasco Co)	200 MW	Project order issued

Regardless of the alternative selected, BPA would obtain transmission easements for operation of the proposed project on private lands, and would obtain right-of-way grants to cross federal and state lands. In addition, existing land use or ownership would not be expected to significantly change along the transmission line right-of-way as a result of the proposed project. However, the project would add to the on-going development of utility-related land uses in the project vicinity. The proposed project thus would contribute incrementally, though in a relatively minor way, to potential cumulative land use impacts in the area.

As discussed in Section 3.1 of this EIS, there are several recreational areas in the vicinity of the proposed project. While some past and present actions have increased recreational access and opportunities in the vicinity, some actions such as the introduction of human uses and development in otherwise natural areas and viewsheds may be viewed as having diminished the recreational experience for some recreational users. Past and reasonably foreseeable future wind development could contribute to the cumulative negative effect on recreational use through the introduction of additional evidence of human occupation in the area. Cumulative development may also adversely affect hunting by occupying areas and restricting access for hunting and temporarily disturbing wildlife during construction. The presence of the proposed project would add incrementally to these impacts. The proposed project thus would contribute incrementally, though in a relatively minor way, to potential cumulative impacts on recreational uses in the area.

Visual Resources

Past and present development and activities have changed the visual landscape in the immediate project vicinity by introducing manmade features and altering natural forms. These features include more urbanized uses along the Columbia River, rural residential uses scattered throughout the project vicinity, and project area roads and utility infrastructure. Areas cleared for agriculture also have changed the visual quality in some areas within the project vicinity. Reasonably foreseeable future actions involving development would be expected to continue this trend.

As discussed in Chapter 3, each action alternative passes through the Columbia River Gorge National Scenic Area to varying degrees. The discussion of cumulative visual impacts by alternative that follows identifies these impacts within the National Scenic Area as well as outside the National Scenic Area. The National Scenic Area analysis is based on views from identified areas within the Gorge that are affected by the action alternatives and the additional actions affecting visual resources that can be seen from the same area. Maps associated with these areas are displayed in Appendix C.

West Alternative

About 10 miles of the West Alterative is within the boundaries of the National Scenic Area. The views from the Columbia River (see Map C-1) and I-84 (see Map C-2) provide the most comprehensive area where cumulative impacts could occur considering the West Alternative and other actions. Not all cumulative actions impacting visual resources from these two areas would likely be seen at the same time, but traveling along these areas would result in more prolonged impacts to visual resources. In addition to the West Alternative, other actions cumulatively impacting visual resources would include The Dalles Dam and transmission lines (primarily those crossing the Columbia River and on the north side of the river); The Dalles; I-84 construction; Columbia Gorge Regional Airport, including air traffic and proposed business park; the future marine terminal; and commercial and residential development along the river, such as Sundoon Destination Resort proposed for Klickitat County east of Dallesport.

As the alternative exits the National Scenic Area, it enters primarily agricultural areas in Klickitat County. Other activities that could occur along, or within view of the alternative primarily include agricultural activities and residential development. As increased subdivision and residential development occurs along the northern portion of the alternative, the new construction would cumulatively reduce the nature of the agricultural landscape and possibly interfere with some views of Mount Adams. In addition, wind farms along the high ridge to the south could be visible, further cumulatively altering the scenic value.

The visual presence of the proposed transmission line would contribute incrementally to the adverse cumulative impact to visual resources in the area. The extent of this contribution would depend on how portions of the proposed line in this area would be constructed. A new single-circuit line would introduce new towers and cleared right-of-way to the visual landscape, while replacing an existing line with a double-circuit configuration (to accommodate both the existing and proposed lines) would avoid additional right-of-of way but the new towers may be more visible than the existing towers.

Middle Alternative

About 6 miles of the Middle Alternative fall within the National Scenic Area. Initially only 1 mile is within the National Scenic Area. The southern portion of this alternative would not be visible from the Columbia River, I-84, Wishram, Rowena Plateau, or State Highway 14. As the alternative turns north to cross the Columbia River and cross the National Scenic Area, it becomes visible to those viewsheds listed above except Rowena Plateau. In terms of other cumulative actions that can be seen from the same locations, it is possible that the Summit Ridge Wind Project in northern Wasco County could be seen, along with wind projects in southern Klickitat County including Windy Point I and II, Windy Flats, and Linden Ranch. In addition, those activities described in the West Alternative could further cumulatively impact visual resources in terms of the duration of impact as one travels through the area.

Cumulative impacts as those described in the West Alternative for the non-scenic area would be generally similar under this alternative. However, cumulative impacts may be greater at certain locations along this alternative due to the contribution of present and future wind development and developed human uses in other areas (i.e., Goldendale Power Plant) given the proximity of this alternative to those developments.

East Alternative

Based on the siting of the East Alternative and its general proximity to the Middle Alternative, the cumulative impacts to visual resources generally would be the same as those described for the Middle Alternative.

Vegetation

Past and present actions have resulted in extensive changes to vegetative communities within the project area. Native vegetative communities in the general vicinity have been substantially altered by agricultural conversion, ranching, residential and commercial uses, road construction, and construction of the various utility infrastructure. These actions have resulted in the removal and permanent conversion of vegetation communities.

The past actions, such as agriculture, livestock grazing, and conservation efforts, which have generally defined the vegetation in the areas for each of the action alternatives, are expected to largely continue into the future. In addition, past, present and future residential development in the northern sections of each alternative will continue to result in the cumulative clearing of native vegetation and the potential introduction or spread of noxious weeds.

West Alternative

The West Alternative has the highest impact on native vegetation because it traverses the least amount of cultivated cropland. Other actions contributing to cumulative impacts include residential development along the northern portion of the alternative that may including native vegetation clearing and the potential introduction and spread of noxious weeds. If this development resulted in additional tree removal along the Little Klickitat River, it could further contribute to cumulative vegetation impacts. In addition, the West Alternative is sited through the Columbia Hills State Park and Nature Preserve. Although efforts are underway to conduct conservation and restoration activities to improve the conditions of native vegetation in this area, these activities could not be conducted in the transmission line right-of-way. This alterntive thus would contribute incrementally to the adverse cumulative impact to vegetation in the area.

Past and present activities, such as ranching, agriculture, and road construction, have resulted in the substantial introduction and spread of noxious weeds in the project corridor and general vicinity. The spread of noxious weeds will continue as a result of ongoing and reasonably foreseeable actions and construction of the proposed project would contribute to this cumulative impact. Operation and maintenance activities also have the potential to contribute to this cumulative impact. The potential contribution of the proposed project would, however, be minimized by project-related mitigation measures designed to minimize the acres of new noxious weed infestations and minimize the contribution to cumulative effects of noxious weed colonization in the project area. The proposed project thus would contribute incrementally, though in a relatively minor way, to potential cumulative noxious weed impacts.

Middle Alternative

Past, present, and future actions with the potential to have cumulative impacts with the Middle Alternative include past and present agricultural, livestock, and road use, as well as the construction and proposed construction of wind projects in the area (Windy Flats and Windy Flats West) will result in the removal of additional native vegetation and increased risk of invasive species infestations and spread. Similar to the West Alternative, some trees may be removed in areas also experiencing residential development, which could further impact vegetation. However, cumulative impacts to vegetation would primarily be restricted to disturbed grassland/shrub steppe areas under this alternative. Potential cumulative impacts related to noxious weeds would largely be the same as described for the West Alternative. The proposed project thus would contribute incrementally, though in a relatively minor way, to potential cumulative vegetation impacts in the area.

East Alternative

Cumulative impacts under this alternative would be similar to those described for the Middle Alternative.

Geology and Soils

Past and present actions have cumulatively affected geology and soil resources in the proposed project area and resulted in soil disturbance, compaction, and erosion. Present and ongoing activities include primarily agricultural land uses, road construction and maintenance, transmission lines, and wind energy development. These actions are likely to continue to occur into the future and also include the potential expansion of Knight Substation.

Cumulative impacts, as they relate to soil compaction and erosion, would vary depending on location. In some areas, compaction would be remedied by farming practices, as construction-related impacts are eliminated during the following growing season. In other areas, erosion could increase, especially in terms of wind blown erosion, depending on the type of agricultural practices that are implemented (e.g., full till or no till). Current and future road construction and maintenance would also contribute to soil erosion and compaction, though affected areas would be limited. However, new road construction combined with agricultural practices could increase soil erosion during precipitation events if soil from fields travels into ditches.

Past, present, and future actions can also contribute to cumulative landslide risk by placing development on unstable slopes without taking adequate slope stabilization measures, and by increasing downslope risks from landslides. BPA is coordinating with state geologists to identify known and potential landslide risks in the vicinity of the proposed project. BPA would work to site its proposed facilities away from known landslide areas where possible, and to design any facilities in landslide areas that cannot be avoided to minimize the potential for exposing these facilities to landslides or increasing landslide risk.

The proposed project would result in minor alterations to topography within the project corridor, from grading and construction of towers and roads. These effects would be localized and limited to the construction footprint of the transmission line. Additionally, soil erosion fromthe proposed project would largely be mitigated by implementation of BMPs during and following construction. The proposed project thus would contribute incrementally, though in a relatively minor way, to cumulative impacts related to geology and soils.

Water Resources and Wetlands

Cumulative impacts to wetlands and water resources in the project vicinity are primarily a result of past and present land development, agricultural and livestock runoff, hydropower development, and road construction and maintenance. These impacts have been occurring since the area was settled and likely have changed in terms of rate and type of input (e.g., increased fertilizer as they were developed). All individual wetlands identified in Chapter 3 as being impacted by this alternative would also be impacted by similar agricultural and road actions. Near Little Klickitat River, additional runoff- related impacts could occur as a result of residential development. The development and maintenance of wind projects could further cumulatively reduce water quality in certain area creeks such as Swale Creek adding to the overall impact. However, these projects likely have stormwater runoff plans and mitigation in place to reduce their overall impacts. Although measures would be taken to avoid or minimize impacts to water resources and wetlands from the proposed project where possible, the project would contribute incrementally, though in a relatively minor way, to cumulative impacts to water resources and wetlands.

Wildlife

Past and present development and other activities have had a cumulative adverse impact on wildlife species and their habitat in the project vicinity. The clearing and conversion of land for urban development, home sites, utility infrastructure, and other uses since the 19th century has resulted in the cumulative loss of wildlife habitat. Agricultural operations have resulted in disturbed grasslands and cropland dominating the area. Existing roads in the project vicinity have led to increased disturbance from human activity, increased landscape fragmentation and the presence of wildlife travel barriers, lost habitat, and spread of noxious weeds. This habitat loss and modification has resulted in the displacement of wildlife species. Wildlife species also have been directly affected by hunting and trapping activities, as well as incidental harm and killing from other human activities in the area. Reasonably foreseeable future actions involving development would be expected to incrementally add to these cumulative impacts. Cumulative impacts to wildlife were analyzed in terms of disturbance and direct mortality as well as habitat disturbance, modification, or destruction.

West Alternative

Development of this alternative would not substantially contribute to cumulative impacts related to wildlife disturbance and habitat in the project vicinity. The portion that extends from Big Eddy Substation to the Columbia River is highly developed, much of the habitat has already been modified, and wildlife species have acclimated to the high levels of disturbance from The Dalles and the construction and operation of The Dalles Dam. Most cumulative actions and impacts to wildlife and wildlife habitat in the Klickitat County portion of the National Scenic Area are related to recreational uses such as hiking and conservation, restoration, and research. This is particularly true for the portion of the alternative that traverses the Columbia Hills State Park and Natural Area Preserve.

As this alternative exits the National Scenic Area, it crosses more active agricultural and livestock grazing areas. Farming and ranching activities, and road maintenance including regarding unpaved roads, result in noise and disturbance that, when combined with transmission line construction activities, increase the level and duration of the disturbance, potentially causing longer periods of project area avoidance. Depending on the timing of the disturbances (i.e., mating and breeding periods), some species could fail to reproduce during that season. Hunting also likely occurs in this portion of the project area increasing disturbance and potential mortality at specific times throughout the year. Additional impacts to wildlife would stem from residential construction in the northern portion of the project area. As additional habitat is converted to houses and roads, wildlife impacts will increase. More common species could benefit in the long term as residential development could result in supplemental food sources during food-limited periods such as winter. However, the presence of dogs and other pets may increase wildlife disturbance and mortality.

To the extent that this alternative would remove trees and occupy areas that could otherwise be used by wildlife, this alternative would contribute incrementally, though in a relatively minor way, to the cumulative impact on wildlife habitat.

As described in Chapter 3, transmission lines pose a risk to migratory birds (including local raptors) because of collision-related mortality. There are number of other transmission and distribution lines that could cumulatively impact migratory birds in the area. In addition, wind turbines present a similar risk in terms of potential collisions. A recent analysis prepared by West, Inc. projected that about 16,750 birds/year (excluding raptors) would be killed. For raptors, this number would be about 516 per year. Some species of birds (e.g., snow geese) migrate at higher altitudes and are not likely to be impacted. However, others make more frequent stopovers and migrate at lower altitudes. Passerines and upland games birds had the largest portion of mortality at 67.1 percent and 12.6 percent, respectively (Johnson and Erickson 2010). The study area considered was the Columbia Basin Plateau, a region much larger than Klickitat and Wasco counties, though a larger portion of the wind projects in the study area is in Klickitat County.

This alternative thus would contribute incrementally to the adverse cumulative impact to migratory birds in the area. There also is the potential for increased cumulative impacts on bat species from the presence of the wind farms, although the proposed project would not be expected to contribute to these cumulative impacts since there would be no impacts to bat species from the proposed project (see Chapter 3).

Middle Alternative

Cumulative impacts from the Middle Alternative are similar to those described in the West Alternative; however, there are several differences. More of the Middle Alternative extends through agricultural areas (as it includes areas in Oregon) and it does not extend through the Columbia Hills State Park and Natural Area Preserve. In addition, the Middle Alternative travels through the area of the proposed Windy Flats West wind project in Klickitat County. Much of the habitat in this area will be fragmented with roads and turbines and the wildlife will experience large disturbances as a result of the construction of the wind project.

East Alternative

The cumulative impact analysis of the East Alternative is similar to the Middle Alternative. The only difference is that the East Alternative traverses the Windy Flats wind project, which has already been constructed.

Fish

Past and present actions that have affected fish include agricultural practices and other human development that have resulted in the loss of streamside riparian cover, the loss of large woody debris sources, and the addition of sediment. In addition, development of the hydroelectric system in the Columbia River has adversely affected both downstream and upstream survival of fish. Harvest of these fish resources, in both the Columbia River and its tributaries and the ocean, has further impacted these resources. In recent years these conditions have all been improving with better passage conditions and directed harvest management.

As described in Chapter 3, there are no-to-low impacts to fish or fish habitat as a result of any of the action alternatives. The project's contribution to cumulative impacts to fish would be largely indirect and based on decreased water quality in fish-bearing streams. Therefore, the proposed project, regardless of action alternative, would not be expected to contribute in a measurable way to cumulative impacts to fish.

Cultural Resources

Cultural resources in the project vicinity have been and are being affected because of past, present, and current development and activities. These cumulative impacts include disturbance of cultural sites, reduction of the cultural integrity of certain sites, and removal of cultural artifacts. Past actions that have affected cultural resources in the project vicinity include construction and operation of the hydro facilities, agricultural activities, highway and railroad construction, construction and operation of the existing BPA transmission lines in the area, and commercial and residential development. Present and ongoing activities in the immediate project vicinity include agricultural activities and existing wind energy facilities. Placement of wind turbines within the viewshed of Historic Properties of Cultural and Religious Significance may negatively affect the use of these areas by local area tribes. Continued conversion of native vegetation to cropland lessens the amount of lands available to tribes for native plant gathering.

During construction of the proposed project, there is also the potential for undiscovered archaeological resources to be impacted. Implementation of mitigation measures as described in Section 3.8 of this EIS would lessen or avoid the potential for impacts to archaeological resources. However, the project may still contribute incrementally to the adverse cumulative impact to cultural resources in the area.

Socioeconomics

Past and present actions have set the baseline for socioeconomics within the counties where the proposed transmission line would be sited. The proposed project, in combination with past, present, and reasonably foreseeable future projects, could cumulatively affect the area's population, housing, and employment.

As described in Chapter 3, the alternatives are not likely to result in changes in population or the need for permanent housing. There may be some low impacts related to the need for temporary lodging for construction workers. However, when this lodging need is combined with those from ongoing and future construction-related activities, the impact to lodging may be moderate-to-high. Construction workers for wind and natural gas development will also require temporary housing, though many workers may be hired from the local area similar to those for the alternatives considered. Based on the analysis in Chapter 3, the area currently has an average occupancy rate of 75 percent. These additional construction activities could further increase the area occupancy rate, when combined with transmission construction activities depending on the timing of construction. In addition, depending on when the new marine terminal is constructed, it could require additional temporary housing or lodging. These moderate to high impacts would be beneficial as they would increase lodging-related revenue and other ancillary businesses such as restaurants, grocery stores, laundromats, gas stations, and other businesses necessary to support temporary construction workers. As available occupancy becomes limited in the immediate area of construction activities, businesses farther from the project area could begin to see benefits.

As describe in Chapter 3, about 48 temporary jobs would be created by the project (30-80 percent filled locally). This increase in employment would last only through the construction of the project. It would also result in minor indirect employment creation. If construction is timed with other construction-related activities, such as those described above, the need for temporary construction workers could increase. In addition, if the pool of available construction workers is limited locally, it will result in construction workers traveling from other areas to work sites. The impact of hiring local workers, though preferable for many reasons, would reduce the benefits described above for temporary lodging needs.

In terms of wind development, temporary employment resulting from construction would also increase. A 2002 Kittitas County wind study modeled that about 85 full and part-time temporary construction jobs would be created for the development of 360 MW of wind energy (ECONorthwest 2002). In addition, the study suggested that an additional 10 full and part-time construction management positions would be created. When considered in terms of the projects listed in Table 4-2 and other current and future actions, this could result in a number of temporary construction jobs or the increase in duration or temporary jobs depending on the timing of various construction projects. When combined with indirect spending as a result of increased employment, construction jobs could assist in lowering the unemployment rates, at least temporarily, for both counties, which currently hover around 9.2 percent.

Transportation

Past actions that have affected transportation in the vicinity of the proposed project include the development of highways, local roads, and railroads; construction and operation of the Columbia River dams and locks; construction and operation of various airstrips in the project vicinity; and traffic associated with residential and commercial development in the area. Present transportation-related actions in the vicinity of the proposed project include ongoing road maintenance projects, and transportation of freight by railroad, barge, and aircraft. Reasonably foreseeable future actions in the vicinity of the proposed project that could affect transportation include ongoing road maintenance activities, continuing residential development (particularly in more rural areas), and construction of commercial and wind energy facilities that would generate increased traffic volumes on local roads.

Cumulative impacts to transportation would be similar across action alternatives because they would all require using the same roads (though there is some minor variation) during construction activities. Cumulative impacts are those that will affect the same roads at the same time as transmission construction related activities. Agricultural vehicles such as tractors and combines traveling along public roads can delay normal traffic patterns. In addition, increased construction-related vehicles for residential and commercial development and wind energy development will further cumulatively impact local traffic patterns. Road reconstruction and maintenance, such as those activities taking place on I-84, would further exacerbate cumlative traffic impacts. Since spring and summer are the primary construction periods, it is likely that construction of the proposed project would contribute to cumulative impacts to traffic volumes and delays; however, given the short-term and relatively low volume nature of traffic associated with the proposed project, the contribution of the proposed project to these cumulative impacts would be small and temporary.

Noise

Although implementation of past and present actions in the project vicinity has resulted in some increase on longer-term noise levels, this noise is very location dependent, and the project vicinity continues to enjoy relatively low noise levels on a continual basis. Past and present actions that have cumulatively increased noise levels in some portions of the area include road construction and ongoing associated road maintenance and traffic use, railroad construction and operation, agricultural activities, residential and commercial development; wind energy development, airport construction and use, construction and operation of The Dalles Dam, and construction and operation of various transmission lines in the area. Reasonably foreseeable future actions in the vicinity of the proposed project that could contribute to cumulatively increased noise levels include continuation of these existing uses as well as further development of new residential and connercial uses and wind energy facilities and associated power transmission infrastructure.

Cumulative noise impacts in the project vicinity typically occur when noise receptors are exposed to noise from sources at about the same time, such as from vehicles, train noise, and wind turbines. There could be cumulative noise impacts if these actions are undertaken simultaneously and close to each other. Construction noise from the proposed project would temporarily add to noise from other activities in the immediate vicinity of portions of the proposed project, such as traffic on project area roads, commercial/industrial activities, and railroad operations. In addition, if any wind projects are constructed at the same time in the immediate vicinity of the proposed project, the construction noise for these wind projects could be cumulatively additive with construction noise from the proposed project. The project thus could contribute incrementally to adverse cumulative impacts to noise on a temporary basis during construction. Once the line is built, corona generated noise from the transmission line also could contribute incrementally, though in a relatively minor way, to cumulative noise impacts in areas near the line.

Public Health and Safety

A number of past, present, and reasonably foreseeable actions in both Wasco and Klickitat counties have and could cumulatively contribute to public health and safety impacts. Primary impacts of construction-related activities relate to increased vehicle traffic and congestion in the areas where construction is occurring. The proposed project would contribute a small increase in the overall risk of injury to the public that could occur during construction, as well as an increase in the risk of fire from construction activities. Other construction activities proposed in Wasco and Klickitat counties also would pose similar risks to the public through increased construction-related traffic. However, it is likely that the cumulative impact would remain low given the many safety precautions that are taken.

Injuries to workers would also remain low cumulatively. In 2008, the U.S. Bureau of Labor Statistics reported injury rates for construction workers (BLS 2010). The results indicated that the rate of injury and illness per 100 full-time workers was about 4.7 percent. Injury and illness included those requiring days away from work, job restriction, or transfer. The cumulative impact to worker health and safety would then correspond to the number of those employed and would likely be about 5 percent.

Although the proposed project would result in higher levels of EMF under and immediately near the proposed transmission line, it would not cumulatively increase the overall level of EMF exposure in project vicinity.

Air Quality

Cumulative impacts to air quality would be similar among all action alternatives. A number of activities have occurred throughout the project area that cumulatively contribute to air quality impacts. As described in Table 4-1, these activities include agricultural uses, ongoing road maintenance, and the burning of wood and fossil fuels in residential and commercial/industrial uses and vehicle use. In addition, present and future residential commercial/industrial development and road construction and maintenance, among other sources, will continue to impact air quality. However, there are no major industrial facilities in the project area and no significant existing air quality problems. Local air pollutant emissions are limited mainly to windblown dust from agricultural operations and tailpipe emissions from traffic along state highways and local roads. The project area is currently designated as in attainment under the Clean Air Act.

Air emissions from the proposed action alternatives would occur during project construction from construction activities, as well as use of vehicles and heavy equipment. These emissions would result in a temporary contribution to cumulative impacts on air quality from pollutants generated by agricultural uses, road maintenance, and other sources in the region. During construction, the proposed action alternatives accordingly would contribute incrementally, though in a relatively minor way, to cumulative impacts related to air quality,.

Greenhouse Gases

Cumulative greenhouse gas concentrations in the atmosphere and corresponding climate change occurring over the past 50 years have been primarily caused by anthropogenic contributions. Greenhouse gas emissions have largely originated from the burning of fossil fuels and the clearing of forests around the world from many and varied sources during this time, as well as for a significant period before that (Karl et al. 2009). Therefore, unlike the cumulative impacts analyses for other resources discussed in this section, the global nature of greenhouse gases makes cataloguing past, present, and reasonably foreseeable future actions for this resource impossible.

Nonetheless, in a general sense, any action where fossil fuels have been or are being burned contributes to greenhouse gas concentrations. Examples of such actions include home heating, automobile and other vehicle use, electricity generation, processing and manufacturing of goods, and wood burning activities, among others. In addition, actions that result in the disturbance of soil or loss of vegetation can also increase concentrations. Vegetation can affect concentrations in two ways. First, if vegetation is removed prior to maturation, the carbon storing potential is lost and CO_2 can no longer be sequestered in that vegetation. Second, if that vegetation is burned, it will release all of the carbon it has sequestered back into the atmosphere as CO_2. These actions have occurred in the past and are likely still occurring, and will continue to occur in the future at some unknown level.

In analyzing the cumulative impact of the Proposed Action, global, national, and regional greenhouse gas emissions were considered. In 2006, the United States Energy Information Administration (EIA) estimated global GHG emissions at 29,017,000,000 metric tons of CO_2 equivalent (EIA 2009). In 2008, total U.S. greenhouse gas emissions were estimated at 6,956,800,000 metric tons of CO_2 equivalent. Overall, total U.S. emissions have risen by approximately 14 percent from 1990 to 2008. In 2007, the four states within BPA's service territory emitted an estimated 180,060,000 metric tons of CO_2 (see Table 4-3).

Table 4-3. Estimated Annual CO_2 Emissions for Each State in BPA's Service Territory.

State	CO_2 Emissions (metric tons)
Idaho	16,280,000
Montana	37,700,000
Oregon	43,520,000
Washington	82,560,000
Total	**180,060,000**

Source: EPA 2007

As a result of increased greenhouse gas concentrations, the earth's temperature has increased by about 1.5 degrees F over the last century (Karl et al. 2009). Models predict that the warming of the planet will continue and could be as much as 11.5 degrees F warmer by 2100 with the current level of emissions. The effect of increased temperatures include sea level rise due to shrinking glaciers, changes in biodiversity as species try to move into more optimal temperature ranges, early initiation of phonological events, lengthening of growing seasons, and thawing of permafrost (Karl et al. 2009).

In the Northwest region of the United States, statistical data indicates that the annual average temperature has risen about 1.5 degrees F over the past century, with some areas experiencing increases up to 4 degrees F. Many experts believe that this temperature rise is a major contributing factor to the 25 percent reduction in average snowpack in the Northwest over the past 40 to 70 years. A continued decline in snowpack in the mountains will decrease the amount of water available during the warm season. A 25- to 30-day shift in the timing of runoff has been observed in some places, and the trend is expected to continue as the region's average temperature is projected to rise another 3 to 10 degrees F in the 21st century (Karl et al. 2009).

In terms of cumulative impacts to the atmospheric levels of greenhouse gases, any addition, when considered globally, could contribute to long-term significant effects to climate change. However, the concentrations estimated for the Proposed Action, when compared to the regional, national, and global rates, are negligible and comparatively insignificant. National and international efforts to reduce greenhouse gas emissions such as the carbon sequestration markets and the Kyoto Protocol may help reduce the rate of emission. In addition, the ability of the Proposed Action to transmit renewable (non-fossil fuel burning) energy such as wind power by providing additional transmission capacity that allows for better use of renewable energy could be viewed as helping to offset the proposed project's contribution to cumulative greenhouse gas impacts.

Chapter 5
Consultation, Review, and Permit Requirements

This chapter addresses federal statutes, implementing regulations, and Executive Orders and other consultation, review, and permit requirements potentially applicable to the proposed project. This EIS is being sent to Tribes; federal agencies; and regional, state, and local governments as part of the consultation process for this project.

5.1 National Environmental Policy Act (NEPA)

This EIS has been prepared by BPA pursuant to regulations implementing the NEPA (42 USC 4321 et seq.), which requires federal agencies to assess, consider, and disclose the impacts that their actions may have on the environment. BPA has assessed the potential environmental impacts of the proposed project in this EIS, has made this EIS available for public comment, and will consider the potential impacts and public comments when making decisions regarding the proposed project.

5.2 Endangered Species Act (ESA) of 1973

The ESA of 1973 (16 USC 1536) as amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife and plants, and the preservation of the ecosystems on which they depend. The ESA is administered by the USFWS for wildlife and freshwater species and by NOAA Fisheries Service (NOAA Fisheries) for marine and anadromous species. The ESA defines procedures for listing species, designating critical habitat for listed species, and preparing recovery plans. It also specifies prohibited actions and exceptions. Section 7 of the ESA requires federal agencies to ensure that the actions they authorize, fund, and carry out do not jeopardize endangered or threatened species or their critical habitats. A federal agency also is required to consult with USFWS and/or NOAA Fisheries if it is proposing an action that may affect listed species or their designated critical habitat. If listed species or designated critical habitat are present and could be affected by the Proposed Action, Section 7 requires that the federal agency prepare a biological assessment (BA) to analyze the potential effects of the action on listed species and critical habitat and make an effect determination for each species. USFWS and/or NOAA Fisheries review the BA and, if they conclude that the action may adversely affect a listed species or their habitat, issue a biological opinion, which includes a take statement and a list of reasonable and prudent alternatives to follow during construction. If USFWS and/or NOAA Fisheries find that the project may affect, but is not likely to adversely affect a listed species or their habitat, they will issue a letter of concurrence.

BPA reviewed the federal lists of the threatened and endangered fish, wildlife, and plant species that may occur in Klickitat and Wasco counties. From both these lists and field surveys of the proposed project corridors conducted during fall 2009 and spring 2010, BPA determined that four federally protected fish species—Chinook salmon, steelhead, sockeye salmon, and bull trout—had the potential to occur in the project area, primarily along their migration route in the Columbia River. No federally protected wildlife or plant species were determined to have the potential to occur in the project area.

The assessment of potential occurrences of threatened and endangered plant, animal, and fish species and their habitats, and potential impacts to these species from the proposed project, are discussed in Sections 3.3 Vegetation, 3.6 Wildlife, and 3.7 Fish. Since no federally listed wildlife and plant species were found in the project area, and since BPA determined there would be no impacts on protected fish species and their critical habitat, consultation with USFWS and NOAA Fisheries under Section 7 of the ESA is not required.

5.3 Fish and Wildlife Conservation Act of 1980

This federal act (16 USC §§ 2901 et seq.) encourages federal agencies to conserve and promote the conservation of nongame fish and wildlife species and their habitats. In addition, the Fish and Wildlife Coordination Act (16 USC 661 et seq.) requires federal agencies undertaking projects on water resources to consult with the USFWS and the state agency responsible for fish and wildlife resources.

No federally threatened or endangered species would be impacted by the proposed project, and there would be no major impacts on water resources. Therefore, no consultation would be necessary. Mitigation designed to avoid and minimize impacts to fish and wildlife and their habitats are identified in Sections 3.6 Wildlife and 3.7 Fish.

5.4 Magnuson-Stevens Fishery Conservation and Management Act

Under Section 305(b) (4) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), NOAA Fisheries is required to provide essential fish habitat (EFH) conservation and enhancement recommendations to federal and state agencies for actions that adversely affect EFH. EFH includes all streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon.

Wherever possible, NOAA Fisheries uses existing interagency coordination processes to fulfill EFH consultations with federal agencies. EFH occurs in Fifteenmile Creek and the Columbia River, in which no impacts have been identified as part of this project. Towers would be set back at least 400 feet from Fifteenmile Creek and 300 feet from the Columbia River. No towers would be within the 100-year floodplain of Fifteenmile Creek or the Columbia River. Additionally, no new access roads would be constructed across either stream. Thus, there would be no impacts on EFH.

5.5 Migratory Bird Treaty Act of 1918

This act implements various treaties and conventions between the United States and other countries, including Canada, Japan, Mexico, and the former Soviet Union, for the protection of migratory birds (16 USC 703-712, July 3, 1918, as amended 1936, 1960, 1968, 1969, 1974, 1978, 1986, and 1989). Under the act, taking, killing, or possessing migratory birds, their eggs, or nests is unlawful. Most species of birds are classified as migratory under the act, except for upland and nonnative birds such as pheasant, chukar, gray partridge, house sparrow, and European starling.

The proposed project may impact migratory birds through increased potential for power line collisions, loss of habitat, potential disruption of navigational mechanisms by EMF, and potential disruption of breeding if temporary construction activities occur during the breeding season. Potential impacts on migratory birds and mitigation measures are discussed in Sections 3.6 Wildlife and 3.7 Fish. In accordance with the Memorandum of Understanding signed in 2006 between USFWS and the U.S. Department of Energy, BPA will consult with USFWS to ensure appropriate mitigation measures would be employed to minimize the risk of bird mortality and help promote the conservation of migratory bird populations.

5.6 Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act of 1940 prohibits the taking or possessing of and commerce in bald and golden eagles, with limited exceptions (16 USC 668-668d, June 8, 1940, as amended 1959, 1962, 1972, and 1978). The Act only covers intentional acts or acts in "wanton disregard" of the safety of bald or golden eagles. Because a small number of both bald and golden eagles may reside within foraging distance of the project area, there is a remote possibility some mortality could result to either bald and/or golden eagles. However, because the Bald Eagle and Golden Eagle Protection Act only covers intentional acts, or acts in "wanton disregard" of the safety of bald or golden eagles, this project is not viewed as subject to its compliance.

5.7 Federal Noxious Weed Act

This federal act, as amended in 2009, directs federal agencies to manage undesirable plant species on federal lands when management programs for those species are in place on state or private land in the same area (7 USC § 2814) (1990). Undesirable plant species are defined as those that are classified as undesirable, noxious, harmful, exotic, injurious, or poisonous, pursuant to state or federal law. A noxious weed list (7 CFR 360.200) is developed by the Secretary of Agriculture, which lists noxious weeds (as defined by the Plant Protection Act) that are subject to restrictions on interstate movement (7 USC § 7712). BPA will conduct surveys for undesirable plant species included on the federal noxious weed lists and included on Oregon and Washington state and county lists.

Construction and maintenance activities would create some risk of spreading undesirable plant species in the project area in Wasco and Klickitat counties. If privately- or state-managed undesirable plant species are found or spread as a result of transmission line construction or maintenance, BPA will coordinate with the state, county, and/or landowner regarding their control or eradication (BPA 2000). See Section 3.3 Vegetation for a discussion of species, impacts, and mitigation measures.

5.8 Clean Air Act

The Clean Air Act as revised in 1990 (PL 101-542, 42 USC §7401) requires EPA and the states to carry out programs intended to ensure attainment of National Ambient Air Quality Standards. The EPA is authorized to establish air quality standards for six "criteria" air pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM-2.5, PM-10), and sulfur dioxide. The EPA uses these six criteria pollutants as indicators of air quality. EPA has established National Ambient Air Quality Standards (NAAQS) for each criteria pollutant, which define the maximum legally allowable concentration. If the NAAQS for a pollutant is exceeded, adverse effects on human health may occur. When an area exceeds these standards, it is designated as a nonattainment area. Pollution control measures are mandated for federal actions in nonattainment areas.

A nonattainment area can be listed for any one, or more, of the criteria pollutants. An area that was once a nonattainment area, but has since improved its air quality enough so that it now meets the EPA established air quality standards, is up-graded to a maintenance area designation. Maintenance areas also have pollution controls imposed on them, but because the air quality is not as poor as in nonattainment areas, the control standards are not as strict in maintenance areas. All other areas not listed by the EPA for air quality degradation are considered attainment areas. The General Conformity Requirements of the Code of Federal Regulations require that federal actions do not interfere with state programs to improve air quality in nonattainment areas. There are no nonattainment areas in the vicinity of the project.

Of the six criteria air pollutants, PM is the main concern of the transmission line and substation construction activities. PM-10 are particles with an aerodynamic diameter smaller than 10 micrometers (µm) and include: "dust, dirt, soot, smoke, and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust" (EPA 2003). PM-2.5 are "fine particles" with an aerodynamic diameter smaller than 2.5 µm. PM-2.5 particles can be "directly emitted from sources such as forest fires or they can form when gases emitted from power plants, industry and automobiles react in the air" (EPA 2006).

In the project vicinity, authority for ensuring compliance with the Clean Air Act is delegated to DEQ and Ecology (Central Region and Eastern Region). Each of these agencies has regulations requiring all industrial activities (including construction projects) to minimize windblown fugitive dust. Chapter 70.94 RCW-Washington Clean Air Act and Chapter 173-400 Washington Administrative Code (WAC) require owners and operators of fugitive dust sources to prevent fugitive dust from becoming airborne and to maintain and operate sources to minimize emissions.

Air quality impacts from fugitive dust and emissions of the proposed project would be low, as discussed in Section 3.13 Air Quality.

5.9 Greenhouse Gases

Executive Orders 13423 and 13514 require federal agencies to measure, manage, and reduce greenhouse gas emissions by agency-defined target amounts and dates (The White House 2009). BPA is currently developing a Sustainability Action Plan, which addresses managing and reducing greenhouse gas emissions by the agency. The proposed project would remove carbon sequesters (trees and other vegetation) and generate emissions of gases (such as carbon dioxide) that contribute to global warming. The removal of vegetation would result in a net reduction in the collectors of carbon in the project area. However, because the amount of clearing would be relatively small, and because low-growing vegetation would regrow in cleared areas, this loss would be small. Construction of the project would be estimated to produce about 409 metric tons in greenhouse gas emissions over the course of 1 year, and operation and maintenance of the line would be expected to produce about 0.7 metric tons per year. These emissions would be well beneath the threshold of EPA's mandatory reporting threshold. Based on these estimates, the proposed project's contribution to greenhouse gas levels in the atmosphere would be ***low***. See Section 3.14 Greenhouse Gases for the complete analysis and discussion.

5.10 Clean Water Act

The Federal Water Pollution Control Act (popularly known as the Clean Water Act) (33 USC §§ 1251 et seq.), regulates discharges into waters of the United States. Implementation of the project would require a permit pursuant to the Clean Water Act as regulated by the Corps for the placement of fill in and the potential disturbance of wetlands and other waters of the United States. Clean Water Act provisions are implemented by the DEQ under Oregon Administrative Rules (OAR) 340 Divisions 41, 42, and 45; and Ecology (RCW 90.48). For Section 404 and 401 verification and approval, project information should be submitted jointly to the Corps and the Oregon DEQ using the Joint Permit Application, and to the Corps and Ecology using the Joint Aquatic Resources Permit. Requirements for implementation of the Clean Water Act in Oregon and Washington are described as follows:

Section 401 of the Clean Water Act requires applicants to seek a federal permit to conduct an activity that results in a discharge into waters of the United States, including wetlands. This permit is issued only after the affected state certifies that existing water quality standards would not be violated. BPA would potentially be putting fill into wetlands; therefore, permits would be obtained as required. Section 401 requires applicants for Section 404 permits to obtain a Section 401 Water Quality Certification from the certifying agency (DEQ). Application for, and granting of, a construction stormwater permit fulfills most of the application requirements for a Section 401 certification.

Section 402 National Pollutant Discharge Elimination System (NPDES) requires an entity to obtain a permit for discharges of pollutants into navigable waters of the state. In Oregon, NPDES stormwater regulations require the notification of DEQ for ground disturbance activities greater than 1 acre. State regulations require the use of BMPs for control of erosion, stormwater discharges, and non-stormwater discharges to waters of the state. The BMPs, including depiction of structural BMPs on grading plans and in specifications, must be documented in an Erosion and Sediment Control Plan. This plan must be adhered to or appropriately modified during construction. If sufficient quantities of hydrocarbons or other regulated liquids are maintained on site, a Spill Prevention, Control, and Countermeasures Plan could also be required.

In Washington, NPDES construction stormwater permits also require notification to Ecology in advance of ground disturbing activities of 1 acre or more. Stormwater controls must be developed to address during and post-construction erosion control, treatment and discharge of dewatering water (if any), and other construction-related activities that could affect receiving water quality. These controls must be documented in a SWPPP. The SWPPP is developed during final project design, adapted by the contractor prior to construction, and revised onsite as necessary. A copy of the SWPPP is maintained onsite during construction and is a basis for environmental compliance inspection during construction. The BMPs specified in the SWPPP must be inspected periodically by a state-certified inspector. Sampling and analysis of stormwater runoff is required to demonstrate compliance with discharge limits.

Section 404 requires authorization from the Corps when there is a discharge of dredged or fill material into waters of the United States, which include wetlands. As discussed in Section 3.5 Water Resources and Wetlands, the placement of towers and roads may require filling more than 0.1 acre each of a number of wetlands (although no more than 0.5 acre each). BPA will coordinate with the Corps concerning the proposed project and its potential impacts on waters of the United States.

Section 303d requires the development of total TMDLs for the Miles Creek subbasin—which includes Fifteenmile Creek—and the Little Klickitat River basin. The TMDL implementation plan for the Miles Creek subbasin that includes Fifteenmile Creek requires the tracking of, and measuring progress toward, reducing instream temperatures. This includes tracking disturbance within the riparian corridor and reducing or mitigating such disturbance. Impairment of water quality from sedimentation in Fifteenmile Creek limits new discharges of this pollutant to the creek. The TMDL implementation plan for the Little Klickitat River basin requires the tracking of, and measuring progress toward, reducing instream temperatures. This includes tracking disturbance within the riparian corridor and reducing or mitigating such disturbance.

If sufficient quantities of hydrocarbons or other regulated liquids are maintained on site, a Spill Prevention, Control, and Countermeasures Plan could also be required according to state regulations (40 CFR 112). The plan must be adhered to during construction.

5.11 Floodplains and Wetlands (Executive Orders 11988 and 11990)

The U.S. Department of Energy mandates that impacts to floodplains and wetlands be assessed and alternatives for protection of these resources be evaluated in accordance with Executive Orders 11988 and 11990, along with the *Compliance with Floodplain/Wetlands Environmental Review Requirements* (10 CFR 1022.12).

No towers or new access roads would be built in any floodplains. There are eight perennial streams that intersect with the route alternatives being considered. These streams range from having deeply incised channels to low gradient, meandering channel patterns. Associated floodplains are generally limited to narrow riparian fringes. An existing access road would need to be upgraded within the 100-year floodplain of Fifteenmile Creek in Oregon, which could mean slightly more compacted soil along the road, but no change in grade or water storage capability. Approximately 0.8–1.2, 1.0, and 0.5 acres of wetlands along the West, Middle, and East alternatives, respectively, would be permanently impacted by towers and access roads. About 0.8–1.8, 0.4–0.7, and 0.4 acres of wetlands along the West, Middle, and East alternatives, respectively, would be temporarily impacted by construction. Impacts on and mitigation for streams, floodplains, and wetlands are discussed in Section 3.5 Water Resources and Wetlands.

5.12 Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act of 1899 (33 USC § 403) regulates all work done in or structures placed below the ordinary high water mark of navigable waters of the United States.

No work associated with the proposed project would occur in such water bodies. However, the proposed project includes conductors that would span the navigable waters of the Columbia River, a "water of the United States" as defined in the Rivers and Harbors Act. Pursuant to the implementing regulations for Section 10, Section 10 permits are required for power transmission lines crossing navigable waters of the United States unless those lines are part of a water power project subject to the regulatory authorities of the U.S. Department of Energy under the Federal Power Act of 1920 (33 CFR §322). Therefore, a Section 10 permit would likely be required for this project.

5.13 Hazardous Materials

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 USC §6901 et seq. [1976]), as amended, is designed to provide a program for managing and controlling hazardous waste by imposing requirements on generators and transporters of this waste, and on owners and operators of treatment, storage, and disposal (TSD) facilities. Each TSD facility owner or operator is required to have a permit issued by EPA or the state.

Small amounts of hazardous wastes may be generated by the proposed project (paint products, motor and lubricating oils, herbicides, solvents, etc.) during construction or operation and maintenance. These materials would be disposed of according to state law and the RCRA.

Each of the action alternatives could generate a large amount of solid waste for tower options that involve the teardown of existing lines. Most of the poles and cross arms removed from the 115-kV Chenoweth-Goldendale line were likely treated with a wood preservative (creosote or pentachlorophenol), listed as hazardous waste under RCRA. Removing any existing 230- or 345-kV lines for double-circuiting segments of the proposed routes would create metal waste. These materials would be disposed of according to state law (see Section 5.13.2) and RCRA.

Toxic Substances Control Act

The Toxic Substances Control Act (15 USC §2601 et seq. [1976]) is intended to protect human health and the environment from toxic chemicals. Section 6 of the Act regulates the use, storage, and disposal of PCBs. BPA adopted guidelines to ensure that PCBs are not introduced into the environment. Equipment used for this project will not contain PCBs. Any equipment removed that may have PCBs will be handled according to the disposal provisions of this Act.

Federal Insecticide, Fungicide and Rodenticide Act

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (77 USC §136 et seq. [1996]) registers and regulates pesticides. BPA limits it use of herbicides (a kind of pesticide) and uses herbicides only under controlled circumstances. Herbicides are used on transmission line rights-of-way and in substation yards to control vegetation, including noxious weeds. When BPA uses herbicides, the date, dose, and chemical used are recorded and reported to state government officials. Herbicide containers are disposed of according to RCRA standards.

5.14 Cultural Resources

Preserving cultural resources allows Americans to have an understanding and appreciation of their origins and history. A cultural resource is an object, structure, building, site or district that provides irreplaceable evidence of natural or human history of national, state or local significance. Cultural resources include National Landmarks, archeological sites, properties of traditional religious and cultural importance to a Native American Tribe (also known as Traditional Cultural Properties), and other properties listed (or eligible for listing) on the National Register of Historic Places. In addition, American Indian Tribes have rights under specific laws, as well as the opportunity to voice concerns about issues under these laws when their aboriginal territory falls within a proposed project area.

Laws and other directives for the management of cultural resources include

- National Historic Preservation Act (NHPA) of 1966 (16 USC 470 et seq.), as amended, inclusive of Section 106
- Executive Order 13007 Indian Sacred Sites
- American Indian Religions Freedom Act of 1978 (PL 95-341, 92 Stat. 469, 42 USC 1996, 1996a)
- Antiquities Act of 1906 (16 USC 431-433)
- Historic Sites Act of 1935 (16 USC 461-467)
- Archaeological Data Preservation Act (ADPA) of 1974 (16 USC 469 a-c)
- Archaeological Resources Protection Act (ARPA) of 1979 (16 USC 470 et seq.), as amended
- Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.)

Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment. Historic properties are properties that are included in the National Register of Historic Places or that meet the criteria for the National Register. If a federal agency plans to undertake a type of activity that could affect historic properties, it must consult with the appropriate State Historic Preservation Officer (SHPO) and/or Tribal Historic Preservation Officer (THPO) to make an assessment of adverse effects on identified historic properties. BPA's 1996 government-to-government agreement with 13 federally-recognized Native American Tribes of the Columbia River basin provides guidance for the Section 106 consultation process with the Tribes.

The NHPA amendments specify that properties of traditional religious and cultural importance to a Native American Tribe (also known as TCPs) may be determined to be eligible for inclusion on the National Register of Historic Places. In carrying out its responsibilities under Section 106, a federal agency is required to consult with any Native American Tribe that attaches religious or cultural significance to any such properties. NAGPRA requires consultation with appropriate Native American Tribal authorities prior to the excavation of human remains or cultural items (including funerary objects, sacred objects, and cultural patrimony) on federal lands or for projects that receive federal funding. NAGPRA recognizes Native American ownership interests in some human remains and cultural items found on federal lands and makes illegal the sale or purchase of Native American human remains, whether or not they derive from federal or Indian land. Repatriation, on request, to the culturally affiliated tribe is required for human remains.

Executive Order 13007 addresses "Indian sacred sites" on federal and tribal land. "Sacred site" means any specific, discrete, narrowly delineated location on federal land that is identified by a Tribe, or a Tribal individual determined to be any appropriately authoritative representative of a Native American religion. The site is sacred by virtue of its established religious significance to, or ceremonial use by, a Native American religion, provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site. This order calls on agencies to do what they can to avoid physical damage to such sites, accommodate access to and ceremonial use of Tribal sacred sites, facilitate consultation with appropriate Native American Tribes and religious leaders, and expedite resolution of disputes relating to agency action on federal lands. The American Indian Religious Freedom Act protects and preserves to American Indians their inherent right of freedom to believe, express, and exercise traditional religions.

In addition to these various laws and directives, the federal government has general trust responsibilities to Tribes under a government-to-government relationship to insure that their reserved rights are protected. Ongoing consultation with the [Tribes] ensures that their rights are protected.

BPA Tribal Policy follows the Department of Energy's American Indian Policy (DOE Order No. 1230.2—Apr. 8, 1992) and serves as guidelines to BPA and the Tribes throughout the development of their government-to-government relationships.

Throughout the EIS process, BPA has worked to involve and consult with the Tribes in the project area and the relevant agencies according to the applicable laws and responsibilities. These include the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of Warm Springs, the Nez Perce Tribe, and the Yakama Nation, as well as the State Historic Preservation Officers for Washington and Oregon and the Advisory Council on Historic Preservation. Tribal lands crossed by the action alternatives consist primarily of private properties owned by tribal members. In addition, the alternative to extend the fiber optic cable to BPA's Wautoma Substation would cross through the Yakama Indian Reservation.

The Tribes have not requested formal government-to-government consultation meetings to date.

Construction of the transmission line and related facilities could potentially affect historic properties and other cultural resources. A cultural resources survey of the corridor was conducted to determine if any cultural resources are present and would be impacted. Eleven cultural resource sites are within the West Alternative's potential right-of-way, although it would be able to avoid all but one of the larger sites and all burial areas. Nine and ten sites are within the Middle and East alternatives' potential rights-of-way, respectively, but would all be avoided. The Middle and East alternatives also cross over an Oregon Trail segment at two points, but straddle both identified segments, resulting in no physical impacts. (See Section 3.8 Cultural Resources of this EIS for more detail). Surveys completed before construction would help further identify sites that may be impacted if they could not be avoided. If, during construction, previously unidentified cultural resources that would be adversely affected by the proposed project are found, BPA would follow all required procedures set forth in the NHPA, NAGPRA, ARPA, and the American Indian Religious Freedom Act. Also, if some sites cannot be avoided, BPA will consult with federal and state agency landowners and the Oregon or Washington SHPO to determine if those sites are eligible for a listing under the NRHP. If they are, then in consultation with the appropriate federal and state agency landowners, SHPO, and/or the affected tribe's THPO, effects will be evaluated and appropriate mitigation applied.

5.15 Federal Aviation Administration Review

As part of transmission line design, BPA seeks to comply with Federal Aviation Administration (FAA) procedures. According to FAR 49 CFR Part 77.13, the FAA requires BPA to submit its designs for FAA approval if a proposed structure is taller than 200 feet from the ground or water surface where the line crosses a body of water, if a conductor is 200 feet above the ground or water surface where the line crosses a body of water, or if any part of the proposed transmission line and/or its structure are within a prescribed distance of an airport. According to FAR 49 CFR Part 77.17, BPA must submit Form 7460-1 (Notice of Proposed Construction or Alteration) for a preliminary transmission line design and receive conditional approval at least 30 days prior to construction. The FAA would then conduct its own study of the project and make recommendations to BPA for airway marking and lighting. General BPA policy is to follow FAA recommendations. At this time, BPA has provided preliminary locations of towers to FAA, which has determined that there are a number of towers along all action alternatives that would require marking and lighting. See Section 3.1 Land Use and Recreation for locations.

5.16 National Trails System Act

Lewis and Clark National Historic Trail. This trail was established under the National Trails System Act (16 USC §§ 1241–1249), as designated by Congress, and is administered by the NPS as a component of the National Park System (NPS 2009). All action alternatives would cross over the trail. BPA is consulting with the NPS on issues relating to the trail and the proposed project.

Oregon National Historic Trail. This trail was established under the National Trails System Act (16 USC 1241–1249), as designated by Congress, and is administered by the NPS as a component of the National Park System (NPS 2006). The Middle and East alternatives would likely be visible near trail mile markers 1, 6, or 7 south of the Columbia River.

5.17 Noise Control Act

The Noise Control Act of 1972 as amended (42 USC §4901 et seq.) sets forth a broad goal of protecting all people from noise that jeopardizes their health or welfare. It places principal authority for regulating noise control with states and local communities. Noise standards applicable to the proposed project are established under Chapter 70.107 RCW for the state of Washington, as described in WAC 173-60-049 and WAC 173-60-050; and ORS Chapter 467 (Noise Control) and the OAR Division 35 (Noise Control Regulations) for the state of Oregon. The regulations are administered by Ecology and DEQ. Responsibility for enforcement of applicable regulations is assigned to local governments in both states.

The allowable hourly noise levels under state law, potential noise impacts associated with the project, and proposed mitigation are described in Section 3.11 Noise.

5.18 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, states that each federal agency shall identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low income populations. Minority populations are considered members of the following groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic if the minority population of the affected area exceeds 50 percent, or is meaningfully greater than the minority population in the project area. The Order further stipulates that the agencies conduct their programs and activities in a manner that does not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination because of their race, color, or national origin. An analysis of the project area shows that although there are some populations with higher proportions of minority or low income groups compared to those in the county and/or state, these proportions are much lower than half and do not result in any minority or low income populations being disproportionately affected compared to other races or ethnicities (see Section 3.9 Socioeconomics). In addition, BPA has considered all input from persons or groups regardless of race, income status, or other social and economic characteristics.

5.19 Federal Communications Commission Regulations

Federal Communications Commission regulations require that transmission lines be operated so that radio and televisions reception would not be seriously degraded or repeatedly interrupted. Further, Federal Communications Commission regulations require that the operators of these devices mitigate such interference.

BPA would comply with Federal Communications Commission requirements relating to radio and television interference from the proposed transmission line if any such interference occurs. While none of the action alternatives are expected to increase electromagnetic interference above existing levels, each complaint about electromagnetic interference would be investigated (see Section 3.12 Public Health and Safety).

5.20 Farmland

The Farmland Protection Policy Act (7 USC §§ 4201 et seq.) directs federal agencies to identify the quantity of farmland converted by federal programs, to identify and consider the adverse impacts of federal programs on farmland preservation, to consider alternative actions that could lessen adverse impacts, and to assure that the federal programs are compatible with state and local plans and programs. The Act's purpose is to minimize the number of federal programs that contribute to the unnecessary and irreversible conversion of agricultural land to nonagricultural uses. Three types of farmland are recognized by the Act: prime farmlands, unique farmlands, and farmland of statewide or local importance.

Depending on the tower option chosen, the towers and new access roads would permanently occupy about 37.3–51.8 acres of both prime farmland and farmland of statewide importance along the West Alternative; 26.8–28.1 acres along the Middle Alternative, and 24.4–26.2 acres along the East Alternative. In addition, both Knight Substation sites would convert 10 acres of prime farmland to a nonagricultural use. No unique farmlands are located in the area. Impacts and mitigation measures for reducing impacts to farmland are discussed in Section 3.1 Land Use and Recreation.

5.21 National Scenic Byways Program

The National Scenic Byways Program designates scenic and historic roads as All-American Roads and/or National Scenic Highways based on their scenic, historic, recreational, cultural, archeological, or natural intrinsic qualities (National Scenic Byways Program 2009a). If these roadways no longer possess the intrinsic qualities that supported their designation or they are not maintained in accordance with their corridor management plan, they can be de-designated (Federal Highway Administration 1995). The management and protection of these scenic byways is carried out by the state departments of transportation under the Oregon Scenic Byway Program (OAR 734-032) and the Washington Scenic and Recreational Highways Strategic Plan RCW 47.39), or the USFS (if on USFS-managed lands).

Three highways in the project vicinity are designated as All-American Roads and/or National Scenic Highways according to the National Scenic Byways Program, including SR-14 in Washington, US-30 in Oregon, and US-97 in Oregon. SR-14 and US-30 are also designated as Scenic Travel Corridors through the Columbia River Gorge National Scenic Area Act (see Section 5.22). See Sections 3.1 Land Use and Recreation, and 3.2 Visual Resources for a discussion of visual impacts along these highways.

5.22 Columbia River Gorge National Scenic Area Act

The Columbia River Gorge National Scenic Area Act (Scenic Act) (16 USC 544–544p) was enacted in 1986 to: (1) protect and provide for the enhancement of the scenic, cultural, recreational, and natural resources of the Columbia River Gorge; and (2) protect and support the economy of the Columbia River Gorge area by encouraging growth to occur in existing urban areas and by allowing future economic development. The Scenic Act established the Columbia River Gorge National Scenic Area, which covers nearly 293,000 acres in six Washington and Oregon counties along the Columbia River Gorge. The National Scenic Area extends along the Columbia River from about the confluence of the Columbia and Sandy rivers to just past the village of Wishram, Washington, about 85 miles to the east.

The National Scenic Area is categorized into three areas: Special Management Areas (SMA), General Management Areas (GMA), and Urban Areas. Areas categorized as SMA contain the most sensitive resources and comprise about 114,600 acres of the National Scenic Area. Areas categorized as GMA include a mixture of historic land uses such as farming, logging and cattle grazing. The Columbia River itself is currently designated GMA as well. GMA lands comprise about 149,400 acres of the National Scenic Area. Development and use of SMA and GMA lands is guided by Columbia River Gorge National Scenic Area Management Plan (Management Plan), which was originally adopted in 1991 and updated in 2007.

The remainder of the National Scenic Area is categorized as Urban Areas. These Urban Areas are exempt from National Scenic Area regulations and the Management Plan. There are 13 designated Urban Areas in the National Scenic Area: Cascade Locks, Hood River, Mosier and The Dalles in Oregon; and North Bonneville, Stevenson, Carson, Home Valley, White Salmon, Bingen, Lyle, Dallesport and Wishram in Washington.

The National Scenic Area is managed on a partnership basis by the Columbia River Gorge Commission, the states of Oregon and Washington, the six counties with land in the National Scenic Area, and the USFS. The Gorge Commission is a bi-state Compact regional planning agency that was authorized by the Scenic Act and created by Washington and Oregon legislation in 1987. The Gorge Commission has several responsibilities under the Act, including planning for the National Scenic Area, implementation of the Management Plan, and monitoring and hearing appeals of land use decisions. The local counties and the Gorge Commission also are responsible for drafting and enforcing land-use ordinances to implement the Management Plan, and for administering development on GMA lands in the National Scenic Area. The USFS's primary role in the National Scenic Area is administering SMA lands, managing 71,000 acres of national forest land, and determining consistency of proposed federal actions in the National Scenic Area with the Scenic Act. Four tribal governments with interests in the National Scenic Area also play an important role in implementing the Management Plan and protecting cultural resources.

Although the Scenic Act provides a comprehensive scheme for regulation of development within the National Scenic Area, the Scenic Act does provide several express exemptions from its provisions for certain uses, activities, and rights. Relevant to the proposed project, the Scenic Act states that:

Nothing in [this Act] shall . . . affect or modify the ability of the Bonneville Power Administration to operate, maintain, and modify existing transmission facilities. See 16 USC 544o(a)(5).

Consistent with this exemption, none of the provisions of the National Scenic Act, Management Plan, or any other National Scenic Area regulations can be applied in such a way as to affect BPA's operation and maintenance of its existing transmission lines and associated facilities, or any planned or proposed modification by BPA of these facilities. In addition to this BPA-specific exemption, the Act states that:

Nothing in [this Act] shall . . . establish protective perimeters or buffer zones around the scenic area or each special management area. The fact that activities or uses inconsistent with the management directives for the scenic area or special management areas can be seen or heard from these areas shall not, of itself, preclude such activities or uses up to the boundaries of the scenic area or special management areas. See 16 USC 544o(a)(10).

Accordingly, the provisions of the Management Plan and other National Scenic Area regulations are considered to apply only to lands actually within the boundaries of the National Scenic Area.

Because the proposed project is a federal project, the USFS is the responsible entity under the Scenic Act for carrying out review of the project under the Scenic Act. Through this review, the USFS will make a determination concerning the consistency of the portion of the proposed project that would be located in the National Scenic Area with the Scenic Act, as well as with applicable provisions of the Management Plan and any other applicable National Scenic Area regulations. Please see Chapter 7 for a discussion of the consistency of the proposed project with the Management Plan.

5.23 National Forest Management Act

The Middle and West alternatives would cross USFS lands. Any new or additional right-of-way for the transmission line and associated access roads on these federal lands could require issuance of a Special Use Permit by the USFS under the National Forest Management Act. BPA would obtain real property rights as appropriate for these public lands. BPA will continue to coordinate with the USFS concerning potential permitting requirements.

5.24 State, Area-Wide, and Local Plan and Program Consistency

The proposed project crosses through two counties in two states: Wasco County in Oregon and Klickitat County in Washington. Depending on the action alternative, from 2 to 7 miles are located in the state of Oregon, and from 20 to 24 miles in the state of Washington. The Wautoma Option for the fiber optic cable would pass through Klickitat, Yakima, and Benton counties in Washington for an additional 72 miles.

CEQ regulations for implementing NEPA require EISs to discuss possible conflicts and inconsistencies of a proposed action with approved state and local plans and laws. The proposed project would be undertaken solely by BPA, which is a federal entity. Pursuant to the federal supremacy clause of the U.S. Constitution, BPA is not obligated to apply for local development or use permits in such circumstances. Therefore, BPA would not make formal application to any of the local jurisdictions for permits such as conditional use permits or shoreline development permits. However, BPA is committed to plan the project to meet or exceed the substantive standards and policies of state and local land use plans and programs to the extent practicable, and would provide the local jurisdictions with information relevant to these permits. (BPA would apply for county shoreline permits if the provisions of the Federal Water Pollution Control Act apply, such as for discharges into waters of the United States). Additional information on the project's consistency with state substantive standards is provided in Chapter 6 of this EIS.

The following section discusses possible conflicts or inconsistencies of the proposed project with Wasco County Comprehensive Plan Goals and Zoning Ordinances, Klickitat County Comprehensive Plan Goals and Zoning Ordinances, several other land use plans relevant to the project in Klickitat County, Critical Area Ordinances, and Transportation Permitting requirements. Oregon Statewide Planning Goals are accounted for in the Wasco County Comprehensive Plan Goals, and Washington does not have a specific state land use plan.

5.24.1 Oregon Land Use Planning

Wasco County Comprehensive Plan Goals

The following land use goals of the Wasco County Comprehensive Plan are relevant to the proposed project:

- Goal #3 – Agricultural Lands: To preserve and maintain agricultural lands (see Policy 1A).
- Goal #4 – Forest Lands: To conserve forest lands by maintaining the forest land base and to protect the state's forest economy by making possible economically efficient forest practices that assure the continuous growing and harvesting of forest tree species as the leasing use on forest land consistent with sound management of soil, air, water and fish and wildlife resources and to provide for recreational opportunities and agriculture (see Policy 3A).
- Goal #5 – Open Spaces, Scenic and Historic Areas and Natural Resources: To preserve open space and protect natural and scenic resources (see Policies 7A, 9C and D, and 10B and E).
- Goal #6 – Air, Water, and Land Resources Quality: To maintain and improve the quality of the air, water and land resources of the County (see Policies 1B and C; 3A, C, E, and H; and 4A–C).
- Goal #7 – Areas Subject to Natural Disasters and Hazards: To protect life and property from natural disasters and hazards (see Policies 1B, C, and E; and 2A, B, and D).
- Goal #9 – Economy of the State: To diversify and improve the economy of Wasco County (see Policies 1A–C, 3, and 5A–C).
- Goal #13 – Energy Conservation: To conserve energy (see Policies 1 and 2A).

In most cases, the design, construction, and placement of the proposed project would be consistent with these goals. However, there are a few instances in which the project may be inconsistent.

Regarding Goal #3 and #9, the project would remove a relatively small amount of agricultural land from production and convert it to the nonagricultural use of towers and access roads. However, wherever possible, BPA would allow the right-of-way to continue to be farmed (see Section 3.1 Land Use and Recreation for impacted acreages). From an economic standpoint, landowners would be compensated for land rights, and project construction would have a temporary positive impact on the economy. Therefore, the overall negative impact on the economy of Wasco County would be small (see Section 3.9 Socioeconomics).

Regarding Goal #4, none of the action alternatives are routed through land designated by Wasco County as forest land, and very few trees would be removed from the right-of-way (see Section 3.3 Vegetation).

The proposed project would conflict somewhat with Goal #5, since a small amount of wildlife habitat would be negatively impacted either temporarily due to construction disturbance or permanently through placement of towers or access roads (see Section 3.6 Wildlife). Affected habitats could include small amounts of riparian and wetland habitat as well as sensitive bird habitat sites. However, towers and roads would be placed further than 100 feet outside of the mean high water mark of streams and lakes, and no wetlands identified on the National Wetlands Inventory maps would be impacted in Wasco County. The proposed project could adversely affect the scenic attributes of the National Scenic Area, two scenic byways, the Lewis and Clark Historic Trail, and the Historic Oregon Trail (see Section 3.2 Visual Resources). No conflicts would be expected with the policy regarding historic, cultural, or archaeological resources (see Section 3.8 Cultural Resources).

The project would be consistent with Goals #6, 7, and 13 (for Goal #6, see Sections 3.4 Geology and Soils, 3.5 Water Resources and Wetlands, 3.11 Noise, and 3.13 Air Quality; for Goal #7, see Sections 3.4 Geology and Soils and 3.5 Water Resources and Wetlands; and for Goal #13, see Chapter 1 Purpose of and Need for Action).

Wasco County Zoning Ordinance

The Exclusive Farm Use Zone is the only land use zone that is crossed by the proposed project in Wasco County (see Map 5-1). Within this zone, a new transmission line would be permitted subject to standards, except for those towers over 200 feet tall, which would be a conditional use. Both would typically require review and approval by the county. While BPA would not apply for a permit, the EIS would be provided to the County, and the project would be designed to meet the standards set forth by the County insofar as is feasible. The project would, therefore, be generally consistent with Wasco County's zoning ordinance.

5.24.2 Washington Land Use Planning

Klickitat County Comprehensive Plan Goals

The following land use goals of the Klickitat County Comprehensive Plan are relevant to the proposed project:

- To maintain and enhance Klickitat County's natural resource base (see Policy 1).
- To promote provision of utilities sufficient to protect the public health and welfare (see Policies 7, 9, and 14).
- To preserve open space for its community-shaping, recreational and ecological value (see Policy 1).

In most cases, the design, construction, and placement of the proposed transmission line and substation for all action alternatives would be consistent with these goals. However, there are a few instances in which the project may be inconsistent.

Regarding Klickitat County's natural resource base, all action alternatives would remove a relatively small amount of agricultural land from production and convert it to the nonagricultural use of towers and access roads (see Section 3.1 Land Use and Recreation for impacted acreages). However, wherever possible, BPA would allow the right-of-way to continue to be farmed. From an economic standpoint, landowners would be compensated for land rights, and project construction would have a temporary positive impact on the economy. Therefore, the overall negative impact on the economy of Klickitat County would be small (see Section 3.9 Socioeconomics).

The proposed project would be generally consistent with the goal regarding the provision of utilities, although underground high-voltage transmission lines would not be feasible (see Chapter 2 Proposed Action and Alternatives)—one of the policies of the goal that is desired when possible. All action alternatives would use at least 9 miles of existing utility right-of-way, allowing BPA to consolidate the location of new and existing transmission infrastructure. In addition, the project would be consistent with the objective of fostering energy production in the county, as the project would increase transmission system capacity.

All action alternatives cross land zoned by Klickitat County as open space (see Map 5-1), which conflicts with the third goal stated above. Some open space would be converted to towers and access roads; however, the converted acreage would be minimal when compared to the total amount of zoned open space in Klickitat County. For the length of the transmission line, the land within the right-of-way would be left in its natural condition as much as possible except where trees would need to be removed for safety. Mitigation measures would be applied to restore disturbed vegetation and minimize impacts on open space areas.

Klickitat County Zoning Ordinance

The project area crosses seven Klickitat County zoning districts, shown in Map 5-1. Table 5-1 lists the zoning districts crossed by the project area and whether transmission lines are a permitted, prohibited, or conditional use in each zone.

Table 5-1. Klickitat County Zoning In the Project Area

Zoning District	Approximate Line Miles	Permitted Use
Extensive Agriculture	W12–Knight Substation; M11–Knight Substation; E15–Knight Substation	Conditional
General Commercial	E14	Conditional
General Industrial	W4	Permitted
Industrial Park	W3–W4	Conditional
Open Space	W5–W11; M8/E8; M9–M11; E9–E15	Conditional
Rural Center	M9/E9	Conditional
Rural Residential	W4–W5	Conditional

Utility facilities are not expressly prohibited in any of the zoning districts that fall within the project area. Furthermore, much of the project area falls within the Energy Overlay Zone, including the area adjacent to the National Scenic Area. The Energy Overly Zone is an area in which wind turbines and solar energy facilities are permitted outright, along with supporting utility and utility infrastructure, although projects are to obtain a permit from the Klickitat County Planning Department to ensure compliance with mitigation conditions. While BPA would not apply for a permit, BPA has indicated that the project would be designed to meet the standards set forth by the County insofar as is feasible. The project would, therefore, be generally consistent with Klickitat County's zoning ordinance.

Washington State Parks and Recreation Commission Land Use Plans

Columbia Hills State Park is the only state park crossed by the proposed project (specifically the West Alternative). The West Alternative would cross through a little over 1 mile of the Columbia Hills State Park through portions of the park designated as Resource Recreation (the most common designation), and Natural Area according to the Master Plan for Columbia Hills State Park (Washington State Parks and Recreation Commission 2003). Resource Recreation is a mid-intensity classification intended to allow recreational opportunities of a higher intensity, while still protecting the integrity of the natural landscape. The Natural Area designation is applied to areas identified as supporting rare or sensitive native plants or important wildlife habitat and is intended to emphasize protection and enhancement of the natural environment through increased management efforts. In addition, the proposed right-of-way passes within about 0.3 mile of the Dalles Mountain Ranch, and would pass immediately adjacent to a parking area on the north end of the park, although it would not affect the use of either facility. While the plan does not specifically list allowed and prohibited land uses for these designations, the construction of a high-voltage transmission line through areas designated for protection of sensitive habitat and maintenance of the natural landscape would have the potential to conflict with the Master Plan. (See Sections 3.1 Land Use and Recreation, and 3.3 Vegetation for a discussion of impacts and proposed mitigation measures).

Klickitat County Shoreline Master Plan

This plan regulates usage of shorelines of Washington within Klickitat County, as required by the Washington State Department of Ecology. Klickitat County's Shoreline Master Plan (Shoreline Plan) assigns a shoreline environment designation to each regulated shoreline and established guidelines for development in those areas. Per the legal description contained in the County's 1996 Shoreline Master Plan Update, the shoreline of the Columbia River is designated a Conservancy environment at both of the potential crossing locations proposed for the project. Utility facilities are a conditional use in the Conservancy environment, normally requiring a Shoreline Conditional Use Permit (Klickitat County 2002). While BPA would not apply for a permit, BPA would comply to the extent practicable with any general regulatory standards from the Shoreline Plan. The project would, therefore, be generally consistent with the Shoreline Plan.

Klickitat County Natural Resources State, Federal, and Local Coordination Plan

This plan is concerned with how state and federal agency actions can impact the custom and culture of Klickitat County through its natural resources. The overall intent of the plan is to ensure that state and federal agencies consider impacts on the county's resources, inform the county and its residents of these impacts, mitigate and minimize them to the extent practicable, and coordinate with the County and its adopted plans and ordinances pertaining to natural resource issues. Policies presented in the plan pertain to socioeconomics, forest resources, agriculture, minerals, water resources, energy resources, fish and wildlife, industry and multiple use, recreation, and weed management. Consistent with the requirements of NEPA, this EIS analyzes and proposes mitigation for impacts on most of the resources mentioned excluding minerals, for which no impacts were identified. The proposed project would be generally consistent with the policies described in the plan pertaining to industry and multiple use. In many cases, BPA would allow the proposed transmission line right-of-way to be managed for other uses, such as agriculture. In addition, BPA makes every attempt to minimize impacts and maintain consistency with local plans and ordinances to the extent practicable. See Sections 3.1 Land Use and Recreation, 3.2 Visual Resources, 3.3 Vegetation, 3.5 Water Resources and Wetlands, 3.6 Wildlife, and

3.7 Fish for details on impacts and mitigation. This EIS is also being made available to Klickitat County and the public for review and comment, and BPA will consider those comments in its final analysis and the decision making process.

5.24.3 Critical Areas Ordinances

Counties in Oregon do not have critical areas ordinances that would address potential geologic hazards in the project area. There are no specific plan and program consistency/floodplains and wetlands protection requirements or guidelines issued by the counties with respect to geologic conditions. Current Oregon building codes are specified in ORS 455.010 through 455.895. Geologic hazard regulations are overseen by the Oregon Department of Land Conservation and Development, as defined in ORS 660.015.

In Washington, Klickitat County established their Critical Areas Ordinance (CAO) in 2003, pursuant to the requirements of the Growth Management Act (RCW Chapter 36.70A), and overseen by the Klickitat County Planning Department. The CAO describes the categories of critical areas in the county, setback and buffer distances, mitigation requirements for unavoidable impacts, and guidance for reducing or mitigating hazards to public health and safety in geologically hazardous areas. It identifies five Critical Areas, including Wetlands; Critical Fish/Wildlife Habitat Conservation Areas; Geologically Hazardous Areas, Aquifer Recharge Areas, and Frequently Flooded Areas, and provides standards for classification and designation of significant geologically hazardous areas. The provisions of the Klickitat County CAO apply to all activities, unless exempted, in unincorporated areas of Klickitat County. BPA has incorporated some of the standards and guidance from the CAO in analyzing and proposing mitigation for impacts on potentially critical areas. See Sections 3.4 Geology and Soils, 3.5 Water Resources and Wetlands, 3.6 Wildlife, and 3.7 Fish for descriptions of impacts and mitigation measures.

5.24.4 Transportation

Oregon and Washington Transportation Permits. According to RCW Chapter 46.44 (Size, Weight, Load) and the ORS Chapter 818 (Vehicle Limits), oversized or overweight vehicles will need transportation permits to travel on highways and local public roads in each state.

The construction contractors will consult with WSDOT, Oregon Department of Transportation (ODOT), Klickitat County Public Works Department, and Wasco County Public Works Department to comply with state and local requirements. Necessary transportation permits for oversized or overweight vehicles used for the project construction and maintenance would be secured as required.

In addition, width and/or height restrictions occur on several locations on SR-14 in the project area. During construction, trucks accessing the project sites via SR-14 will likely pass through most of these areas. The construction contractors will use alternative routes for trucks exceeding the restrictions. Restricted areas include the following:

- Mile Post (MP) 19 to MP 83.53. Located southwest of the study area near line mile W3. No loads longer than 125 feet are allowed. A route detour is available via Oregon.
- Lyle Tunnels, MP 76.77 to 76.91. Loads wider than 10 feet are required to have three pilot cars (two front and one rear).
- Cook Underwood Tunnels. No loads wider than 12 feet are allowed. Loads wider than 8.5 to 10 feet are required to have one front pilot car and loads wider than 10 to 12 feet are required to have three pilot cars (two front and one rear).

Chapter 6
Consistency with State Substantive Standards

As discussed in Chapter 4, BPA is a federal agency subject to state regulation only if there has been a waiver of federal sovereign immunity through federal law, consistent with the supremacy clause of the U.S. Constitution. Certain federal laws, such as the Clean Water Act and Clean Air Act, have provided this waiver of federal sovereign immunity, and BPA's activities thus can be regulated by state entities under these laws. In addition, the Federal Land Policy Management Act (FLPMA), 43 USC §1701 et seq., provides a limited waiver of federal sovereign immunity, such that federal agencies including BPA are required to comply with specific substantive provisions for environmental protection that may be identified by states for portions of the federal agency's activities that would be located on federal lands.

Notwithstanding these aspects of federal supremacy, BPA is committed to planning its proposed transmission line projects to be consistent or compatible to the extent practicable with state plans and programs, as well as any substantive standards that these plans and programs may contain, even when not required by federal law. To work towards this goal, BPA typically provides project information relevant to state permitting processes to state entities with a potential interest in the project. In designing and carrying out its proposed projects, BPA also strives to meet or exceed the substantive standards and policies of state regulations.

To further memorialize this approach, BPA entered into a series of Memoranda of Understanding (MOUs) and Memoranda of Agreement (MOAs) in the 1980s with individual Pacific Northwest states concerning BPA's activities in each state. Each MOU called for general cooperation between BPA and each state regarding BPA's activities in that state, and each MOA called for cooperation specifically on the siting of proposed federal transmission facility projects to be located in that state. Each MOA also called for the development of project-specific work plan agreements between BPA and the state for individual BPA transmission line projects to be located in that state.

In the MOU and MOA with the states of Washington and Oregon, the agencies that were designated with the responsibility for entering into and carrying out work plan agreements for each individual BPA transmission line project are the Washington EFSEC and the Oregon DOE. Because the proposed Big Eddy-Knight Transmission Project would be located in both Washington and Oregon, BPA has entered into work plan agreements with the Washington EFSEC and Oregon DOE for this project. Under these agreements, the state agencies have provided BPA with potentially applicable state substantive standards that they believe should be addressed in this EIS to aid state agency review of the proposed project. It is the objective of BPA and Washington EFSEC and Oregon DOE that by identifying and considering these standards as early as possible, the proposed project can be designed to be consistent or compatible with these standards to the maximum extent practicable.

The remainder of this chapter identifies those state substantive standards that are potentially applicable to BPA's proposed project, and evaluates the extent to which the proposed project would be consistent with these standards. This discussion is organized by the state agency that has established each standard, with the standards of each agency further organized by resource topic where appropriate. In most cases, BPA believes that implementation of its own design, construction, and operation standards would serve to meet or exceed the state substantive standard that has been identified. However, in some cases, additional measures may be required to be consistent with a particular state standard. For any state standards where it is likely that consistency cannot be achieved, an explanation is provided.

6.1 Washington EFSEC Standards

Washington EFSEC is the state agency responsible for siting new energy facilities in the state of Washington, including certain thermal power plants, alternative energy facilities, natural gas pipelines, and electrical transmission lines. Washington EFSEC's authority in this area is provided by RCW Chapter 80.50, and is implemented through WAC Title 463.

BPA's proposed transmission lines are not subject to Washington EFSEC's siting jurisdiction except for portions proposed to be located on federal lands. However, BPA will seek to be consistent with Washington EFSEC's substantive standards to the extent practicable, regardless of the proposed project's location on or off federal lands.

The following Washington EFSEC substantive standards from WAC Title 463 (WAC 463-26, 463-60, 463-72, and 463-74) are potentially applicable to the proposed project:

6.1.1 Natural Environment – Energy and Natural Resources

- The application shall describe the rate of use and efficiency of consumption of energy and natural resources during both construction and operation of the proposed facility.
- The application shall describe the sources of supply, locations of use, types, amounts, and availability of energy or resources to be used or consumed during construction and operation of the facility.
- The application shall describe all nonrenewable resources that will be used, made inaccessible or unusable by construction and operation of the facility.
- The application shall describe conservation measures and/or renewable resources that will or could be used during construction and operation of the facility.

Consistency: While BPA does make every effort to comply with state substantive standards, the above standards are not applicable to the proposed project. Information regarding the rate of use and efficiency of consumption of energy and other resources has not been provided in this EIS because BPA is not required to submit an application to Washington EFSEC for construction of the proposed transmission line. Impacts to natural resources are addressed by resource in Chapter 3. Irreversible and Irretrievable Commitment of Resources (i.e., nonrenewable resources) are discussed in Section 3.17.

- The application shall describe any scenic resources which may be affected by the facility or discharges from the facility.

Consistency: Sections 3.1 (Land Use and Recreation) and 3.2 (Visual Resources) describe the proposed project's impact on scenic resources including impacts to recreational areas. Impacts to recreation resources would range from none to moderate. Impacts to scenic resources are assessed in Section 3.2 for the general regional setting, as well as for the National Scenic Gorge and its key viewing areas. There would be no discharges from the transmission line.

6.1.2 Transportation

- Transportation systems. The application shall identify all permanent transportation facilities impacted by the construction and operation of the energy facilities, the nature of the impacts, and the methods to mitigate impacts. Such impact identification, description, and mitigation shall, at least, take into account:
  (a) Expected traffic volumes during construction, based on where the work force is expected to reside;

  (b) Access routes for moving heavy loads, construction materials, or equipment;

  (c) Expected traffic volumes during normal operation of the facility;

  (d) For transmission facilities, anticipated maintenance access; and

  (e) Consistency with local comprehensive transportation plans.
- Vehicular traffic. The application shall describe existing roads, estimate volume, types, and routes of vehicular traffic which will arise from construction and operation of the facility. The applicant shall indicate the applicable standards to be utilized in improving existing roads and in constructing new permanent or temporary roads or access, and shall indicate the final disposition of new roads or access and identify who will maintain them.
- Waterborne, rail, and air traffic. The application shall describe existing railroads and other transportation facilities and indicate what additional access, if any, will be needed during planned construction and operation. The applicant shall indicate the applicable standards to be utilized in improving existing transportation facilities and in constructing new permanent or temporary access facilities, and shall indicate the final disposition of new access facilities and identify who will maintain them.
- Parking. The application shall identify existing and any additional parking areas or facilities which will be needed during construction and operation of the energy facility, and plans for maintenance and runoff control from the parking areas or facilities.
- Movement/circulation of people and goods. The application shall describe any change to the current movement or circulation of people or goods caused by construction or operation of the facility. The application shall indicate consideration of multipurpose utilization of rights of way and describe the measures to be employed to utilize, restore, or rehabilitate disturbed areas. The application shall describe the means proposed to ensure safe utilization of those areas under applicant's control where public access will be granted during project construction, operation, abandonment, termination, or when operations cease.
- Traffic hazards. The application shall identify all hazards to traffic caused by construction or operation of the facility. Except where security restrictions are imposed by the federal government the applicant shall indicate the manner in which fuels and waste products are to be transported to and from the facility, including a designation of the specific routes to be utilized.

Consistency: Construction and improvement of the access road system for the proposed project is discussed in Section 2.3 (Project Components, including Access Roads). Section 3.10 Transportation describes the proposed project’s impact on transportation resources including expected traffic volumes during construction and maintenance, proposed access routes during construction and maintenance, and possible impacts on local traffic during construction. The movement or circulation of people or goods would not be impacted by the proposed project. Potential impacts to waterborne, rail, and air traffic are also addressed in Section 3.10. Road use during construction and operation of the line would comply with regional transportation plans as discussed in Section 3.10. Access roads constructed and used during line construction would also be used during maintenance of the transmission line. Fuel would be transported to work sites using the same access roads discussed in Chapter 2 and Section 3.10. Staging areas that would be used to store construction materials and vehicles are discussed in Section 2.3.

6.1.3 Socioeconomics

- The application shall include a detailed socioeconomic impact analysis which identifies primary, secondary, and positive as well as negative impacts on the socioeconomic environment in the area potentially affected by the project, with particular attention to the impact of the proposed facility on population, work force, property values, housing, health facilities and services, education facilities, governmental services, and local economy. The study area shall include the area that may be affected by employment within a 1-hour commute distance of the project site. The analysis shall use the most recent data as published by the U.S. Census or state of Washington sources.
- The analysis shall include the following:

  (a) Population and growth rate data for the most current 10-year period for the county or counties and incorporated cities in the study area;

  (b) Published forecast population figures for the study area for both the construction and operations periods;

  (c) Numbers and percentages describing the race/ethnic composition of the cities and counties in the study area;

  (d) Average per capita and household incomes, including the number and percentage of the population below the poverty level for the cities and counties within the study area;

  (e) A description of whether or not any minority or low-income populations would be displaced by this project or disproportionately impacted;

  (f) The average annual work force size, total number of employed workers, and the number and percentage of unemployed workers including the year that data are most recently available. Employment numbers and percentage of the total work force should be provided for the primary employment sectors;

  (g) An estimate by month of the average size of the project construction, operational work force by trade, and work force peak periods;

  (h) An analysis of whether or not the locally available work force would be sufficient to meet the anticipated demand for direct workers and an estimate of the number of construction and operation workers that would be hired from outside of the study area if the locally available work force would not meet the demand;

  (i) A list of the required trades for the proposed project construction;

  (j) An estimate of how many direct or indirect operation and maintenance workers (including family members and/or dependents) would temporarily relocate;

(k) An estimate of how many workers would potentially commute on a daily basis and where they would originate.

- The application shall describe the potential impact on housing needs, costs, or availability due to the influx of workers for construction and operation of the facility and include the following:

  (a) Housing data from the most recent 10-year period that data are available, including the total number of housing units in the study area, number of units occupied, number and *percentage* of units vacant, median home value, and median gross rent. A description of the available hotels, motels, bed and breakfasts, campgrounds, or other recreational facilities;

  (b) How and where the direct construction and indirect work force would likely be housed. A description of the potential impacts on area hotels, motels, bed and breakfasts, campgrounds, and recreational facilities;

  (c) Whether or not meeting the direct construction and indirect work force's housing needs might constrain the housing market for existing residents and whether or not increased demand could lead to increased median housing values or median gross rents and/or new housing construction. Describe mitigation plans, if needed, to meet shortfalls in housing needs for these direct and indirect work forces.

  The application shall have an analysis of the economic factors including the following:

  (a) The approximate average hourly wage that would likely be paid to construction and operational workers, how these wage levels vary from existing wage levels in the study area, and estimate the expendable income that direct workers would likely spend within the study area;

  (b) How much, and what types, of direct and indirect taxes would be paid during construction and operation of the project, and which jurisdictions would receive those tax revenues;

  (c) The other overall economic benefits (including mitigation measures) and costs of the project on the economies of the county, the study area, and the state, as appropriate, during both the construction and operational periods.

- The application shall describe the impacts, relationships, and plans for utilizing or mitigating impacts caused by construction or operation of the facility to the following public facilities and services:

  (a) Fire;

  (b) Police;

  (c) Schools;

  (d) Parks or other recreational facilities;

  (e) Utilities;

  (f) Maintenance;

(g) Communications;

(h) Water/storm water;

(i) Sewer/solid waste;

(j) Other governmental services.

- The application shall compare local government revenues generated by the project (e.g., property tax, sales tax, business and occupation tax, payroll taxes) with their additional service expenditures resulting from the project; and identify any potential gaps in expenditures and revenues during both construction and operation of the project. This discussion should also address potential temporal gaps in revenues and expenditures.
- To the degree that a project will have a primary or secondary negative impact on any element of the socioeconomic environment, the applicant is encouraged to work with local governments to avoid, minimize, or compensate for the negative impact. The term "local government" is defined to include cities, counties, school districts, fire districts, sewer districts, water districts, irrigation districts, or other special purpose districts.

Consistency: Section 3.9 Socioeconomics provides a detailed discussion of the socioeconomic impacts from the proposed project including impacts on population, work force, property values, housing, health facilities and services, education facilities, governmental services, and local economy in Klickitat and Wasco counties.

6.1.4 Land Use Zoning

- The council shall make a determination as to whether the proposed site is consistent and in compliance with land use plans and zoning ordinances pursuant to RCW 80.50.090 (2).

Consistency: Area-wide and local plan and program consistency is addressed in Section 5.24. Potential impacts to land use are addressed in Section 3.1 Land Use and Recreation.

6.1.5 Site Restoration and Preservation

- When a site is subject to preservation or restoration pursuant to a plan as defined in WAC 463-72-040 through 463-72-060, the certificate holder shall conduct operations within terms of the plan; shall advise the council of unforeseen problems and other emergent circumstances at the site; and shall provide site monitoring pursuant to an authorized schedule. After approval of an initial site restoration plan pursuant to WAC 463-72-040, a certificate holder shall review its site restoration plan in light of relevant new conditions, technologies, and knowledge, and report to the council the results of its review, at least every 5 years or upon any change in project status. The council may direct the submission of a site preservation or restoration plan at any time during the development, construction, or operating life of a project based upon council's review of the project's status. The council may require such information and take or require such action as is appropriate to protect the environment and all segments of the public against risks or dangers resulting from conditions or activities at the site.

Consistency: Implementation of mitigation measures described in Chapter 3 of this EIS would reduce possible impacts during construction and maintenance and provide site restoration following construction.

6.1.6 Geology and Soils

- The seismicity standard for construction of energy facilities shall be the standards contained in the state building code.

Consistency: BPA will include any seismic standards applicable to transmission line construction from the State of Washington's building code in its design specifications for the proposed transmission line.

6.1.7 Water Quality

- Waste water discharges from projects under [EFSEC's] jurisdiction shall meet the requirements of applicable state water quality standards, chapter 173-201A WAC, state groundwater quality standards, chapter 173-200 WAC, state sediment management standards, chapter 173-204A WAC, requirements of the Federal Water Pollution Control Act as amended (86 Stat 816,33 USC 1251, et seq.) and regulations promulgated thereunder.

Consistency: Through its compliance with the Clean Water Act, BPA seeks appropriate certifications and authorizations from state water quality regulatory agencies for its proposed projects. BPA will meet all applicable standards identified through this process to protect water quality from construction and operation of the proposed transmission line. See Section 3.5 for information concerning the proposed project's potential impacts on water quality, and Section 5.10 for more information concerning BPA's Clean Water Act compliance activities.

6.1.8 Wetlands

- Wetland impacts shall be avoided wherever possible.
- Where impacts cannot be avoided, the applicant shall be required to take one or more of the following actions (in the following order of preference): Restore wetlands on upland sites that were formerly wetlands; create wetlands on disturbed upland sites; enhance significantly degraded wetlands; and preserve high-quality wetlands that are under imminent threat.
- Wetland mitigation actions proposed to compensate for project impacts shall not result in a net loss of wetland area except when the lost wetland area provides minimal functions and the mitigation action(s) will clearly result in a significant net gain in wetland functions as determined by a site-specific function assessment.

Consistency: In designing its proposed projects, BPA attempts to avoid identified wetland areas where feasible. If wetlands cannot be avoided, BPA works to minimize potential impacts and compensate appropriately for unavoidable impacts. BPA thus would act consistently with EFSEC's standards related to wetlands during construction and operation of the proposed transmission line. See Section 3.5 for information concerning the proposed project's potential impacts on wetlands, and Section 5.10 for more information concerning BPA's activities to comply with wetland regulations such as Section 404 of the CWA.

6.1.9 Fish and Wildlife

- EFSEC encourages applicants to select sites that avoid impacts to any species on federal or state lists of endangered or threatened species or to priority species and habitats.
- An applicant must demonstrate no net loss of fish and wildlife habitat function and value.
- Restoration and enhancement are preferred over creation of habitats due to the difficulty in successfully creating habitat.
- Mitigation credits and debits shall be based on a scientifically valid measure of habitat function, value, and area.
- The ratios of replacement habitat to impacted habitat shall be greater than 1:1 to compensate for temporal losses, uncertainty of performance, and differences in functions and values.
- Fish and wildlife surveys shall be conducted during all seasons of the year to determine breeding, summer, winter, migratory usage, and habitat condition of the site.

Consistency: In designing its proposed projects, BPA attempts to avoid impacts to fish and wildlife species where possible. Field surveys of the project corridor for wildlife species were conducted in summer 2009 and spring 2010. Potential impacts to ESA-listed species discussed in Sections 3.6 Wildlife and 3.7 Fish, which also assess potential effects to state-listed species and priority habitat and species.

6.1.10 Air Quality

- Air emissions from energy facilities shall meet the requirements of applicable state air quality laws and regulations promulgated pursuant to the Washington State Clean Air Act, chapter 70.94 RCW, and the Federal Clean Air Act (42 USC 7401 et seq.), and chapter 463-78 WAC.

Consistency: To the extent that air emissions resulting from construction and maintenance of the proposed transmission line and substation are regulated under state law, the project would comply with these regulations (see Section 3.13 Air Quality). Because operation of the proposed line would not result in any air emissions, there are no applicable standards for project operation.

6.1.11 Public Health and Safety

- The provisions of chapter 173-303 WAC shall apply to the on-site activities, at energy facilities subject to this chapter, which involve the generation, storage, transportation, treatment or disposal of dangerous wastes.
- No person shall cause or permit noise to intrude into the property of another person which noise exceeds the maximum permissible noise levels set forth below in this section.
- The noise limitations established are as set forth in the following table after any applicable adjustments provided for herein are applied.

Table 6-1. Noise Limitations

EDNA[1] of Noise Source	EDNA of Receiving Property		
	Class A	**Class B**	**Class C**
Class A	55 dBA	57 dBA	60 dBA
Class B	57	60	65
Class C	60	65	70

[1] EDNA, environmental designations for noise abatement.

- Between the hours of 10:00 p.m. and 7:00 a.m. the applicable noise limitations shall be reduced by 10 dBA for receiving property within Class A environmental designations for noise abatement (EDNAs).
- At any hour of the day or night the applicable noise limitations may be exceeded for any receiving property by no more than: (i) 5 dBA for a total of 15 minutes in any one-hour period; or (ii) 10 dBA for a total of 5 minutes in any one-hour period; or (iii) 15 dBA for a total of 1.5 minutes in any one-hour period.
- Sounds originating from temporary construction sites as a result of construction activity are exempt from these standards, except where such provisions relate to the reception of noise within Class A EDNAs between the hours of 10:00 p.m. and 7:00 a.m.

Consistency: BPA would comply with all applicable state regulations concerning the generation, storage, transportation, treatment or disposal of dangerous wastes during construction and maintenance of the proposed transmission line. BPA also would conduct its construction activities for the proposed line in conformance with EFSEC's standards concerning maximum permissible noise levels through using appropriate muffling devices on construction equipment and limiting construction to daytime and evening hours (see Section 3.11 Noise). Noise impacts during operation of the proposed line would be negligible, and Knight Substation would meet state noise standards as discussed in Section 3.11.

6.2 Washington Department of Natural Resources Standards

The project area includes state lands managed by DNR. This agency manages uplands for many purposes, including protection of state and federal threatened and endangered species, revenue for school construction, and environmental protection. Lands held in trust to support public beneficiaries generate earnings that help build or remodel public schools and universities. These revenues come from timber harvest on state trust lands, as well as from leases to farmers and ranchers and leases for mineral exploration and wind power generation (DNR 2009). The DNR trust lands crossed by the proposed action alternatives are currently leased to farmers, ranchers, and wind development. A portion of the DNR lands crossed lies within a DNR-designated Natural Area Preserve. BPA would obtain easements and permits as appropriate for any DNR lands crossed by the proposed project.

The following DNR policies are potentially applicable to the proposed project:

6.2.1 Compliance and Cooperation with other State and Federal Laws

- PO08-028: The department will comply with SEPA by managing activities on trust agricultural and grazing lands through a phased review process.
- PO08-035: The department will actively promote and maintain long-term relationships with public and private organizations that affect the agricultural and grazing program.
- PO13-002: It is the policy of the department to prepare a site-specific management plan for each Natural Area Preserve. The provisions in Natural Areas Preserve Act in chapter 79.70 RCW establish a state system of natural area preserves and a means of preservation for those areas.
- The department will comply with Chapter 43.21C RCW SEPA and Chapter 197-11 WAC SEPA Rules for all non-exempt proposed actions as defined by the SEPA laws including Chapter 332-41 WAC DNR SEPA Procedures.

Consistency: BPA is committed to planning its proposed transmission line projects to be consistent or compatible to the extent practicable with existing land uses. See Sections 3.1 Land Use and Recreation, 3.3 Vegetation, and 3.9 Socioeconomics for information concerning the proposed project's potential impacts on agricultural and grazing lands and mitigation measures identified to reduce or eliminate impacts to those resources. See Section 5.20 for information on the Farmland Protection Policy Act which directs federal agencies to identify and quantify adverse impacts on farmlands.

As described in the introduction to this chapter, BPA is working with Washington EFSEC to help ensure this EIS is adoptable under SEPA for all state and local agencies. This EIS does analyze the significant impacts of the proposal to the SEPA-defined natural and built environment.

6.2.2 Natural Areas Preserve Act

- PO13-002: It is the policy of the department to prepare a site-specific management plan for each Natural Area Preserve. The provisions in Natural Areas Preserve Act in chapter 79.70 RCW establish a state system of natural area preserves and a means of preservation for those areas.

DNR's Natural Heritage Plan 2007 and 2009 update identify priorities for conserving the State of Washington's native species, ecosystems, and natural heritage. The plan is updated every two years to reflect new conditions that affect conservation planning and priorities.

Consistency: The proposed West Alternative would cross the Columbia Plateau Eco Region's Columbia Hills Natural Area Preserve. See Sections 3.1 Land Use and Recreation, 3.3 Vegetation, 3.6 Wildlife and 3.7 Fish.

6.2.3 Geology and Soils

- PO08-029: The department will actively maintain or enhance soil productivity and quality on agricultural and grazing lands.

- The provisions in chapter 43.92 RCW shall apply to geologic hazards, which include assessment and mapping of seismic, landslide, and tsunami hazards, estimation of potential consequences, and likelihood of occurrence.

Consistency: In designing its proposed projects, BPA attempts to reduce impacts to soil productivity by implementing mitigation measures as listed in Section 3.4 Geology and Soils. Geologic hazards are also taken into account during line design; landslides are avoided if possible and towers are designed to withstand seismic hazards. See Section 3.4 for a discussion of areas along the proposed routes with landslide or seismic hazards.

6.2.4 Water Quality

- PO08-031: The department will maintain or enhance the quality and longevity of water resources originating from, flowing through, or applied on department-managed lands.

Consistency: As discussed above for Washington EFSEC water quality standards and in Section 5.10, BPA seeks appropriate certifications and authorizations from state water quality regulatory agencies and will meet all applicable standards identified through this process to protect water quality. See Section 3.5 Water Resources and Wetlands for information concerning the proposed project's potential impacts on water quality and for mitigation measures that would reduce those impacts.

6.2.5 Biological Resources

- PO-008: The department will actively participate with public and private sectors in developing and implementing pest and weed management programs.
- PO08-030: The department will maintain and enhance desirable vegetative communities on trust lands used for crop production, grazing, and wildlife habitat when compatible with agricultural and grazing program goals.
- The department will comply with Title 17 RCW Weeds, Rodents, and Pests.
- The department will comply with Chapter 15.58 RCW Washington Pesticide Control Act.

Consistency: As discussed in Section 2.3.5, BPA's vegetation management would be guided by its Transmission System Vegetation Management Program EIS. Additionally, BPA works with the county weed boards and landowners on area-wide plans for noxious weed control.

6.2.6 Cultural Resources

- PO08-034: The department will, within trust management obligations, protect significant archaeological and cultural resources on agricultural and grazing lands.
- The department will comply with PO06-001 Historical, Cultural, and Archeological sites.

Consistency: As discussed in Section 5.14, there are many laws and other directives for the management of cultural resources with which BPA seeks compliance. Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties on all lands impacted by projects including agricultural and grazing lands. As discussed in Section 3.8 Cultural Resources, a cultural resources inventory of the action alternatives is being conducted.

6.2.7 Land Use and Socioeconomics

- PO08-012: The department will sell valuable materials from and lease, permit or contract agricultural and grazing lands for other surface and subsurface uses when in the best interest of the trust beneficiaries. In such cases:
- Existing agricultural lessees will be compensated by subsequent users for loss when crops or authorized improvements are damaged, when the lease is terminated, or lease renewal negotiation is denied.
- Existing grazing lessees will be compensated by subsequent users for loss when crops or authorized improvements are damaged, when the lease is terminated, or lease renewal negotiation is denied.
- Chapter 332-52 WAC public access and recreation.
- RCW 79.10.120 Multiple uses compatible with financial obligations of trust management.
- RCW 79.10.125 Land open to public for fishing, hunting, and nonconsumptive wildlife activities.
- RCW 79.36.440 Right-of-way for public roads.
- RCW 79.36.510 Utility pipe lines, transmission lines, etc.
- RCW 79.36.520 Utility pipe lines, transmission lines, etc. – Procedure to acquire.
- RCW 79.36.530 Utility pipe lines – Appraisal – Certificate – Reversion.
- RCW 79.38.040 Permits for use of roads.

Consistency: As described above, BPA is committed to planning its proposed transmission line projects to be consistent or compatible to the extent practicable with existing land uses. See Section 3.1 Land Use and Recreation for mitigation measures identified to reduce potential impacts to landowners and their lessees and socioeconomics.

6.2.8 Fish and Wildlife

- PO08-032: The department will recognize the natural resource values of riparian zones and implement management plans to maintain or enhance these zones.
- PO08-033: The department will avoid effects on plant and animal species considered endangered. Within trust management obligations, the department will avoid adverse effects on species considered threatened and consider avoiding or lessening effects on species considered sensitive.

Consistency: As described above under consistency with EFSEC standards, BPA attempts to avoid impacts to fish and wildlife species where possible. Sections 3.6 Wildlife and 3.7 Fish display the listed and proposed species that are either known to occur or have the potential to occur in the project area, the proposed project's potential impacts on wildlife and fish, and mitigation measures identified to minimize those impacts.

6.2.9 Transportation and Access

PO14-020 pertaining to forest roads in DNR's Policy Manual states the following:

- The department will develop and maintain forest roads to meet trust objectives and Board of Natural Resources policy, including protecting and enhancing the asset value.

- To minimize adverse environmental impacts, the department will rely on the requirements of DNR's Habitat Conservation Plan, state forest practices rules and the State Environmental Policy Act, and will minimize the extent of the road network, consistent with other Board of Natural Resources policy.

In response to DNR's policy and in order to achieve the regulatory requirements under Washington Forest Practice Act, a comprehensive discussion of DNR standards for roads designed, constructed, maintained, and abandoned on state managed lands was developed in the Draft 2010 Forest Roads Guidebook.

Three general management practices characterize a small portion of the objectives and standards outlined in the Draft 2010 Forest Roads Guidebook, but are representative of the considerations DNR must make when adding a new road to the overall transportation system:

Build no more new road than is necessary to accomplish and economically conduct harvest and/or management objectives for the basic plan of operations, regardless of whether a road is in sensitive areas or not.

The protection of sensitive species and areas including, but not limited to, streams and watersheds is vital. Proper logging methods, road locations and construction techniques must be considered to mitigate a potential increase in erosion from forest areas and sediment delivery to surface water.

Consider the overall transportation plan for a geographic area. Don't ignore pre-planning for future sales and access. This will avoid construction of parallel roads or extra lengths of roads to access far corners that will be harvested in the future.

Consistency: Where the West Alternative would cross DNR land, some trees would be removed. However, the amount would be relatively small and would not require additional roads not planned for the project. The trees that would be removed for the project are not for timber harvest (see Section 3.3 Vegetation).

6.2.10 Public Health and Safety

- The provisions of chapter 332-24 WAC and chapter 76.04 RCW shall apply to forest protection measures and operator responsibilities related to fire prevention and fire hazard abatement.

Consistency: BPA is committed to reducing the potential for fire during construction. See Sections 3.3 Vegetation and 3.12 Public Health and Safety for mitigation measures identified to minimize potential health and safety risks from fire.

6.3 Washington Department of Fish and Wildlife Standards

WDFW serves as state's principal agency on species protection and conservation. Legislative mandate RCW 77.04.012 established that wildlife, fish, and shellfish are property of the state and that WDFW is entrusted by and through the Fish and Wildlife Commission to…"preserve, protect, perpetuate, and manage the wildlife and food fish, game fish, and shellfish…" and "…attempt to maximize the public recreational game fishing and hunting opportunities of all citizens…"

In 2003, WDFW and a broad range of wind power stakeholders developed the WDFW Wind Power Guidelines to provide consistent statewide direction for development of land-based wind energy projects still protecting the state's wildlife and habitat. The Guidelines were revised in 2009 (WDFW 2009c). While the proposed project is not a wind energy project, the following guidelines for impact avoidance and minimization are potentially applicable to the proposed project:

- Where appropriate develop in agricultural and other disturbed lands, including using existing transmission corridors and roads where possible.

Consistency: Where feasible, BPA typically considers line alternatives that are routed across already disturbed areas such as agricultural lands, and attempts to use existing roads where possible. See Sections 2.2 and 2.34 for proposed alternative development and placement of roads, and Section 3.1 Land Use and Recreation for potential impacts to land uses including agriculture.

- Avoid high bird and bat aggregation areas, and areas used by sensitive status species.

Consistency: BPA attempts to route transmission lines away from these areas where possible; however, because new lines most often extend from one specific existing substation to another existing substation, routing options can be limited. See Section 3.6 Wildlife for the proposed project's potential impacts on wildlife and mitigation measures identified to minimize those impacts.

- Encourage the protection of Priority Habitats and Species.

Consistency: BPA attempts to route transmission lines away from sensitive species' habitat where possible; however, because new lines most often extend from one specific existing substation to another existing substation, routing options can be limited. As described above, see Section 3.6 Wildlife of this EIS.

- Minimize use of overhead collector lines, unless underground collector lines are not appropriate or feasible due to environmental conditions (e.g., topography, soil conductivity, environmental impacts, etc.).

Consistency: BPA would not construct collector lines for the proposed project. Undergrounding of high-voltage (230- and 500-kV) transmission lines is usually not an option because of the greater environmental impacts and costs of undergrounding. See Section 2.6 for alternatives considered but eliminated from detailed study.

- When overhead lines are used, use designs that avoid and minimize impacts to raptors and other birds (refer to APLIC guidelines regarding adequate conductor spacing and use of perch guards).

Consistency: BPA always designs conductor spacing to comply with APLIC (see Section 3.5.2).

- Use tubular towers to reduce the likelihood that birds will perch on towers and to possibly reduce the risk of collision. Avoid use of lattice towers, particularly those with horizontal cross-members.

Consistency: The industry standard design for towers for high-voltage transmission lines is steel lattice towers. See Section 2.3 for information on the design of the proposed transmission line.

- Avoid using permanent tower types that employ guy wires. If guy wired towers are approved, encourage the requirement of bird flight diverters on the guy wires.

Consistency: BPA typically does not use guy wires on towers for its high-voltage transmission lines. In the event that guy wires are necessary, BPA would consider placing bird flight diverters on the guy wires. See Section 3.6 Wildlife for proposed mitigation measures identified to minimize impacts to birds.

- Discourage the use of rodenticides to control rodent burrowing around towers.

Consistency: BPA does not use rodenticides.

- Minimize the use of lights on towers and facilities structures, in accordance with federal, state, and local requirements.

Consistency: BPA typically only uses lights on very tall towers (such as at river crossings) and towers near airports/heliports, in compliance with FAA requirements. See Section 3.1 Land Use and Recreation for locations where lights may be required.

- Control noxious weeds in accordance with federal, state, and local laws.

Consistency: BPA controls weeds in accordance with federal, state, and local laws. See Section 3.3 Vegetation for proposed mitigation measures to reduce or eliminate the potential for the spread of noxious weeds under the action alternatives.

- Encourage the control of detrimental weedy species that invade as a result to disturbance from construction, maintenance and operation.

Consistency: BPA controls weeds in accordance with federal, state, and local laws (see Section 3.3 Vegetation).

- Encourage the permitting authority to require a fire protection plan and a complete road siting and management plan that includes vehicle-driving speeds that minimize wildlife mortality.

Consistency: Because BPA is not subject to state or county permitting authorities, this guideline does not apply to the proposed project. However, Section 3.12 Public Health and Safety does include proposed mitigation for the safe operation of vehicles and construction equipment.

- Reduce availability of carrion *(animal carcasses).*

Consistency: This guideline does not apply to the proposed project.

- Minimize roads and stream crossings.

Consistency: BPA typically proposes to build/improve the minimum amount of roads needed to access the transmission line and avoid stream crossings where possible. See Section 2.3 for information on the design of the proposed transmission line.

- Encourage a decommissioning condition for restoration of the site to approximate or improved pre-project conditions that would require removal of the turbines and infrastructure when the project ceases operation.

Consistency: This guideline does not apply to the proposed project.

6.4 Washington Department of Ecology

Ecology is the state agency responsible for protecting air and water quality in the state of Washington, including management of shorelines and wetland areas and implementation of federal and state water pollution control laws and regulations.

6.4.1 Shorelines and Wetlands

The Coastal Zone Management Program is authorized by the Coastal Zone Management Act of 1972 and administered at the federal level by the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management, Coastal Programs Division. Management of the program is delegated to the states participating in the program. In Washington, Ecology administers the program. The Coastal Zone Management Act requires federal development projects and activities directly affecting the coastal zone "shall be conducted in a manner which is, to the maximum extent practicable, consistent with approved state management programs" (see Section 307(c)(1), (2)).

A federal agency or applicant for a federal license, permit, or financial assistance is responsible for determining whether the proposed activity may affect any natural resource, land use, or water use in Washington's coastal zone. Ecology will concur with a determination if the federal activity is consistent to the maximum extent practicable with the Washington Coastal Zone Management Program. Consistency with the state program is described below.

The Washington State Shoreline Management Act establishes a planning program and regulatory permit system initiated at the local level under state guidance. While Ecology is designated as the lead state agency, local governments exercise primary authority for implementing the Act. Each local government's master program consists of a shoreline inventory and a "shoreline master program" (SMP) to regulate shoreline uses. The SMP for Columbia County, adopted June 1975, regulates land uses impacting shorelines of the state in Columbia County. The proposed transmission facilities would only impact state shorelines if the towers or access roads would be located within 200 feet of them or their associated wetlands. Regulations pertaining to utilities are listed in Section 16 of the SMP. Utility services in shoreline areas designated Conservancy, Rural and Urban Environments, shall be permitted subject to the following regulations:

- All utility systems shall be underground when such undergrounding is economically feasible.
- All clearing for installation of maintenance shall be kept to the minimum width necessary.
- Upon completion of the installation of utility systems or of any maintenance, disturbed areas shall be restored as nearly as practical to the pre-existing condition.
- Utilities shall be located above flood levels wherever practical.

Consistency: In Washington, the action alternatives for the proposed project would cross the Columbia River, Swale Creek, and the Little Klickitat River. Towers and access roads would be placed as far from the water's edge as feasible, floodplains would be avoided, clearing kept to a minimum, and disturbed areas would be reseeded. Please see Section 3.5 Water Resources and Wetlands.

6.4.2 Water Quality

The following Ecology substantive standards from Chapter 90.48 RCW, Chapter 173-216 WAC, Chapter 173-220 WAC, Chapter 173-200 WAC, and Chapter 173-201A WAC are potentially applicable to the proposed project:

- Proper erosion and sediment control practices must be used on the construction site and adjacent areas to prevent upland sediments from entering surface water. All ground disturbance by construction activities must be stabilized. When appropriate, use native vegetation typical of the site.
- Any operation which would generate a waste discharge or have the potential to impact the quality of state waters, must receive specific prior authorization from Ecology.
- Routine inspections and maintenance of all erosion and sediment control BMPs are recommended both during and after development of the sites.
- A Stormwater Pollution Prevention Plan for the project site may be required and should be developed by a qualified person(s). Erosion and sediment control measures in the plan must be implemented prior to any clearing, grading, or construction. These control measures must be effective to prevent soil from being carried into surface water by stormwater runoff. Sand, silt, and soil can damage aquatic habitat and are considered pollutants. The plan must be upgraded as necessary during the construction period.
- Proper disposal of construction debris must be in such a manner that debris cannot enter the natural stormwater drainage system or cause water quality degradation of surface waters. Dumpsters and refuse collection containers shall be durable, corrosion resistant, nonabsorbent, nonleaking, and have close fitting covers. If spillage or leakage does occur, the waste shall be picked up immediately and returned to the container and the area properly cleaned.
- The operator of a construction site that disturbs one acre or more of total land area, and which has or will have a discharge of stormwater to a surface water or to a storm sewer, must apply for coverage under Ecology's NPDES Construction Stormwater General Permit.

Consistency: Water quality standards are discussed in Section 5.10. BPA seeks appropriate certifications and authorizations from state water quality regulatory agencies and will meet all applicable standards identified through this process to protect water quality. See Sections 3.4 Geology and Soils and Recreation and 3.5 Water Resources and Wetlands, respectively, for information concerning the proposed project's potential impacts on soils and water quality and for mitigation measures that would reduce potential impacts.

6.4.3 Air Quality

Ecology substantive standards from Chapter 42.21A RCW and Chapter 173-400 WAC related to general regulations of air pollution sources establish attainable standards and rules applicable to control and/or prevention of emissions of air contaminants. Ecology suggests the development of a Fugitive Dust Control Plan (FCDP) to identify project-related fugitive dust sources, implementation procedures for dust abatement, and how dust control measures will comply with applicable provisions outlined in WAC 173-400-040.

Consistency: See Sections 3.4 Geology and Soils and 3.13 Air Quality for a discussion of dust and air quality impacts and for mitigation measures to control emissions and fugitive dust. BPA will prepare a Fugitive Dust Control Plan.

6.5 Washington Department of Archaeology and Historic Preservation Standards

The Department of Archaeology and Historic Preservation works with agencies, tribes, private citizens, and developers to identify and develop protection strategies to ensure that Washington's cultural heritage is not lost. In Washington, archaeological sites and Native American graves are protected from known disturbance by a variety of state laws. While federal law applies to all federal and Native American lands, Washington state law applies to all other lands. The following state laws on archaeology and historic preservation for the management of cultural resources are potentially applicable to the proposed project:

- Indian Graves and Records (RCW 27.44)
- Archaeological Sites and Resources (RCW 27.53)
- Archaeological Excavation and Removal Permit (WAC 25-48)
- Abandoned and Historic Cemeteries and Historic Graves (RCW 68.60)
- Advisory Council on Historic Preservation (WAC 25-12)

Consistency: As discussed in Section 5.14, Cultural Resources, Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties. If a federal agency plans to undertake a type of activity that could affect historic properties, it must consult with the appropriate State Historic Preservation Officer to make an assessment of adverse effects on identified historic properties. BPA will comply with NHPA and all applicable state laws.

6.6 Oregon Department of Energy

DOE is the state agency responsible for overseeing the development of large energy facilities in Oregon. A proposed facility must undergo a review process that meets the siting standards before being issued a site certificate, which authorizes a developer to construct and operate an energy facility.

The following substantive standards from OAR Chapter 345, Division 22 and Division 24 are potentially applicable to the proposed project:

6.6.1 Soil and Geologic Resources

- The provisions in OAR 345-022-0022 require that applicants consider potential impacts to soil resources.
- The provisions in OAR 345-022-0020 require that applicants design, engineer, and construct proposed facilities to avoid dangers to human safety presented by seismic hazards expected to result from maximum probably ground motion events.

Consistency: BPA will include any seismic standards applicable to transmission line construction from the state of Oregon's building code in its design specifications for the proposed transmission line (see Section 3.4 Geology and Soils).

6.6.2 Land Use

- The provisions in OAR 345-022-0030 ensures that proposed energy facilities will comply with Oregon's land use planning goals adopted by the Land Conservation and Development Commission (LCDC).
- The Council must decide whether the proposed energy facility complies with LCDC rules and goals directly applicable to the facility under ORS 197.646(3).

Consistency: BPA is committed to planning its proposed transmission line projects to be consistent or compatible to the extent practicable with existing land uses. See Section 3.1 Land Use and Recreation for mitigation measures identified to reduce potential impacts to land use.

6.6.3 Fish and Wildlife Habitat

- The provisions in OAR 345-022-0060 require that proposed facilities comply with habitat mitigation goals and standards of ODFW.
- The provisions in OAR 345-022-0070 require that applicants provide appropriate studies that identify state-listed threatened or endangered species that could be affected by the proposed energy facility. Applicants should consult with the Oregon Department of Agriculture (ODA) and ODFW.

Consistency: In designing its proposed projects, BPA attempts to avoid impacts to fish and wildlife species where possible. Field surveys of the project corridor for wildlife species were conducted in summer 2009 and spring 2010. Potential impacts to ESA-listed species discussed in Sections 3.6 Wildlife and 3.7 Fish, which also assess potential effects to state-listed species and priority habitat and species.

6.6.4 Aesthetics

- The provisions in OAR 345-022-0080 protect scenic values that local land use or federal management plans identify as significant or important. Proposed facilities affecting scenic values identified as significant must propose appropriate measures to reduce impact.

Consistency: Please see Section 3.2 Visual Resources for impacts to visual resources and mitigation measures to lessen those impacts.

6.6.5 Historic, Cultural, and Archaeological Resources

- The provisions in OAR 345-022-0090 protect public interest in preserving historic, cultural, or archaeologically significant places. Applicants must conduct appropriate surveys to identify and avoid places of potential significance. If the project involves construction on an archaeological site, the applicant may need a permit from the SHPO.

Consistency: As discussed in Section 5.14, there are many laws and other directives for the management of cultural resources with which BPA seeks compliance. Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties on all lands impacted by projects including agricultural and grazing lands. As discussed in Section 3.8 Cultural Resources, a cultural resources inventory of the action alternatives is being conducted.

6.6.6 Recreation

- The provisions in OAR 345-022-0100 require evaluation of potential impact to recreational opportunities at the construction site or in the surrounding area. If significant impact is likely, the Council may require avoidance or mitigation measures to reduce impact to recreational opportunities.
- Impacts to protected state and national areas specified in OAR 345-022-0040 will be sufficiently mitigated to less than significant impact.

Consistency: Please see Section 3.1 Land Use and Recreation for impacts to recreational areas in the project and for mitigation measures to lessen those impacts.

6.6.7 Socioeconomics

- The provisions in OAR 345-022-0110 require applicants to assess proposed facility needs for water, wastewater disposal, storm water, and solid waste. Expected population increases, impacts to housing, traffic safety, police, and fire protection, heath care and schools must also be analyzed for expected temporary and permanent impacts.

Consistency: Please see Section 3.9 Socioeconomics for potential impacts to socioeconomics for the project and mitigation measures to lessen those impacts.

6.6.8 Public Health and Safety

- ORS Chapter 467.020 and 467.030 relate to DEQ noise regulation for energy facilities. OAR 340-035-0035 establish noise control regulations for industry and commerce, including energy facilities.
- No person owning or controlling a new industrial or commercial noise source located on a previously unused industrial or commercial site shall cause or permit the operation of that noise source if the noise levels generated or indirectly caused by that noise source increase the ambient statistical noise levels, L10 or L50, by more than 10 dBA in any one hour, or exceed the levels specified in Table 8.
- Provisions in OAR 345-022-0120 require applicants to plan to minimize solid waste and wastewater generated during construction and operation of the proposed facility. Applicants must propose methods to handle waste through collection, storage and disposal.
- The applicant should consult with DEQ to list all hazardous materials potentially stored or used at the facility site during construction and operation as well as ensure compliance with ORS Chapters 465 and 466 related to use, clean up, and disposal of hazardous materials.

Consistency: BPA would comply with all applicable state regulations concerning the generation, storage, transportation, treatment or disposal of dangerous wastes during construction and maintenance of the proposed transmission line (see Section 3.12 Public Health and Safety). BPA also would conduct its construction activities for the proposed line in conformance with DEQ's standards concerning maximum permissible noise levels through using appropriate muffling devices on construction equipment and limiting construction to daytime and evening hours (see Section 3.11 Noise). Noise impacts during operation of the proposed line would be negligible as discussed in Section 3.11.

6.6.9 Air Quality

- Provisions in OAR 345-024-05000 provide specific standards for base load gas plants, non-base load power plants, and non-generating energy facilities that emit carbon dioxide. The following limitations are in place:

Base load gas plants	0.675 lb. CO_2 / kWh
Non-base load gas plants	0.675 lb. CO_2 / kWh
Nongenerating facilities	0.504 lb. CO_2 / horsepower-hour

Consistency: To the extent that air emissions resulting from construction and maintenance of the proposed transmission line are regulated under state law, the project would comply with these regulations (see Section 3.13 Air Quality). Because operation of the proposed line would not result in any air emissions, there are no applicable standards for project operation.

6.6.10 Water Resources

- The Oregon Department of State Lands will require a removal-fill permit if 50 cubic yards or more of material is removed, filled or altered within a jurisdictional water of the State. The removal-fill permit will be issued separately from the 404 permit issued by the US Army Corps of Engineers.
- A Limited Water Rights permit is required if new water rights are necessary for the proposed project.

Consistency: Through its compliance with the Clean Water Act, BPA seeks appropriate certifications and authorizations from state water quality regulatory agencies for its proposed projects. BPA will meet all applicable standards identified through this process to protect water quality from construction and operation of the proposed transmission line. See Section 3.5 Water Resources and Wetlands for information concerning the proposed project's potential impacts on water quality, and Section 5.10 for more information concerning BPA's Clean Water Act compliance activities.

In designing its proposed projects, BPA attempts to avoid identified wetland areas where feasible. If wetlands cannot be avoided, BPA works to minimize potential impacts and compensate appropriately for unavoidable impacts. BPA thus would act consistently with standards related to wetlands during construction and operation of the proposed transmission line. See Section 3.5 for information concerning the proposed project's potential impacts on wetlands, and Section 5.10 for more information concerning BPA's activities to comply with wetland regulations such as Section 404 of the Clean Water Act.

Chapter 7
Consistency with the Management Plan for the Columbia River Gorge National Scenic Area Substantive Standards

7.1 Overview

Portions of the action alternatives for the proposed project are located within the Columbia River Gorge National Scenic Area, which was established in 1986 by the Columbia River Gorge National Scenic Area Act (16 U.S.C. 544-544p). The National Scenic Area, which covers nearly 293,000 acres in six Washington and Oregon counties, extends east along the Columbia River from about the confluence of the Columbia and Sandy rivers to about 85 miles just past the town of Wishram, Washington. Because the proposed project is a federal project, the U.S. Forest Service is the responsible entity under the Scenic Act for carrying out review of the project. Through this review, the USFS will make a determination concerning the consistency of the portion of the proposed project that would be in the National Scenic Area with the provisions of the Scenic Act.

To carry out the Scenic Act, the Columbia River Gorge Commission and the USFS have developed the Columbia River Gorge National Scenic Area Management Plan. The Gorge Commission adopted the original Management Plan in October 1991, and the U.S. Secretary of Agriculture concurred with the Management Plan in February 1992. Revisions to the Management Plan were adopted in 2004 and incorporated into an updated Management Plan in 2007.

The Management Plan includes guidelines and land use designations within the National Scenic Area and identifies goals, objectives, policies and guidelines for resource protection and enhancement; action programs for recreation development, economic development, enhancement strategies, and interpretation and education; and establishes the roles of the Gorge Commission, the USFS, and Indian tribal governments. Part II, Chapter 7 of the Management Plan also states that operation, maintenance, and modification of BPA's existing transmission facilities in the National Scenic Area is exempt from regulation under the Management Plan or land use ordinances adopted by the counties or the Gorge Commission pursuant to the Scenic Area Act.

To facilitate USFS review of the project, this chapter describes project consistency with the land use designations crossed by the project as well as the four resources identified for protection and enhancement: Scenic Resources, Natural Resources, Cultural Resources, and Recreation Resources.

7.2 Land Use

The three action alternatives have varying transmission line routes through the National Scenic Area, with different miles of line, uses of existing rights-of-way and access roads, and acreages of impact. Please see Table 7-1 for a comparison of impacts of the alternatives within the National Scenic Area.

Table 7-1. Impacts in the National Scenic Area by Action Alternative

	Permanent Impacts (acres)				Temporary impacts			
	Towers[1]	New Roads	Upgrade Existing Roads	Total[1]	Total Temporary Impacts (acres)[1]	Miles of Line	New Right-of-Way[1] (acres)	Miles of New Corridor
West Alternative	6–14	23	23	52–60	18–42	9.5	72-119	5.2
Middle Alternative	3–4	14	6	23–24	11–16	5.5	40-43	1.8
East Alternative	4–7	12	20	36–39	14–44	7.5	1-5	0

[1] Impacts are presented as ranges from all possible tower options. Double-circuit options would have the greatest impacts from towers.
[2] The "Temporary Tower Impacts" column provides the total of the temporary tower construction impacts and removal of existing towers (where applicable).

The Management Plan includes guidelines and land use designations for lands designated as General Management Areas (GMA) and Special Management Areas (SMA) within the National Scenic Area. All action alternatives would be located in GMAs. The GMA is further broken down by land use designations. The alternatives cross four of these designations: Urban Areas, Bureau of Indian Affairs land, Large Scale Agriculture, and Agriculture Special (see Tables 7-2 and 7-3 and Map 7-1).

Urban Areas and Bureau of Indian Affairs lands are exempt from the provisions of the Scenic Act; Large Scale Agriculture has review requirements for utility use, and Agriculture Special prohibits new utility facilities.

Table 7-2. National Scenic Area Land Use Designations and Review Use Requirements

Land Use Designation	Line Mile Locations[1]	Review Use and Applicable Requirements[2]
Urban Area	WME0; W3–4; ME9	Exempt
Bureau of Indian Affairs	W3; M9–10; E9–11; E12	Exempt
Large Scale Agriculture	W1–2; W4–9; ME1; ME7–ME8; M10–11; E10; E11–13	Review Required May be allowed if the following are met: • There is no practicable alternative location with less adverse effect on agricultural lands. • The size is the minimum necessary to provide the service.
Agriculture Special	W2–3; W9–10	Prohibited

[1] Approximate line miles are the miles along each alternative (West=W, Middle=M, East=E), starting from 0 miles at Big Eddy Substation and ending at Knight Substation Sites 1 or 2.

Source: Management Plan with revisions 2004, amendments through June 2007.

Table 7-3. National Scenic Area Land Use Designations Crossed by the Action Alternatives

National Scenic Area Land Use Designation	Miles of Transmission Line per Alternative		
	West Alternative	Middle Alternative	East Alternative
Urban Areas	2.2	0.8	0.8
Bureau of Indian Affairs	0	0.8	1.3
Large-Scale Agriculture	6.0	3.5	4.7
Agriculture Special	0.9	0	0

Source: Management Plan with revisions 2004, amendments through June 2007

Large Scale Agriculture. Locating utilities within large-scale agriculture would require certain conditions be met for consistency with that designation. Utility facilities necessary for public service may be allowed upon showing that (1) there is no practicable alternative location with less adverse effect on agricultural lands, and (2) the size is the minimum necessary to provide the service (Management Plan, page ll-1-12).

Through the large scale agricultural areas, the proposed action alternatives would mostly impact rangeland with a slight impact on nonirrigated agricultural land (see Table 7-4 for acreages of land uses impacted by each action alternative). As described in Section 3-1 Land Use and Recreation, although tower footprints and access roads would remove acreage from grazing, the line would generally be compatible because livestock could still maneuver around the towers, within the right-of-way, and along roads to access their range. All action alternatives use portions of existing right-of-way, and for options that would use double-circuit towers, rebuilding existing towers would lessen the overall amount of agricultural area removed from use (new tower footprints, minus the existing tower footprints).

Table 7-4. Land Uses Impacted by the Action Alternatives within the National Scenic Area

Land Use	Permanent Impacts[1,2] (acres)		
	West Alternative	Middle Alternative	East Alternative
Irrigated Cropland	0	0	0
Nonirrigated Cropland	3–4	0.3–0.4	0.3–0.4
Orchards/Vineyards	0.3	0	0
Rangeland	30–34	23	35–37
Conservation/Recreation	19–23	0	0
Prime Farmland	0	0.9	0.9
Farmland of Statewide Importance	38–44	24	21–22

[1] Permanent impacts are due to tower footings, new access roads, and access road upgrades.
[2] Impacts are presented as ranges from all possible tower options. Double-circuit options would have the greatest impacts from towers.

The proposed 500-kV line is the minimum kilovolt size necessary to meet the proposed project need (see Chapter 1 of this EIS). BPA is considering two tower sizes for the proposed line: single-circuit towers, which are the minimum size necessary to hold the proposed 500-kV line; and double-circuit towers. Although double-circuit towers are larger, they would accommodate two lines, allowing some existing lines to be removed. Also, double-circuit towers would allow future upgrades of existing lines without the construction of new towers. For example, East Option 3 would place the existing Harvalum-Big Eddy 230-kV line on double-circuit towers for a portion of the route and the McNary-Ross 345-kV line on double-circuit towers for a portion of the route. This would allow for a future upgrade of the existing lines to 500-kV without requiring new towers for these route portions, which cross the Columbia River and head into Big Eddy Substation. For the West Alternative, Options 4, 5, and 6 propose double-circuit towers for the first 5 miles from Big Eddy Substation. The use of double-circuit towers for this portion of the West Alternative would not remove an existing line (there are no existing lines in this area), but it would allow for a future line to cross the Columbia River and connect into Big Eddy Substation without needing new towers through this area.

Agriculture Special. Two portions of the West Alternative (near line miles W2-3 and W9-10) would cross land designated as Agriculture Special under the Management Plan. Construction of new utility facilities or roads is prohibited in Agriculture Special-designated areas (Management Plan, page ll-1-19). Any construction of new facilities or roads in this area thus would be inconsistent with the Agriculture Special designation. BPA could likely route the West Alternative around the Agriculture Special land at line miles W2-3. At line miles W9-10, the land crossed has an existing BPA transmission line, right-of-way and access roads that were built in 1947, prior to the Scenic Act. Limiting construction to modification of existing BPA facilities in this area may serve to exempt this construction from Scenic Act review requirements, pursuant to the BPA-specific exemption in the Scenic Act (see Section 5.22 Columbia River Gorge National Scenic Area Act). BPA currently is working with the USFS to help further assess the consistency of the proposed project in this area with applicable Management Plan provisions.

7.3 Scenic Resources

For scenic resources, the goal of the Management Plan is to emphasize protection and enhancement of Columbia River Gorge landscapes seen from key viewing areas. New utility transmission lines shall be visually subordinate as seen from key viewing areas to the maximum extent practicable (Management Plan, page I-1-6).

“New main lines on lands visible from key viewing areas for the transmission of electricity…shall be built in existing transmission corridors unless it can be demonstrated that use of existing corridors is not practicable. Such new lines shall be underground as a first preference unless it can be demonstrated to be impracticable” (Management Plan, page I-1-10).

Unlike lower-voltage distribution cables used to deliver power to individual homes, it is impracticable to underground high-voltage transmission cables. For a 500-kV line, three individual cables would have to be manufactured and installed at a cost about 10 times the cost of an overhead design. In addition, the costs of maintaining an underground high-voltage line is much greater and more difficult, and the environmental impacts are typically greater than impacts from an overhead line. Please see Section 2.6 Alternatives Considered but Eliminated from Detailed Study for more information about undergrounding.

The proposed action alternatives would be seen from three of the key viewing areas identified in the Management Plan: Highway I-84, Washington State Route 14, and the Columbia River (see Table 7-5). The other key viewing areas in the Management Plan are either too far away or blocked by terrain. The West Alternative is also potentially visible from Rowena Plateau, but it is far enough away that it would be difficult to distinguish the transmission towers. See Section 3.2 Visual Resources for more description and photo simulations of the views from these key viewing areas. Also see Appendix C for maps that show viewshed analyses from key viewing areas and for skyline assessments that show which towers would break the skyline from key viewing areas.

All three action alternatives use existing corridor for some or all of their routes through the National Scenic Area (see Table 7-1); some would be parallel to existing BPA right-of-way and some would use existing, vacant BPA right-of-way.

Table 7-5. Key Viewing Areas

Key Viewing Area	Possible Views of Project Area?	Alternatives Visible
Historic Columbia River Highway	No	
Crown Point	No	
Highway I-84, including rest stops	Yes	West, Middle, East (but not from rest stops)
Multnomah Falls	No	
Washington State Route 14	Yes	West, Middle, East
Beacon Rock	No	
Panorama Point Park	No	
Cape Horn	No	
Dog Mountain Trail	No	
Cook-Underwood Road	No	
Rowena Plateau and Nature Conservancy Viewpoint	Unlikely	Small portion of Middle and East, but distant so towers would not be visible
Portland Women's Forum State Park	No	
Bridal Veil State Park	No	
Larch Mountain	No	
Rooster Rock State Park	No	
Bonneville Dam Visitor Centers	No	
Columbia River	Yes	West, Middle, East
Washington State Route 141	No	
Washington State Route 142	No	
Oregon Highway 35	No	
Sandy River	No	
Pacific Crest Trail	No	
Old Washington State Route 14 (County Road 1230)	No	
Wyeth Bench Road	No	
Larch Mountain Road	No	
Sherrard Point on Larch Mountain	No	

7.4 Natural Resources

The Scenic Area Act directs the Gorge Commission and the USFS to inventory, protect, and enhance natural resources. New development may not adversely affect natural resources [Scenic Gorge Act, Section 6(d)(3)]. The Management Plan provides guidelines and regulates uses for the protection of wetlands; streams, ponds, lakes, and riparian areas; wildlife habitat; rare plants; and natural areas.

Wetlands. See Section 3.5 Water Resources and Wetlands for potential impacts of the project alternatives on wetlands. BPA will work to locate all towers and roads to avoid wetlands and wetland buffers where possible. If avoidance is not feasible, BPA will work with the USFS regarding wetland delineations, determination of wetland buffers, replanting buffer zones with native plant species, rehabilitation of wetland areas, and wetland compensation as applicable.

Streams, Ponds, Lakes and Riparian Areas. See Section 3.5 Water Resources and Wetlands for potential impacts of the action alternatives on water bodies and Section 3.3 Vegetation for potential impacts to riparian zones. No transmission towers would be located in water bodies, and very little riparian vegetation would be removed (West Alternative only). Culverts would likely be needed in intermittent streams or dry washes. BPA will work with the USFS on tower and road siting, appropriate buffer rehabilitations, and culvert style and sizing, as applicable.

Wildlife Habitat. See Section 3.6 Wildlife for potential impacts of the action alternatives on wildlife and wildlife habitats. Additional assessment of potential occurrence and impacts of species protected within the National Scenic Area is found in Appendix D. Field surveys have been conducted by professional wildlife biologists to determine occurrences of wildlife species, and BPA will continue to work with the USFS and the appropriate state Departments of Fish and Wildlife to avoid and protect sensitive wildlife areas and sites.

Rare Plants. See Section 3.3 Vegetation for potential impacts of the action alternatives on rare plants. Additional assessment of potential occurrence and impacts of species protected within the National Scenic Area is found in Appendix D. Field surveys have been conducted by a professional botanist to determine occurrences of rare plant species, and BPA will continue to work with the USFS and the appropriate state Natural Heritage Programs to avoid and protect rare plants. See Table 7-5 for the acreage of impact each action alternative would have on various vegetation cover types and priority ecosystems within the National Scenic Area.

Natural Areas. Of the 45 natural areas identified for protection under the Management Plan, the proposed action alternatives would affect one, the Columbia Hills. Chapter 3 describes the potential impacts of the action alternatives and access roads across the Columbia Hills.

Table 7-6. Vegetation Types Impacted by the Action Alternatives within the National Scenic Area

Vegetation Cover Types and Associated Priority Ecosystems[1]	Permanent Impacts[1,2] (acres)		
	West Alternative	Middle Alternative	East Alternative
Shrub-Steppe	0	0	0
Grassland	17–21	0	0
Idaho fescue-houndstongue hawkweed[3]	2.7–3.1	0	0
Disturbed Shrub-Steppe/Grassland	31–34	23	35–38
Woodland[4]	1.6–2.2	0	0
Total	6–15	23	35–38

[1] Priority Ecosystems are listed in italics beneath their associated Vegetation Cover Type in this column.

[2] Impacts for tower construction are presented in a range because they differ by tower option. Single-circuit tower options have lower impacts; double-circuit tower options higher impacts.

[3] Idaho fescue-houndstongue hawkweed values are included with grassland values, and so are not added into the totals.

[4] Impacts to woodlands are calculated based on tree removals, which are considered permanent impacts only.

7.5 Cultural Resources

One purpose of the Scenic Area Act is to “protect and provide for the enhancement of the …cultural…resources of the Columbia River Gorge [Section 3(1)].” Cultural resources include archaeological resources, historic buildings and structures, and traditional cultural properties. As a federal agency, BPA will comply with Section 106 of the Historic Preservation Act of 1966 (see Sections 3.8 Cultural Resources and 5.14 Cultural Resources). As part of this compliance, BPA is conducting cultural surveys and is in consultation with the appropriate tribes, the Oregon State Historic Preservation Office, the Washington State Department of Archaeology and Historic Preservation, and the USFS. Known cultural sites will be avoided where feasible and mitigation and monitoring will be implemented where appropriate.

7.6 Recreation Resources

The Scenic Act has a directive to protect and enhance the recreation resources of the Columbia River Gorge [Section 3(1)]. The proposed project would not affect the function of or access to recreational resources, but would have some visual impacts (see Sections 3.1 Land Use and Recreation, and 3.2 Visual Resources). During the construction period, access to isolated areas around tower and road sites would be limited and traffic may be slowed with the movement of trucks or equipment to construction sites. For information about potential visual impacts to scenic byways, see Sections 3.2 Visual Resources and 7.2 Land Use and Recreation.

Chapter 8
List of Preparers

The Big Eddy–Knight Transmission Project draft EIS is being prepared by BPA with the technical assistance of environmental consultants. Individuals responsible for preparing the draft EIS, along with their affiliation, experience, and education, are listed below in alphabetical order by last name.

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Chapter 9
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Chapter 10
Agencies, Organizations, and Persons Receiving this EIS

The project mailing list contains tribes; local, state, regional, and federal agencies; utilities; public officials; interest groups; businesses; special districts; libraries; colleges/universities; the media; and potentially interested or affected landowners. They have directly received or have been given instructions on how to receive all project information made available so far, and they will have an opportunity to review the draft and final EIS. Specific entities (other than private persons) receiving this EIS are listed below by category.

Federal Agencies

Army Corps of Engineers

Bureau of Indian Affairs

Bureau of Land Management

Environmental Protection Agency

Fish and Wildlife Service

Forest Service Center

Forest Service, Columbia River Gorge National Scenic Area

National Marine Fisheries Service

National Park Service

Rural Development

Regional Commission

Columbia River Gorge Commission

Tribes or Tribal Groups

Confederated Tribes of the Umatilla Indian Reservation

Confederated Tribes of the Warm Springs Reservation

Confederated Tribes and Bands of the Yakama Nation

Nez Perce Tribe of Idaho

State Agencies, Oregon

Department of Agriculture

Department of Economic & Community Development

Department of Energy

Department of Environmental Quality

Department of Fish and Wildlife Northeast Region

Department of Fish and Wildlife

Department of Forestry

Department of Human Services

Department of Land Conservation and Development

Department of Lands Eastern Region

Department of Parks and Recreation

Department of State Lands

Department of Transportation

Department of Water Resources

Natural Resource Office

State Agencies, Washington

Department of Agriculture

Department of Commerce

Department of Community Development

Department of Community Trade and Economics

Department of Ecology

Department of Ecology Central Regional Office

Department of Fish and Wildlife

Department of Natural Resources

Department of Parks and Recreation

Department of Transportation

Department of Planning

Department of Public Works

Energy Facility Site Evaluation Council

Governor's Office of Regulatory Assistance (Central Region)

Library Government Publication

Natural Heritage Conservation and Recreation

Office of Governor, Natural Resources Office

Parks and Recreation Commission

Water Resources

Public Officials, Oregon

Federal Representative Greg Walden

Federal Senator Ron Wyden

Governor Ted Kulongoski

State Representative Greg Smith

State Representative Jeff Merkley

State Senator David Nelson

State Senator Ted Ferrioli

Public Officials, Washington

Federal Representative Doc Hastings

Federal Senator Maria Cantwell

Federal Senator Patty Murray

Governor Christine Gregoire

State Representative Bruce Chandler

State Senator Jim Honeyford

Local Governments, Oregon

City of The Dalles

Wasco County

Local Governments, Washington

City of Goldendale
City of White Salmon
Benton County
Klickitat County
Yakima County

Businesses

Alternative Wind Power LLC
Beaconsfield Associates II LP
Bowdish Farms LLC
BP Alternative Energy North America Inc.
BP West Coast Products LLC
Bull Mountain Development Company No. 1 LLC
Burlington Northern & Santa Fe Railroad Company
Burlington Northern and Santa Fe Railroad Company
Caithness Shephards Flat LLC
Cannon Northwest Wind Partners LLC
Chehalis Power Generating LTD
Columbia Energy Partners LLC
Dallesport Lumber Company LLC
Dallesport Properties LLC
Davenport Power LLC
Divers Company LLC
Eckton Ranch LLC
Elcon Associates
EnXco
Erikson Phillips PLLC
Estate of William L. Eddins
Eurus Energy America Corporation
Exxel Energy USA, Inc.
Finley BioEnergy LLC
Flying H Ranch, Inc.
Fulton Gard Family LTD Partnership
Garner Family Partnership
Hardy Energy Consulting
Harvest Wind Energy Corporation
Henley Group LTD
Hill Ken, Inc.
Infinity Wind Power, Inc.
Kay Kayser Ranches, Inc.
Klickitat River Enterprises LLC
Lewis County Title Company
Lotus Group USA, Inc.
McKay & Sposito, Inc.
MWH Americas, Inc.
Northwest Storage, Inc.
Oregon Trail Wind Farm LLC
Pacific Northwest Generating Coop
Patu Wind Farm
Planet Glassberg
Point Environmental, Inc.
Powerex Corporation
PP&L Energyplus Company LLC
PPM Energy LLC
Project Patch
PS Power Generation
Public Power Council
Puget Sound Energy, Inc.
Pyramid Line & Cattle Company
RES America Developments, Inc.
RES Americas
Schreiner Farms, Inc.
Spokane County Title Company
Teck Cominco Metals LTD
Thomas Foley and Associates, Renewable Northwest Project
Transalta Energy Marketing US Inc.
UPC Oregon Wind LLC
Western Renewable Power LLC
Western Wind Power

Horizon Wind Energy LLC
Horseshoe Bend Ranch
Iberdrola Renewables, Inc.
ICF, formerly Jones and Stokes
Idaho Power Company LP
Wind Power Associates Inc.
Wind Power Associates LLC
Windy Flats Partners LLC
Windy Point Partners LLC

Utilities

Avista Corporation
Clark Public Utilities No. 1
Flathead Electric Coop
Lakeview Light and Power
PacifiCorp
Portland General Electric Company
Tacoma Power
Wasco Electric Coop Inc.

Interest Groups

1000 Friends of Oregon
Audubon Society of Portland
Blue Mountain Audubon Society
Blue Mountain Land Trust
Central Oregon Audubon Society
Charitable Trust
Columbia Gorge Economic Development Association
Columbia Land Trust
County of Wasco Historical Society
East Fork Hills Rural Association
Freshwater Trust
Friends of Columbia Gorge
Klickitat County Historical Society
Lower Columbia Basin Audubon Society
Maryhill Museum of Fine Arts
Mid Columbia Council of Governments
National Wildlife Federation
National Wind Watch
Nature Conservancy Oregon
Nature Conservancy Washington
Northwest Energy Coalition
NW Wind Partners
Oregon Apollo Alliance
Oregon Environmental Council
Oregon Farm Bureau Federation
Oregon Natural Desert Association
Oregon Public Utilities Commission
Oregon Rangeland Trust
Oregon Rural Action
Oregon Wild
Pacific Environmental Advocacy Center/Northwest Environmental Defense Center
Palouse Audubon Society
Peace Meal Gardens
Public Generating Pool
Renewable Northwest Project
Save our Scenic Area
Seattle Audubon Society
Sierra Club
Spokane Audubon Society
The Mountaineers
Trust for Public Lands
Vancouver Audubon Society
Washington Environmental Council
Washington Environmental Law Center
Washington Pilots Association
Washington State Cattlemen’s Association
Washington Trails
Washington Wildlife Federation
Willapa Hills Audubon Society
Yakima Valley Audubon Society

Media

Newspapers:
The Dalles Chronicle
Tri-City Herald
Goldendale Sentinel

Television:
KNDU (Tri-Cities)
KVEW (Tri-Cities)
KFFX (Tri-Cities)

Radio Stations:
KONA-AM (Tri-Cities)
KFLD-AM (Tri-Cities)
KTCR-AM (Tri-Cities)
KWWS-AM (regional public radio)
KODL-AM (The Dalles)
KOCI-AM (The Dalles)
KLCK-AM (Goldendale)

University Repository Libraries

Central Washington University
Eastern Washington University
Evergreen State College
Northwestern University
Oregon State University
Portland State University
University of Oregon
University of Washington

Chapter 11
Glossary and Acronyms

Glossary

access road — Roads constructed to each tower site first to build the tower and line, and later to maintain and repair it.

alluvial fan — A fan-shaped geological deposit consisting of material deposited by a moving stream that radiates downslope from the point where the stream emerges from a narrow valley onto a plain.

alluvium — Deposits left by flowing water, usually clay, silt, sand, or gravel.

altithermal — The dry postglacial period extending from 7500 to 4000 years ago, during which time temperatures were believed to be distinctly higher than present temperatures. The term can also be used relating to any time period or climate characterized by high or rising temperatures.

ambient — Surrounding natural conditions or environment of a given place at a given time.

ampere (A) — A unit of measurement of electric current, which is the rate that electrons flow in a wire; one ampere is 6.023 x 1023 electrons per second. The measurement is similar to gallons per minute of water in a pipe.

anadromous fish – Fish that hatch and rear in fresh water, migrate to the ocean (salt water) to grow and mature, and migrate back to fresh water to spawn and reproduce.

anticline — A fold in which older rocks are at the core of the fold and younger rocks are at the outer surface of the fold (e.g., an inverted "U").

aquatic exploitation — The fishing and/or gathering of food resources from water, in this case, from the Columbia River.

aquifer — Groundwater zone with water of sufficient volume, transmissivity, and quality to facilitate economic use.

arcuate – Shaped like an arc.

armoring — To give protection using a surface layer of gravel in a river bed preventing erosion of the material below.

average daily traffic — The total number of cars passing over a segment of roadway, in both directions, on a typical day.

basalt — Lava with a composition that is relatively high in iron and manganese.

bedrock — Solid rock beneath the soil and surface rock.

benching — A shelf-like area of rock with steep slopes above and below.

benthic — Of, relating to, or occurring at the bottom of a body of water.

Best Management Practices (BMPs) — A practice or combination of practices that are the most effective and practical means of preventing or reducing the amount of pollution generated by nonpoint sources.

Biological Opinion — A document that states the opinion of the USFWS as to whether a federal action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. It may also determine if the proposed action would result in an “incidental taking” of a listed species (see “incidental take” below).

bird diverters — Devices utilities place on transmission conductors, overhead ground wires, fiber optic cables or other wires so birds can see the wires and avoid colliding with them**.**

blackout — The disconnection of the source of electricity from all electrical loads (users) in a certain geographical area.

blasting — The controlled use of explosives to excavate or remove rock.

breeding area —The geographic area used by a pair of bald eagles during the breeding season. Breeding areas must include some evidence of past reproduction, but may not include an existing nest of bald eagles.

buffer — A barrier of permanent vegetation between waterways and human land uses.

bull trout — Members of the char subgroup of the salmon family (salmonids), which also include the Dolly Varden, lake trout, and Arctic char.

bus — A conductor or group of conductors that serves as a common connection for two or more circuits and is used to interconnect equipment of the same voltage. In substations, BPA uses mostly rigid bus made of aluminum pipe which varies in size from 2 inches to 8 inches in diameter.

bairn — A small grouping of rocks stacked in a linear or circular manner.

candidate species — Species identified by the USFWS or NMFS as meeting the definition of threatened or endangered and therefore considered candidates for being placed on the federal lists of threatened or endangered wildlife and plants.

capacity — The maximum load that a generator, piece of equipment, substation, transmission line, or system can carry under existing service conditions.

carbon monoxide (CO) — An odorless and colorless gas formed from one atom of carbon and one atom of oxygen.

Category 5 water — A category of water quality as defined by EPA that includes polluted water bodies that require but do not yet have a water quality improvement project (TMDL). These impaired water bodies make up the 303 (d) list under the Clean Water Act (CWA).

census block group — The smallest area for which a census compiles sample data; comprised of census blocks.

census county division (CCD) – A subdivision of a county that is a relatively permanent statistical area established cooperatively by the Census Bureau and state and local government authorities.

census tract – A subdivision of a county smaller than a CCD that often follows visible features, but may also follow governmental boundaries and other non-visible features; homogenous with respect to population characteristics, economic status, and living conditions.

circuit — One alternating current transmission line, made up of three conductors; this would be called a “single-circuit line.” A “double-circuit line” would be made up of two sets of three conductors.

Clean Water Act 303(d) list – List of waterbodies that do not meet water quality standards as set by the EPA under the CWA.

climax — The stable and self-perpetuating end stage of an ecosystem.

colluvium — Rock fragments, sand, etc., that accumulate on steep slopes or at the foot of cliffs.

combustion pollutants — Gases or particles that come from burning materials.

compaction (Soils) — Compression of soil pores from rolling, tamping, or use of heavy equipment on soil. Soils become hardened, difficult to cultivate, and impermeable to air and water.

conductor — The wires that carry the electrical current on a transmission line.

conductor fitting — A steel inner sleeve, and an aluminum outer sleeve that when compressed with a hydraulic press, connect two lengths of conductor together.

construction agreement roads — Roads that are proposed by the construction contractor to facilitate the construction process.

corona — Corona occurs in regions of high electric field strength on conductors, insulators, and hardware when sufficient energy is imparted to charged particles to cause ionization (molecular breakdown) of the air.

corridor — A strip of land forming a passageway for transportation or utility facilities.

counterpoise — A series of aluminum wires buried in the ground at the base of transmission towers that take a lightening charge from the ground wire on the tower and dissipate it into the earth.

critical habitat – As defined in the Endangered Species Act, specific areas within the geographic area occupied by a listed species at the time of listing, on which are found biological and physical features essential to the conservation of the species and which may require special management considerations for protection.

cross arms — The horizontal supports on a wood pole or steel transmission tower that support the insulators.

CRP lands — Lands enrolled in the Conservation Reserve Program.

cryptogamic crust — A hard soil crust dominated by a plant community of algae, lichens, or mosses. These soil crust organisms are called cryptogams.

cull — Culls are live trees with external, visible defects that make them unsuitable for merchantable timber.

cultural resources — A general term frequently used to refer to a wide range or archeological sites, historic structures, museum objects, and traditional cultural places.

culvert — A corrugated metal or concrete pipe used to carry or divert runoff water from a drainage; usually installed under roads to prevent washouts and erosion.

cumulative impacts – The impact on the environment which results from the incremental impact of the action when added to the past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions.

current — The amount of electrical charge flowing through a conductor (as compared to voltage, which is the force that drives the electrical charge).

cut-and-fill — Process of constructing a road or canal whereby the amount of material from cuts roughly matches the amount of fill needed to make nearby embankments.

danger tree — A tree of sufficient height to potentially hit a tower or the conductors if it were to fall or be blown over.

dBA — The first two letters (dB) are an abbreviation for decibel, the unit in which sound is most commonly measured (see decibel). The last letter (A) is an abbreviation for the scale (A-scale) on which the sound measurements were made.

dead-end towers — Heavy towers designed for use where the transmission line loads the tower primarily in tension rather than compression, such as in turning large angles along a line or bringing a line into a substation.

debitage — Residual material resulting from stone tool manufacture or maintenance. Individual pieces are referred to as flakes or blades if they contain evidence of manufacturing, or shatter, if they lack such evidence.

debris flow — Rapid movement of water-charged mixtures of soil, rock, and organic debris down steep stream channels.

decibel (dB) — A unit of sound measurement. In general, a sound doubles in loudness for every increase of ten decibels.

delta configuration — Three wires of a transmission line circuit in a triangular, or delta, shape with one wire higher than the others. EMF levels decline more rapidly with this design.

dewatering — To divert or remove water from a excavated area, stream or river channel.

diagnostic artifacts — An artifact that maintains a distinguishing mark or displays a certain characteristic that allows the object to be placed with some certainty into a chronological period.

distinct population segments (DPS) — A subgroup of a vertebrate species that is treated as a species for purposes of listing under the Endangered Species Act. It is required that the subgroup be separable from the remainder of and significant to the species to which it belongs.

distribution line – The local wires from a distribution utility's lower voltage electric system used to deliver electric energy to end users.

double-circuit towers — Towers that can hold two transmission lines.

downcutting — When streams cut channels down into the rock, steepening valley walls; downcutting typically produces narrow valleys.

dry wash — A streambed that carries water only during and immediately following rainstorms.

duripan — A highly consolidated or weakly cemented soil layer that can impede plowing.

easement — A grant of certain rights to the use of a piece of land. This includes the right to enter the property to build, maintain, and repair the facilities. Permission for these activities is included in the negotiation process for acquiring easements on private land.

ecosystem — Interacting system of elements in a biological community, together with interactions with the surrounding environment.

electromagnetic fields (EMF) — The two kinds of fields (electric and magnetic) produced around the electric wire or conductor when an electric transmission line or any electric wiring is in operation.

electrofishing — Employing an electric current to attract or stun fish in order to take a census of a population.

emergent — An aquatic plant having its stem, leaves, etc., extending above the surface of the water.

endangered species — Those species officially designated by the USFWS or the NMFS as being in danger of extinction throughout all or a significant portion of their range. A designation (or the variant "listed endangered [LE]") also used by state agencies for state lists.

Endangered Species Act (ESA) — A 1973 Federal law, amended in 1978 and 1982, to protect troubled species from extinction. NOAA Fisheries and the USFWS decide whether to list species as threatened or endangered. Under the Act, federal agencies must avoid jeopardy to and aid the recovery of listed species.

Energy Overlay Zone — A Klickitat County, Washington zoning overlay that promotes construction of wind power generation and associated transmission infrastructure.

environmental impact statement (EIS) — A detailed statement of environmental impacts caused by an action, written as required by the National Environmental Policy Act.

eolian sands — Sands that are the product of wind erosion.

ephemeral stream — A channel that carries water only during and immediately following rainstorms. Sometimes referred to as a dry wash.

essential fish habitat (EFH) — Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (Magnuson Fishery Conservation and Management Act).

evolutionarily significant units – A population or group of populations that is considered distinct for purposes of conservation under the ESA.

exceedence levels (L levels) — Refers to the A-weighted sound level that is exceeded for a specified percentage of the time during a specified period. Thus, L10 refers to a particular sound level that is exceeded 10 percent of the time.

expansive soil — Soil that contains minerals that are capable of absorbing water.

exotic species — Species that are not native to a particular region.

eyrie — The nests of birds of prey usually built in high places such as trees or cliffs.

fallow land — Cropland that is not seeded for a season; it may or may not be plowed.

farmland of statewide importance — Land, in addition to prime farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oil seed crops. Farmlands of statewide importance typically include land that is nearly prime farmland and has the potential to economically produce high crop yields.

federally listed — Species listed as threatened or endangered by the USFWS.

fiber optic cable — Special wire installed on the transmission line that is used for communication between one location and another. Fiber optic technology using light pulses instead of radio or electrical signals to transmit messages.

fish-bearing stream — Any water that has fish presence, or is used by fish, even if for only one day a year.

fissure — A long narrow depression in the land surface.

Flashover — A disruptive discharge through the air around or over the surface of an insulator produced by the application of a voltage of sufficient magnitude to cause the breakdown path to become ionized and result in an electric arc or fault. Can be caused by lightning surges on a transmission line.

floodplains — Areas adjacent to rivers and streams that might be flooded during high water; those that have a 1 percent chance of being flooded in a given year are 100-year floodplains.

forb — Any herbaceous plant that is not a grass or not grasslike.

ford — A shallow place in a stream, river, etc., where the water depth does not prevent vehicle movement. Ford construction can include grading and stabilizing streambanks at the approaches and adding coarse fill material within the channel to stabilize the road.

fugitive dust— Any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of the activities of people.

gauss — A unit of magnetic induction.

geographic information system (GIS) — A computer system that analyzes graphical map data.

geologic unit — Geologic units are physiographic units and rock lithology or coarse stratigraphy of exposed bedrock.

glacial moraine — Material transported by a glacier and then deposited; can be sand, gravel, boulders, etc.

glacial outburst flooding —A hydrological phenomenon that refers to the sudden release of water stored in glaciers.

glacial outwash — Stratified sediment, consisting chiefly of sand and gravel, removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the terminal moraine or the margin of an active glacier.

glacial till — Unstratified, unsorted, glacial drift of clay, silt, sand, boulders and gravel.

greenhouse gas — Chemical compounds found in the earth's atmosphere that absorb and trap infrared radiation, or heat, re-radiated from the surface of the earth.

ground wires — Two small wires on a transmission line that would take the charge of a lightening strike to protect the conductors.

groundwater — Water that occurs below the surface of the erth, where it occupies spaces in soils or geologic strata.

grubbing — Removal of all surface objects, brush, roots, and other protruding obstructions, not designated to remain, and all trees and stumps marked for removal.

habitat types — Lands capable of producing similar plant communities at climax.

headscarp — The uppermost failure plane on a landslide.

herbaceous — Plants whose growing stems possess little or no woody tissue.

herbicide — A chemical substance used to kill, slow, or suppress the growth of plants.

hertz (Hz) — The unit of frequency in cycles per second; power systems in the U.S. operate with a frequency of 60 Hz.

high-voltage — Lines with 230-kV or above electrical capacity.

horst — A geologic block that is bounded by normal faults with the down-thrown side of the faults to the outside of the block.

hydrocarbons — A group of chemical compounds containing only hydrogen and carbon.

hydrolic modifications — Permanent impacts to streams or other water bodies that can be caused by installing culverts or bridges.

hydrology — The science of the properties, distribution, and circulation of water.

hydroperiod — Within wetlands, the hydroperiod is the duration of soil saturation or inundation.

hydrofluorocarbons (HFCs) — Hydrofluorocarbons, organic compounds that contain only one or a few fluorine atoms, are the most common type of industrial organofluorine compounds found. HFCs are used as refrigerants and their atmospheric concentrations are rapidly increasing causing international concern about their rising contribution to anthropogenic radiative forcing emissions (global warming).

indigenous — Existing naturally in a region, state, country, etc.

insulators — Nonreflective bell-shaped devices made of porcelain or fiberglass that prevent the electricity from jumping from the conductors to the tower and going to the ground.

intermittent — Referring to periodic water flow in creeks or streams.

invertebrates — Any animal without a backbone or spinal cord; any animal other than a fish, amphibian, reptile, bird, or mammal.

irreversible commitment of resources —The use of nonrenewable resources such as minerals and petroleum-base fuels. Irretrievable commitments of resources cause the lost production or use of renewable resources such as timber or rangeland.

isolate finds — A singular artifact (e.g., projectile point, historic bottle, or 1922 Model T) or a grouping of artifacts that do not meet a specific density ratio to be classified as a site.

kilovolt — One thousand volts. (See **Volt.**)

landslide — Any mass-movement process characterized by downslide transport of soil and rock, under gravitational stress, by sliding over a discrete failure surface; or the resultant landform. Can also include other forms of mass wasting not involving sliding (rockfall, etc.).

large woody debris (LWD) — Any piece of downed wood larger than 4 inches in diameter and 6 feet long.

liDAR — A remote sensing technology employing eye-safe laser pulses originating from a helicopter or airplane and used to collect terrain data.

line losses — Energy consumed by the conductor generating heat during transport of power through each line; a function of load, circuit length, conductor size, and electrical “resistance.”

liquefaction — The fluid-like behavior of soils during a seismic event.

lithic — Made of stone.

lithosol – Literally, rocky soil. Very thin soil formed from the weathering of the underlying rocks.

load — The amount of electric power or energy delivered or required at any specified point or points on a system. Load originates primarily at the energy-consuming equipment of customers.

load growth — Increase in demand for electricity. (See **Load**.)

loess — An unstratified usually buff to yellowish brown loamy deposit found in North America, Europe, and Asia and believed to be chiefly deposited by the wind.

lomatium — Lomatium, referred to in English by Sahaptin native speakers as Indian celeries, produces edible sprouts, stems, and shoots and would be harvested seasonally. Lomatium habitat is fund on talus slopes and rocky lowlands along streams.

low-gradient — With gentle slopes.

mafic vent — Eruptive location for lava with relatively high concentrations of iron and manganese (i.e., in this area, basalt).

marker balls – Marker balls are used on power transmission lines that span a large distance. The purpose of these marker balls is to indicate to low-flying aircraft where the transmission lines are so that they do not fly into them (these collisions are referred to as a "wire strike"). The FAA mandates their usage. While from the ground it is easy to identify where the transmission lines are against the sky as a backdrop, the thin transmission lines are often difficult to see from the air with a varied terrain backdrop.

mass wasting — The downward movement of rock debris.

megawatts (MW) — A megawatt is one million watts, or one thousand kilowatts; an electrical unit of power.

midden — The layer of soil which contains the byproducts of human activity as the result of the accumulation of these materials on their living surface.

milligauss (mG) — A unit used to measure magnetic field strength; one-thousandth of a gauss.

Miocene epoch — A subdivision of geologic time within the Tertiary Period, between about 26 and 7 million years ago.

mitigation measures — Steps taken to lessen the impacts of proposed activities on a specific resource. Measures may include reducing the impact, avoiding it completely, or compensating for the impact.

monitor species — Those species for which Washington state monitors status and distribution either because they have been listed as state threatened, endangered, or sensitive within the previous 5 years; they require a habitat that has limited availability during at least some portion of their life cycle; they are environmental indicators; or their taxonomy is in question and it is unclear whether they should be included as listed species.

National Environmental Policy Act (NEPA) — This act requires an environmental impact statement on all major federal actions significantly affecting the quality of the human environment. [42 U.S.C. 4332 2(2)(C).]

native species— Species of plants, animals, or birds that originated in a given ecological area.

nitrogen oxides — A group of compounds consisting of various combinations of nitrogen and oxygen atoms.

nonattainment area — An area that does not meet air quality standards set by the Clean Air Act for specified localities and periods.

nonnative species — Species that have migrated or have been imported to an ecological area. Nonnative plants or species may compete for space and nutrients with a (more desirable) native species.

normal fault — A fault where overlying rocks have dropped downward relative to the underlying rocks across a failure plane; fault plane surfaces are typically near vertical.

Notice of Intent (NOI) — A public notice that an environmental impact statement will be prepared and considered in the decision making for a proposed action.

noxious weeds — Plants that are injurious to public health, crops, livestock, land or other property.

100-year floodplain — Areas that have a 1 percent chance of being flooded in a given year. (See **Floodplain**.)

ordinary high water mark (OHWM) — An elevation that marks the boundary of a lake, marsh, or streambed. It is the highest level at which the water has remained long enough to leave its mark on the landscape. Typically, it is the point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial.

outage — Events caused by a disturbance on the electrical system that requires the provider to remove a piece of equipment or a portion or all of a line from service. The disturbances can be either natural or human-caused.

overload — Moving too much current flow over transmission facilities. Equipment has safeguards: in the event of system overload, switches will disconnect sensitive equipment from the flow of electricity.

palliatives — Compounds used to mitigate fugitive dust on roads in arid climates. Several types of palliatives are found to control dust which includes polymer emulsions, lignosulfonates, chloride salts, synthetic fluids, an asphalt emulsion, a polysaccharide solution, a polyacrylamide, and a guar gum.

palustrine— Wetland or marsh, including inland marshes, swamps, bogs, fens, tundra, and floodplains.

particulate matter (PM) — Airborne particles including dust, smoke, fumes, mist, spray, and aerosols.

passerines — Birds belonging to the avian order *Passeriformes*, which includes the perching birds. Passerine birds make up more than half of all living birds. They are of small to medium size, have three toes pointing forward and one pointing back, and are often brightly colored. Larks, swallows, jays, crows, wrens, thrushes, cardinals, finches, sparrows, and blackbirds are all passerine birds.

perched groundwater — Ground water in a saturated zone of material that is underlain by a relatively impervious stratum which acts as a barrier to downward flow and which is separated from the main ground water body by a zone of unsaturated material above the main ground water body.

perennial streams — a watercourse that flows throughout a majority of the year in a well-defined channel.

pithouse — A semi-subterranean "earth-lodge" dwelling. Usually consisted of an earth-covered log framework roof over a circular to rectangular structure.

polychlorinated biphenyls (PCBs) — Oily, persistent substance formerly manufactured for use in electrical equipment, primarily as a dielectric in capacitors, no longer used by BPA.

power circuit breakers — A breaker is a switching device that can automatically interrupt power flow on a transmission line at the time of a fault, such as a lightning strike, tree limb falling on the line, or other unusual events. The breakers would be installed at the substation to redirect power as needed.

prehistoric — Referring to cultural resources that predate European settlement in North America.

prime farmland – Federally designated land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses.

priority area or ecosystem — A specific plant-community type identified by the Oregon Natural Heritage Program or Washington Natural Heritage Program as high-quality or rare ecosystems based on global, national, and state data, for which conservation efforts should be focused.

priority habitat — Natural animal habitats that have unique or significant value to a diverse assemblage of animal species and are used in guiding conservation and management priorities of the state.

radial power source — A single source of power to a particular customer.

redundant power source —Two sources of power to a particular customer.

revegetate — Re-establishing vegetation on a disturbed site.

right-of-way — An easement for a certain purpose over the land of another, such as a strip of land used for a road, electric transmission line, pipeline, etc.

riparian habitat — The zone of vegetation that extends from the water's edge landward to the edge of the vegetative canopy. Associated with watercourses such as streams, rivers, springs, ponds, lakes, or tidewater.

roller-chopper — A drum with bars attached to the side that is pulled behind a bulldozer or tractor. The roller-chopper is used to break down slash.

sag — The distance that the conductor droops below a straight line between two towers.

salmonid — Fish belonging to the family of salmonidae, including salmon, trout, char, whitefish, and allied freshwater and anadromous fish.

scabland — Elevated land that is essentially flat-lying and covered with basalt and has only a thin soil cover, sparse vegetation, and usually deep, dry channels.

scoping — Part of the environmental impact document process where significant issues are identified for detailed analysis.

sedimentation — The deposition or accumulation of sediment.

sensitive species — A species that is vulnerable or declining and could become endangered or threatened in the state of Washington.

sere — A sequence of ecological stages from the initial stage (early-seral; usually following a disturbance) to the climax stage (late-seral).

single-circuit tower — A tower that can support only one transmission line.

special-status species — Those species protected under the federal ESA as threatened, endangered, or candidate species; those listed by USFWS as species of concern; and those listed for protection by the states of Oregon and Washington.

species — A group of interbreeding individuals not interbreeding with another such group; similar, and related species are grouped into a genus.

Species of Concern — Species considered by the USFWS to potentially be in jeopardy, but for which sufficient information does not exist to support listing on the federal threatened or endangered wildlife and plant lists.

strike-slip fault – Fault where one rock body moves horizontally against another along a failure plane; fault plane surfaces are typically vertical. A right lateral fault indicates that rocks across the fault have moved to the right relative to the observer.

substation dead-end towers — These are the towers within the substation where incoming or outgoing transmission lines end. Substation dead-ends are typically the tallest structure within the substation.

substation rock surfacing — A 3-inch layer of rock, selected for its insulating properties, is placed on the ground within the substation to protect operation and maintenance personnel from danger during substation electrical failures.

surface water — Water collecting on the ground or in a stream, river, lake, sea or ocean.

suspension tower — A tower designed to support conductors strung along a virtually straight line with only small turning or descending or ascending angles. About five suspension towers are used each mile; tangent towers have no turn angle; angle towers have light or heavy turning abilities.

switches — Devices used to mechanically disconnect or isolate equipment; found on both sides of circuit breakers.

syncline — Fold in which older rocks are at the outer surface of the fold and younger rocks are at the core of the fold (e.g, "U").

system reliability — The ability of a power system to provide uninterrupted service, even while that system is under stress.

tap — The point at which a transmission line is connected to a substation or other electrical device to provide service to a local load.

tariff — Schedules detailing utility rates, rules and regulations, and terms of service filed for approval with a regulatory agency. Usually relative to retail, end-use customer service, although for all practical purposes BPA's Wholesale Power and Transmission Rate Schedules are tariffs filed before FERC.

threatened species — Those species listed by the USFWS or the NMFS as likely to become endangered within the foreseeable future through all or a significant portion of their range. A designation also used by state agencies for state lists.

thrust fault — A fault where overlying rocks have overridden the underlying rocks along a failure plane; fault plane surfaces are typically much flatter than those associated with normal or strike-slip faults.

trackhoe — (Also known as excavators) are heavy equipment consisting of a boom, bucket and cab on a rotating platform.

traditional cultural properties (TCPs) — Landmarks or sites identified by an existing community as being important to that community's historic identity, traditional knowledge and culture.

transformers — Electrical equipment usually contained in a substation that is needed to change voltage on a transmission system.

transmission line — The towers, insulators, conductors, and other equipment used to transmit electrical power at high voltage to electric distribution facilities (substation).

tuff – Volcanic fragments (usually ash) consolidated to the point of becoming a rock. Tuffaceous indicates rocks with a high proportion of volcanic ash.

turbidity — The extent to which water is muddy or cloudy due to the presence of suspended matter.

undesirable plant species — Those plant species that are "undesirable, noxious, harmful, exotic, injurious, or poisonous, pursuant to state or federal law," and that should be managed where county or private management plans are in place, as stated in the federal Noxious Weed Act.

volt — The international system unit of electric potential and electromotive force.

voltage — The driving force that causes a current to flow in an electrical circuit.

watershed — The area that drains to a common waterway.

wetlands — An area where the soil experiences anaerobic conditions because of inundation of water during the growing season. Indicators of a wetland include types of plants, soil characteristics, and hydrology of the area.

woody debris — Materials left over from cutting or harvesting, such as limbs of branches of a tree. Woody debris may be placed in stream channels to slow and divert water flow and improve habitat for fish.

zoning — Regulations used to guide growth and development; typically involve legally adopted restrictions on uses and building sites in specific geographic areas to regulate private land use.

Acronyms

acre·year	per acre per year
µm	micrometers
ACGIH	American Conference of Governmental Industrial Hygienists
ACHP	Advisory Council on Historic Preservation
ADPA	Archaeological Data Preservation Act
ADT	average daily traffic
AGC	Associated General Contractors of Washington
aMW	average megawatts
APLIC	Avian Power Line Interaction Committee
ARPA	Archaeological Resources Protection Act
ATC	available transmission capacity
BLM	Bureau of Land Management
BIA	Bureau of Indian Affairs
BA	Biological Assessment
BLM	Bureau of Land Management
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe Railroad
BPA	Bonneville Power Administration
°C	degrees Celsius
CAO	Critical Areas Ordinance

CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CHNAP	Columbia Hills Nature Area Preserve
CO_2	carbon dioxide
Corps	U.S Army Corps of Engineers
CP	counterpoise
CRGC	The Columbia River Gorge Commission
CRGNSA	Columbia River Gorge National Scenic Area
CRP	Conservation Reserve Program
DAHP	Department of Archaeology and Historic Preservation
dBA	A-weighted decibels
DEQ	Oregon Department of Environmental Quality
DGER	Washington Department of Geology and Earth Resources
DLCD	Department of Land Conservation and Development
DNR	Washington Department of Natural Resources
DOE	Department of Energy
DPS	distinct population segment
DSL	Oregon Department of State Lands
E	endangered species
Ecology	Washington State Department of Ecology
EDNA	Environmental Designations for Noise Abatement
EFH	essential fish habitat
EFSC	Oregon Energy Facility Siting Council
EFSEC	Washington Energy Facility Site Evaluation Council
EIA	Energy Information Administration
EIS	environmental impact statement
EMF	electromagnetic fields
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
F	fahrenheit

FAA	Federal Aviation Administration
FAC	facultative
FACU	facultative upland
FACW	facultative wetland
FAR	Federal Aviation Regulation
FCDP	Fugitive Dust Control Plan
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy Management Act
FR	Federal Register
FSA	Farm Service Agency
G	gauss
GIS	geographic information system
GMA	General Management Areas
Gorge	Columbia River Gorge
GPS	global positioning system
GUA	Gorge Urban Area
GWP	global warming potential
HFCs	hydrofluorocarbons
I	Interstate
ICES	International Committee on Electromagnetic Safety
IMPLAN	Impact Analysis for Planning
IPCC	Intergovernmental Panel on Climate Change
kV	kilovolt
kWh	kilowatt hours
L_{eq}	equivalent sound level
LCDC	Land Conservation and Development Commission
LE	listed (state) endangered species
LiDAR	Light Detection and Ranging
Line mile W, M, E, WM, ME	line mile West (W), Middle (M), East (E), West and Middle (WM), Middle and East (ME)
m	meter
Magnuson-Stevens	Magnuson-Stevens Fishery Conservation and Management Act

Act	
Management Plan	Columbia River Gorge National Scenic Area Management Plan
mG	milligauss
mg/l	milligrams/liter
MOU	memorandum of understanding
MOA	memorandum of agreement
MP	milepost
MW	megawatt
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards (NAAQS)
NAGPRA	Native American Graves Protection and Repatriation Act
National Scenic Area	Columbia River Gorge National Scenic Area
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act
NI	no indicator
NL	not listed
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NOS	Network Open Season
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NTUs	nephelometric turbidity units
NWI	National Wetlands Inventory
OAR	Oregon Administrative Rules
OASIS	Open-Access Same-Time Information System
OBL	obligate
ODA	Oregon Department of Agriculture

ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ORNHIC	Oregon Natural Heritage Information Center
DOGAMI	Oregon Department of Geology and Mineral Industries
ORS	Oregon Revised Statutes
Parks	Washington Department of Parks and Recreation
PCBs	polychlorinated biphenyls
PEM	palustrine emergent
PFCs	perfluorocarbons
PL	public law
PM	particulate matter
ppm	parts per million
PSS	palustrine scrub-shrub
PUD	public utility district
RAS	remedial action scheme
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RM	river mile
ROW	right-of-way
RUSLE	Revised Universal Soil Loss Equation
S	(State) sensitive species
SCS	Soil Conservation Service
SEPA	State Environmental Policy Act
SF_6	sulfur hexafluoride
SHPO	State Historic Preservation Office
SMA	Special Management Areas
SMP	Shoreline Master Program
SoC	species of concern
SPCC	Spill Prevention, Control, and Countermeasures
SPPP	Stormwater Pollution Prevention Plan
SR	State Route
SF_6	sulfur hexafluoride
SWPPP	Stormwater Pollution Prevention Plan

T	threatened species
TCP	traditional cultural properties
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TSD	treatment, storage, and disposal facility
USC	United States Code
UPRR	Union Pacific Railroad
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
USGS	United States Geological Survey
VDTs	video display terminals
V/m	volts/meter
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WECC	Western Electricity Coordinating Council
WNHP	Washington Natural Heritage Program
WHO	World Health Organization
WL	wetland
WRD	Oregon Water Resources Department
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSPRC	Washington State Parks and Recreation Commission
WWTP	wastewater treatment plant

Chapter 12
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BONNEVILLE POWER ADMINISTRATION

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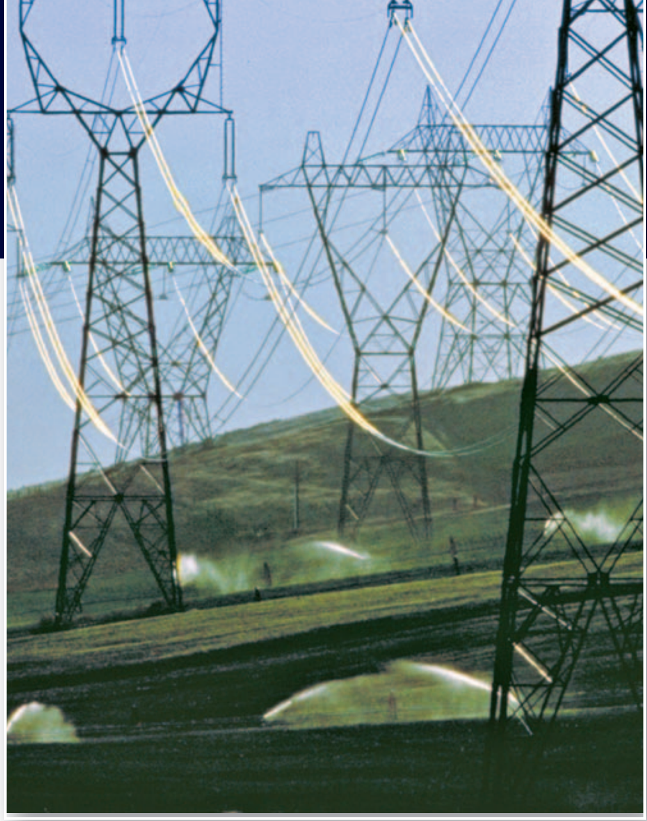
Appendix A

Living and Working Safely Around High-Voltage Power Lines

BONNEVILLE POWER ADMINISTRATION

LIVING AND WORKING SAFELY

AROUND HIGH-VOLTAGE POWER LINES



High-voltage power lines can be just as safe as the electrical wiring in our homes — or just as danger-ous. The key is learning to act safely around them.

This booklet is a basic safety guide for those who live and work around power lines. It deals primarily with nuisance shocks caused by induced voltages and with possible electric shock hazards from contact with high-voltage lines.

In preparing this booklet, the Bonneville Power Administration has drawn on more than 70 years of experience with high-voltage power lines. BPA operates one of the world's largest networks of long-distance, high-voltage lines, ranging from 69,000 volts to 500,000 volts. This system has more than 200 substations and more than 15,000 miles of power lines.

BPA's lines make up the main electrical grid for the Pacific Northwest. The grid delivers large blocks of power to substations located near load centers. Public and investor-owned utilities and rural cooperatives take delivery of the power at these points and deliver it to the ultimate customers.

BPA's lines cross all types of property: residential, agricultural, industrial, commercial and recreational.

If you have questions about safe practices near power lines, call BPA.

Due to safety considerations many of the practices suggested in this booklet are restrictive. This is because they attempt to cover all possible situa-tions, and the worst conditions are assumed. In certain circumstances, the restrictions can be re-evaluated. To determine what practices are applicable to your case, contact BPA at 1-800-836-6619 or find the contact information for the local BPA office at *www.transmission.bpa.gov/LanCom/Real_Property.cfm*.

Using the Right-of-Way

Before a power line is built, BPA negotiates with the landowner for the right to cross the land as required for the construction, operation and maintenance of the line. Usually, BPA acquires right-of-way rights to construct, operate and maintain a power line and the right to keep the right-of-way clear of all structures, fire hazards, vegetation and any other use that may interfere with the operation or maintenance of the line. Most crops, less than 10 feet in height, can be grown safely under power lines. Orchards, Christmas trees and structure-supported crops (i.e., trellises) require special consideration.

Call BPA if you plan to use the right-of-way for any use.

BPA's "Landowner's Guide for Compatible Use of BPA Rights-of-Way" explains how to apply for permission to use a portion of a BPA right-of-way for approved purposes. This document can be found online at *www.transmission.bpa.gov/LanCom/Real_ Property.cfm* or by contacting BPA at 1-800-836-6619.

Construction and maintenance of any structures are specifically prohibited within a BPA right-of-way. Coordinating with BPA early in your planning process can keep you safe and avoid wasting time and money.

Most crops, less than 10 feet in height, can be grown safely under power lines.

General Safe Practices

BPA designs and maintains its facilities to meet or exceed the rules set forth in the National Electrical Safety Code. BPA provides information on safe practices because serious accidents involving power lines can be avoided if simple precautions are taken. Every kind of electrical installation — from the 110-volt wiring in your home to a 500,000-volt power line — must be treated with respect.

The most significant risk of injury from a power line is the danger of electrical contact. Electrical contact between an object on the ground and an energized wire can occur even though the two do not actually touch. In the case of high-voltage lines, electricity can arc across an air gap. The gap distance varies with the voltage at which the line is operated. Unlike the wiring in a home, the wires of overhead power lines are not enclosed by electrical insulating material.

The most important safe practice is this:

Avoid bringing yourself, or any object you are holding, too close to an overhead power line.

In other words, do not lift, elevate, build or pass under a power line with any object, equipment, facility or vehicle that could come close to the energized wires.

BPA does not recommend that anyone attempt to calculate how close they can come to a power line. As a general precaution, when under a line, never put yourself or any object any higher than 14 feet above the ground.

The National Electrical Safety Code specifies a minimum safe clearance for each operating voltage. BPA builds its lines so the clearance between the wires of a power line and the ground meets or exceeds the minimum safe clearance set forth in the code. Therefore, do not alter the ground elevation; without first applying to BPA, call 1-800-836-6619 to ensure safe distances are maintained.

Vehicles and large equipment that do not extend more than 14 feet in height, such as harvesting combines, cranes, derricks and booms, can be operated safely under all BPA lines that pass over roads, driveways, parking lots, cultivated fields or grazing lands.

For your safety, coordinate with BPA if you need to exceed the 14-foot limitation.

Possible Shock Hazards

The previous section discussed dangerous electrical contact conditions that can occur when getting too close to the high-voltage wires. This section

Farm equipment or large machinery 14 feet or less in height may be operated safely under all BPA lines in cultivated fields.

will discuss the possible electrical shock hazards that can occur when touching transmission towers or metallic objects near the power line but away from the high-voltage wires.

These types of shocks are caused by a voltage induced from the power line into the nearby metallic objects. Typically the shocks can be avoided when the nearby metallic objects are grounded or connected to earth. The severity of these shocks depends on the operating voltage of the power line, the distance from the conductor, the size or length of the object, its orientation to the line and how well the object is grounded.

Normally, shocks do not occur when BPA's guidance is followed (see the following sections). However, under certain conditions, non-hazardous nuisance shocks can still occur and possibly cause discomfort.

The severity of nuisance shocks can vary in sensation from something similar to a shock you might receive when you cross a carpet and then touch a door knob to touching the spark-plug ignition wires on your lawnmower or car. The nuisance shock, however, would be continuous as long as you are touching the metallic object. Such objects include vehicles, fences, metal buildings or roofs and irrigation systems that are near the line or parallel the line for some distance.

The possibility of nuisance shocks can be eliminated by grounding metal pipe when unloading near BPA lines.

Irrigation Systems

All types of irrigation systems have been operated safely near BPA power lines for years. Nonetheless, caution should be used in storing, handling and installing irrigation pipe, and in operating spray irrigation systems near power lines.

To avoid electrical contact with power lines, two very important safety practices should be observed at all times:

1. While moving irrigation pipe under or near power lines, keep the equipment in a horizontal position to keep it away from overhead wires.

2. Electricity can be conducted through water so never allow the irrigation system to spray a continuous stream onto power lines or towers.

In addition, central pivot circular irrigation systems installed near or under power lines can develop hazardous shock potentials during operation and maintenance. To eliminate these hazards:

- Provide a good electrical ground for the pivot point.
- Do not touch the sprinkler pipe or its supporting structures when the system is operating under or parallel to and near a power line.
- Perform repairs/maintenance of the system with the sprinkler pipe perpendicular to the power line.

For more information on storing, handling, installing or operating an irrigation system on BPA rights-of-way and to apply to use BPA's right-of-way please contact BPA at 1-800-836-6619. A copy of "Guidelines for Installation and Operation of Irrigation Systems" will be provided when you contact BPA for approval. This document describes methods for safely installing and operating an irrigation system under high-voltage power lines. This document also can be obtained at *www.transmission.bpa.gov/LanCom/Real_ Property.cfm.*

Irrigation pipe should be moved in a horizonal position under and near all power lines to keep it away from the lines overhead.

Underground Pipes, Telephone Cables and Electric Cables

Underground pipes and cables may be compatible with power lines provided installation and maintenance are done properly. Pipes and cables should not be installed closer than 50 feet to a BPA tower, any associated guy wires or grounding systems. These grounding systems are long, buried wires that are sometimes attached to the structures and can run up to 300 feet along the right-of-way. These grounding systems are not visible above ground and must be located before installing any underground utilities.

Proper positioning of underground utilities is required to prevent an accident in an extreme case when an unusual condition might cause electricity to arc from the high-voltage wire to the tower and then to ground. This could produce a dangerous voltage on underground piping or cable system. Contact BPA at 1-800-836-6619 to apply before installing any underground utilities within a BPA power line right-of-way.

Fences

BPA strongly discourages locating fences within the right-of-way as they can cause a potential safety hazard and an access problem (particularly in high-density subdivisions). Contact BPA at 1-800-836-6619 if you are interested in submitting an application to place a fence on the right-of-way using the guideline that the location must be a minimum of 50 feet from BPA structures as well as other considerations discussed below.

Wire Fences

Barbed wire and woven wire fences insulated from ground on wood posts can assume an induced voltage when located near power lines. If you are having a shock-related problem, call BPA for an investigation. The fence may need to be grounded if:

- it is located within the right-of-way;
- it parallels the line within 125 feet of the outside wire and is longer than 150 feet; or
- it parallels the line 125 to 250 feet from the outside wire and is longer than 6,000 feet.

These fences should be grounded at each end and every 200 feet with a metal post driven at least 2 feet into the ground. Attach all wire strands of the fence to the metal post. Install the grounding posts at least 50 feet from the nearest transmission tower. If shocks are experienced when contacting a fence or gate, or if you have any questions about the need for grounding, call BPA at 1-800-836-6619.

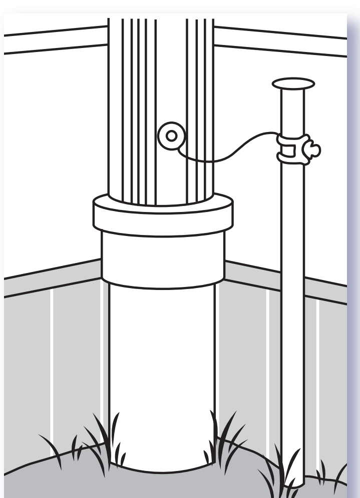
Electric Fences

In situations where a fence cannot be grounded (electric fences, for example), a filter may be installed to remove voltages induced by the power lines. BPA may provide this filter after an investigation has been conducted. Do not use fence chargers that are not approved by Underwriters' Laboratories, Inc. They may carry voltages and currents that are hazardous to anyone touching the fence — even if power lines are not present. For more information about fences, fence chargers or filters, call BPA at 1-800-836-6619.

Buildings

This section applies to buildings outside BPA's rights-of-way, since BPA prohibits buildings within a right-of-way.

Buildings located off BPA's rights-of-way may collect an induced voltage. This voltage is often drained through the building's plumbing, electrical service, metal sheeting or metal frame. If the voltage does not drain through the systems described above, then it can result in a nuisance shock situation.



Example of grounding a metal building at a down spout.

BPA recommends grounding metallic components on buildings near a power line when:

- the building is within 100 feet of the outside wire;
- the building has more than 2,000 square feet of metal surface and is within 100 to 150 feet of the outside wire; or
- the building is used to store flammable materials and is within 250 feet of the outside wire.

BPA will assist in grounding metallic objects after receiving a request and an investigation has been conducted. Call BPA at 1-800-836-6619 if you are having shock-related problems or if you have any question on grounding a building.

Vehicles

Under some high-voltage lines, vehicles can collect an induced voltage. This is particularly true if the vehicle is parked on a nonconductive surface such as asphalt or dry rock. You can drain the voltage from your vehicle to the ground by attaching a chain that reaches the ground or by leaning a metal bar against your vehicle. The only way to be sure you won't get shocked is to park your car away from the high-voltage power line.

BPA has specific restrictions for parking and roads within the right-of-way to keep possible shocks at a low level. Contact BPA at 1-800-836-6619 to apply before locating roads and parking areas within the BPA right-of-way.

Refueling vehicles is not allowed on BPA rights-of-way because there is a chance that a spark from an induced voltage could ignite the fuel.

Lightning

Lightning will usually strike the highest nearby object, which might be a power line tower or wire. Transmission facilities are designed to withstand lightning strikes by channeling them to ground at the tower.

Play it safe. Stay away from power lines and other tall objects during electrical storms. Lightning is dangerous if you are standing near where it enters the ground.

Fires

Smoke and hot gases from a large fire can create a conductive path for electricity. When a fire is burning under a power line, electricity could arc from the wire, through the smoke and to the ground, endangering people and objects near the arc. BPA does not permit burning within the right-of-way.

Field burning and other large fires in and around power lines can damage power lines and cause power outages. Water and other chemicals used to extinguish those fires should never be directed toward a power line.

Contact BPA at 1-800-836-6619 if you need to burn near a BPA right-of-way.

A fire burning under a power line can create a dangerous situation. Stay away from lines if a fire is nearby.

Kite Flying and Model Airplanes

BPA strongly discourages anyone from flying a kite or model airplane anywhere near a power line. The electricity from the line can travel through the string or hand line and electrocute a person on the other end. If your kite or model airplane is about to touch a power line, drop the string or hand line instantly, before it touches the line. Do not try to pull the kite or airplane down or climb up after it. Call the nearest electric utility.

Vandalism, Shooting and Trespassing

People entering high-voltage electrical facilities, such as substations and power line rights-of-way, for the purpose of vandalism or theft, run the risk of serious injury or death. For example, when hunting, do not shoot at transmission facilities. Gunshot damage can cause flashovers or may cause the wire to fall to the ground. This could be a serious hazard to anyone close to the power line. It could also cause a power outage and a fire.

Removal of equipment from substations or power line facilities can result in unsafe operating conditions and put people nearby at risk of serious injury or death. Those who cause willful damage to BPA transmission facilities or associated property can be prosecuted by the federal government, the property owner, or both.

Please report damage to transmission facilities to BPA's Crime Witness Program at 1-800-437-2744. The Crime Witness Program allows you to confidentially report an illegal activity that you witness against BPA's transmission system, property or personnel. This includes:

- Shooting at power lines, transmission towers or substation equipment.

- Dumping any waste or material on BPA property.
- Vandalism to BPA property, buildings and vehicles.
- Theft of BPA equipment, supplies, tools or materials.

This program offers rewards of up to $25,000 for information leading to the arrest and conviction of the perpetrator(s).

Tall Objects

Facilities

Temporary or permanent facilities within the right-of-way such as, light standards, signs, above-ground utilities, etc., can create unsafe situations when constructed too close to BPA power lines and structures. Permissable heights for such facilities can vary depending on site specfic conditions. Call BPA at 1-800-836-6619 to apply for these uses.

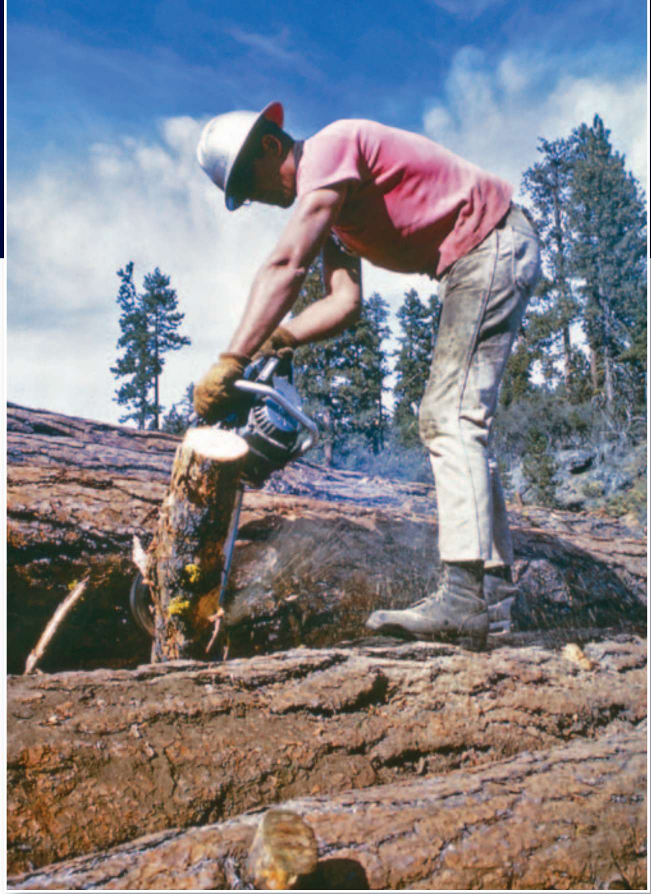
Activities

As a precautionary practice, do not raise any metal object more than 14 feet in the air underneath a power line. For example, when you mount an antenna on a vehicle that you plan to operate on a BPA right-of-way, do not let it extend more than 14 feet above the ground.

Before you sail a boat on a lake or river, check the allowable clearance under any power line. We recommend that all masts or guy wires above the deck be connected electrically to an underwater metallic part such as the keel or centerboard.

This precaution, which protects against lightning or accidental contact with a power line, may save your life.

Remember, if you plant, dig or build within the right-of-way an application is required. Any activities or use with a reach capacity greater than 14 feet (eg. cranes, dump trucks, irrigation systems, etc.) may cause safety concerns. Please specifically identify these uses and equipment in your application. Contact BPA to apply at 1-800-836-6619.



Cutting trees within power line rights-of-way can be dangerous. It is safer to have BPA do it for you.

Pools

BPA does not permit the building of swimming pools within BPA rights-of-way because it impedes our ability to operate and maintain the power line and presents a potential safety hazard to the public. Hazards range from possible electrical contact with the wires (with pool skimmers or rescue poles, for example) to dangers that can be encountered during and after lightning strikes on transmission facilities.

Climbing

Climbing on power line towers or guy wires can be extremely hazardous. Do not do it under any circumstance. It is dangerous and illegal.

Pacemakers

Under some circumstances, voltages and currents from power lines and electrical devices can interfere with the operation of some implanted cardiac pacemakers. However, we know of no case where a BPA line has harmed a pacemaker patient.

As a precaution, people who may have reason to be very near high-voltage facilities should consult with a physician to determine whether their particular implant may be susceptible to power line interference.

If a person with a pacemaker is in an electrical environment and the pacemaker begins to produce a regularly spaced pulse that is not related to a normal heartbeat, the person should leave the environment and consult a physician.

Trees and Logging

No logging or tree cutting should be done within BPA's right-of-way without first contacting BPA at 1-800-836-6619 to apply. In many cases, BPA owns the timber within its rights-of-way.

Additionally, logging or tree cutting near power lines can be very hazardous and requires special caution. Since trees conduct electricity, if one should fall into or close to a power line, the current could follow the tree trunk to the ground and endanger anyone standing near its base. Here are two simple rules:

1. If you come upon a tree that has fallen into a power line, stay away from it.

2. If you accidentally cause a tree to fall into a power line, run for your life! Do not go back to retrieve your saw or equipment. Call BPA or your local utility immediately.

If you have trees either on or close to the right-of-way that need to be cut, contact BPA at 1-800-836-6619. It is unsafe to do it yourself.

Since power line rights-of-way usually are not owned by BPA but are acquired through easements from landowners, trees or logs stacked within or alongside the rights-of-way are not public property. People removing trees and logs without permission are stealing and can be prosecuted.

Explosives

If you plan to detonate explosives near a BPA power line, apply to BPA well in advance by calling 1-800-836-6619 or find the contact information for your local office at *www.transmission.bpa.gov/LanCom/Real_ Property.cfm.* BPA will tell you if any special precautionary measures must be taken at a particular blasting site.

Any blasting near or within BPA rights-of-way must not damage any BPA facilities or permitted uses within the rights-of-way. Do not use electric detonating devices when blasting within 1,000 feet of a power line. Use of non-electric methods of detonation will avoid the danger of accidentally discharging an electric blasting cap due to induced voltages from energized transmission facilities.

Towers and Wires

- Do not climb towers.
- Do not shoot or otherwise damage transmission facilities.
- Never touch a fallen wire.
- Do not attempt to dismantle towers.
- Do not attach anything to towers.
- Stay away from towers and lines during extreme windstorms, thunderstorms, ice storms or under other extreme conditions.

Preventive measures include:

- Report any suspicious activities to BPA at 1-800-437-2744 or to your nearest electrical utility.
- Stay away from and report damage to transmission facilities to BPA at 1-800-437-2744 or your nearest electrical utility.
- Stay away from and report broken, damaged or abnormally low-hanging wires to BPA at 1-800-437-2744 or your nearest electrical utility.

Conclusion

We live in an age of electric power. Almost everything we do requires it. Consequently, high-voltage power lines have become about as commonplace as the wiring in our homes. Nevertheless, every year people are killed or seriously injured by power lines and home wiring. In almost every case, lives could have been saved and injuries avoided if the basic safety practices outlined in this booklet had been followed. BPA and your local utilities make every effort to design and build power lines that are safe to live and work around. Ultimately, however, the safety of high-voltage lines depends on people behaving safely around them. No line can practicably be made safe from a person who, through ignorance or foolishness, violates the basic principles of safety. Please take time now to learn the practices outlined in this booklet and share your knowledge with your family, friends and colleagues. Your own life, or that of a loved one, might well hang in the balance.

Related BPA Publications and Guidelines

For more information, call BPA at 1-800-836-6619 for the following publications:

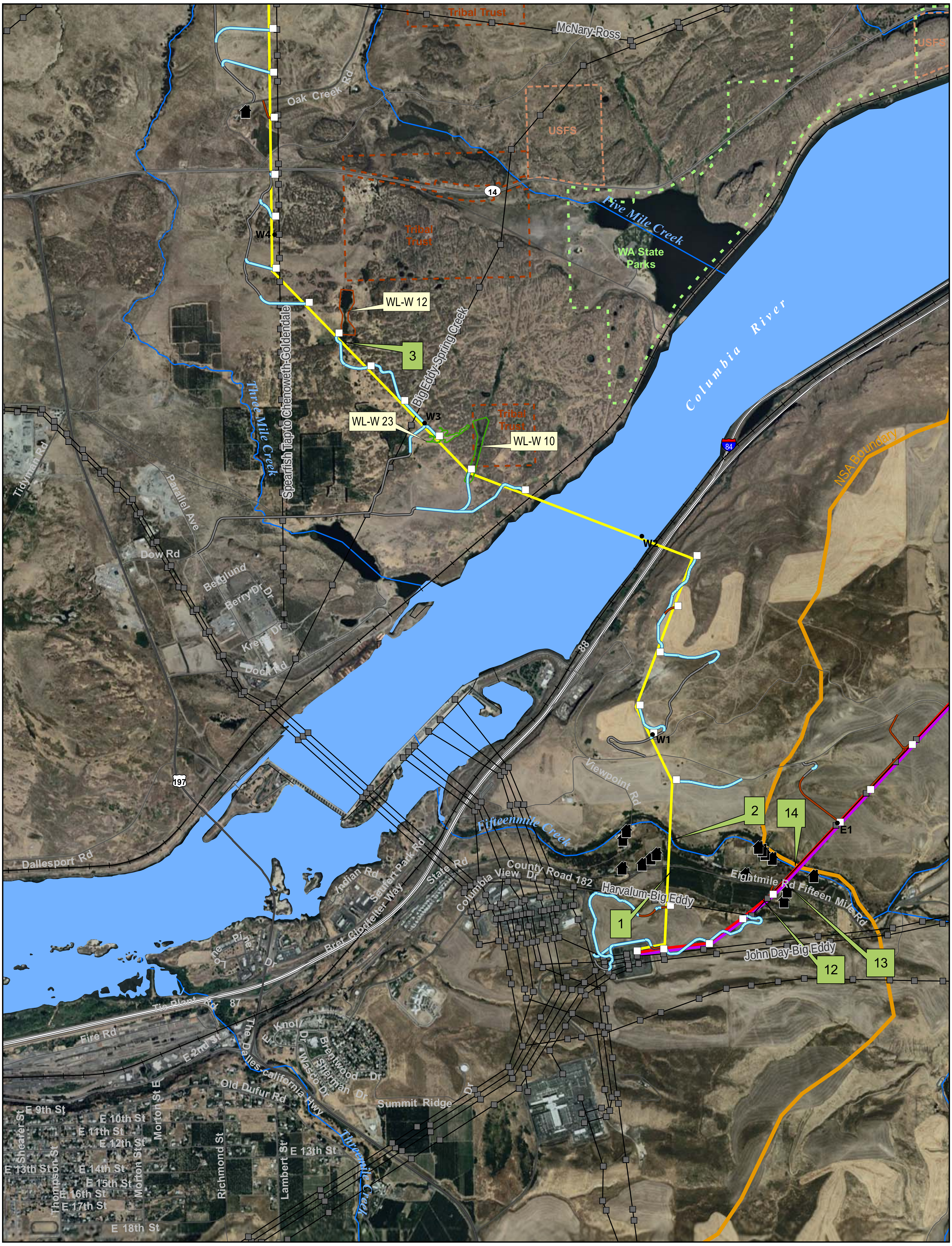
1. **"Landowner's Guide for Compatible Use of BPA Rights-of-Way"** (DOE/BP-3657)
2. **"Landowner's Guide to Trees and Transmission Lines"** (DOE/BP-3076)
3. **"Keeping the Way Clear for Better Service"** (DOE/BP-2816)
4. **"Guidelines for Installation and Operation of Irrigation Systems"**

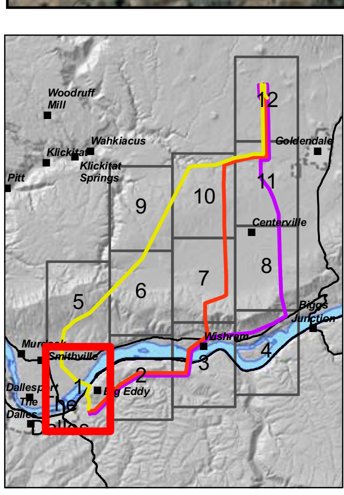
These documents also can be found at *www.transmission.bpa.gov/LanCom/Real_Property.cfm.*

BONNEVILLE POWER ADMINISTRATION
PO Box 3621 Portland, Oregon 97208-3621
DOE/BP–3804 • October 2007 • 3M

Appendix B

Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

*Wetlands may be larger than depicted extending beyond the right-of-way.

0 0.25 0.5 0.75 1 Miles

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Map B-1. Aerial Photomap Series

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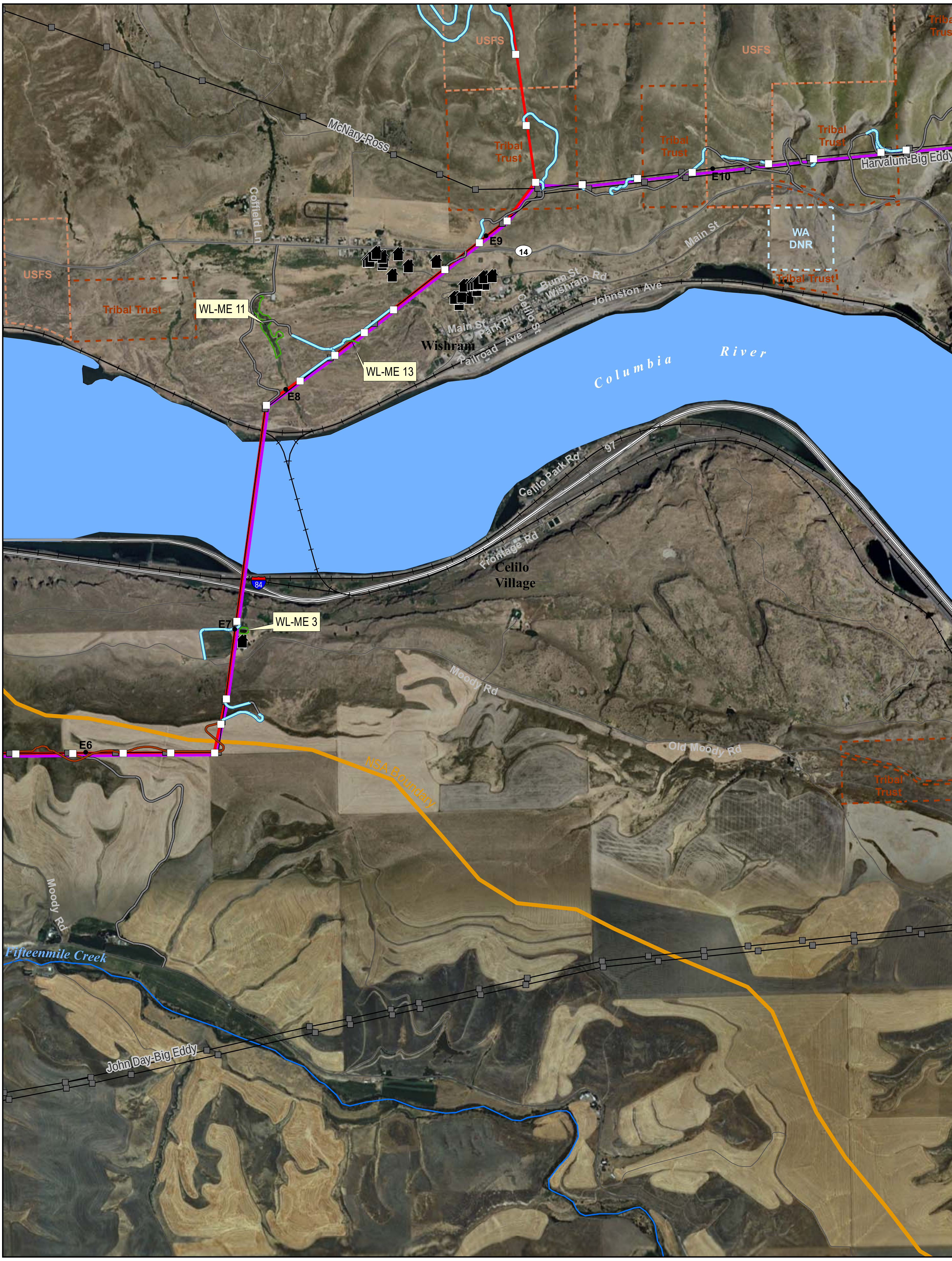
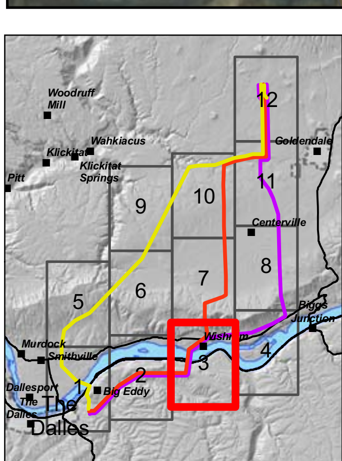
Map B-2. Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

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N E S W

0 0.25 0.5 0.75 1 Miles

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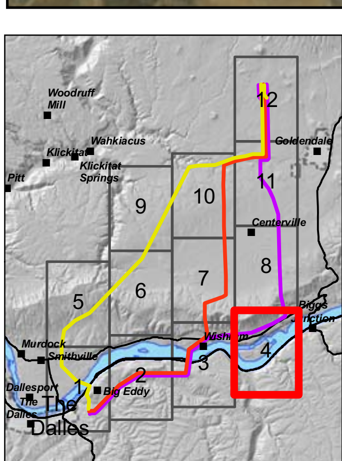
Map B-3. Aerial Photomap Series



Existing Facilities

- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities

- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads

- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey

- Confirmed Wetland*
- Unverified Wetland*
- Wetland id Potentially Impacted Wetland
- Woodland #

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N W E S

0 0.25 0.5 0.75 1 Miles

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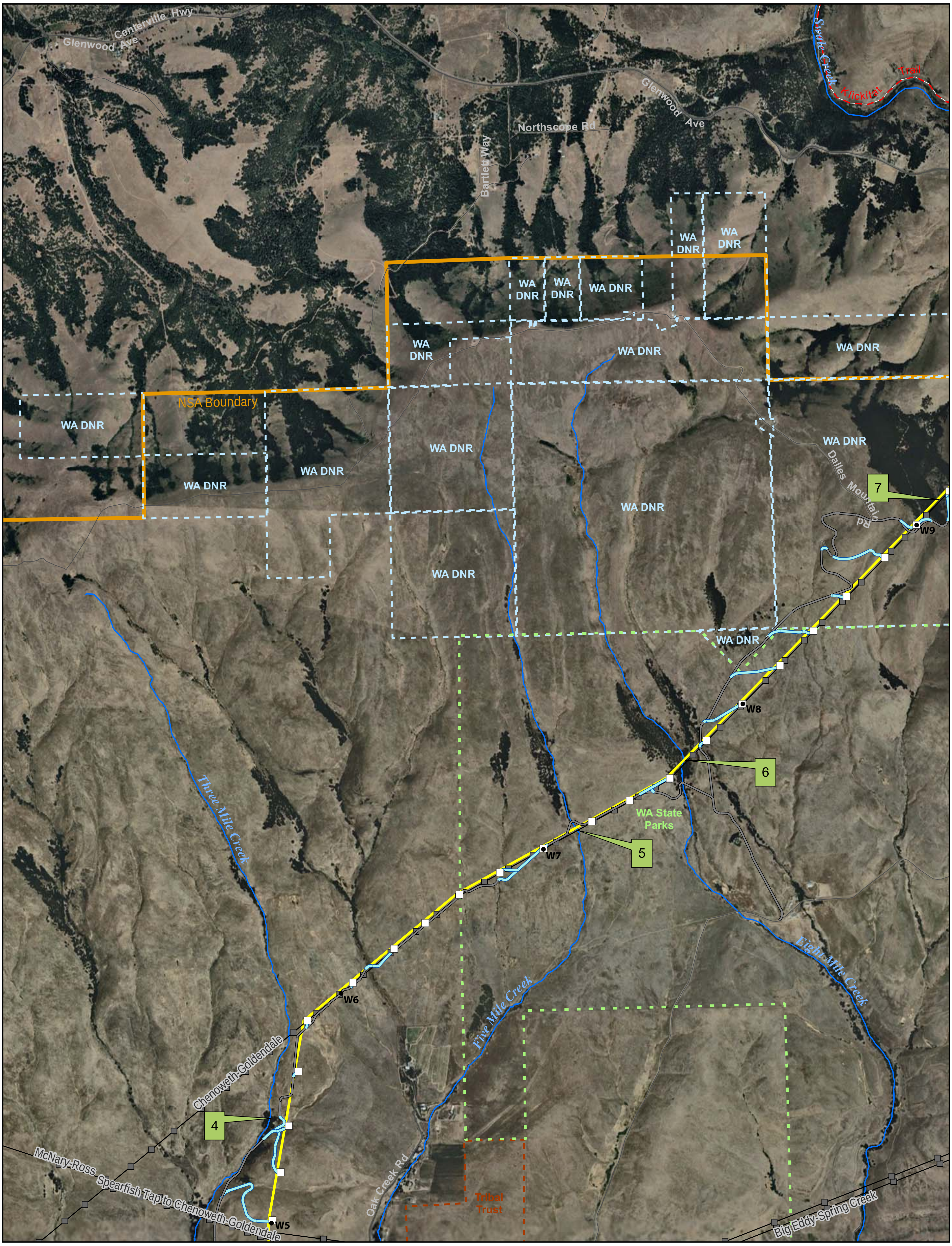
Map B-4. Aerial Photomap Series



Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id Potentially Impacted Wetland
- Woodland #

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N S E W

0 0.25 0.5 0.75 1 Miles

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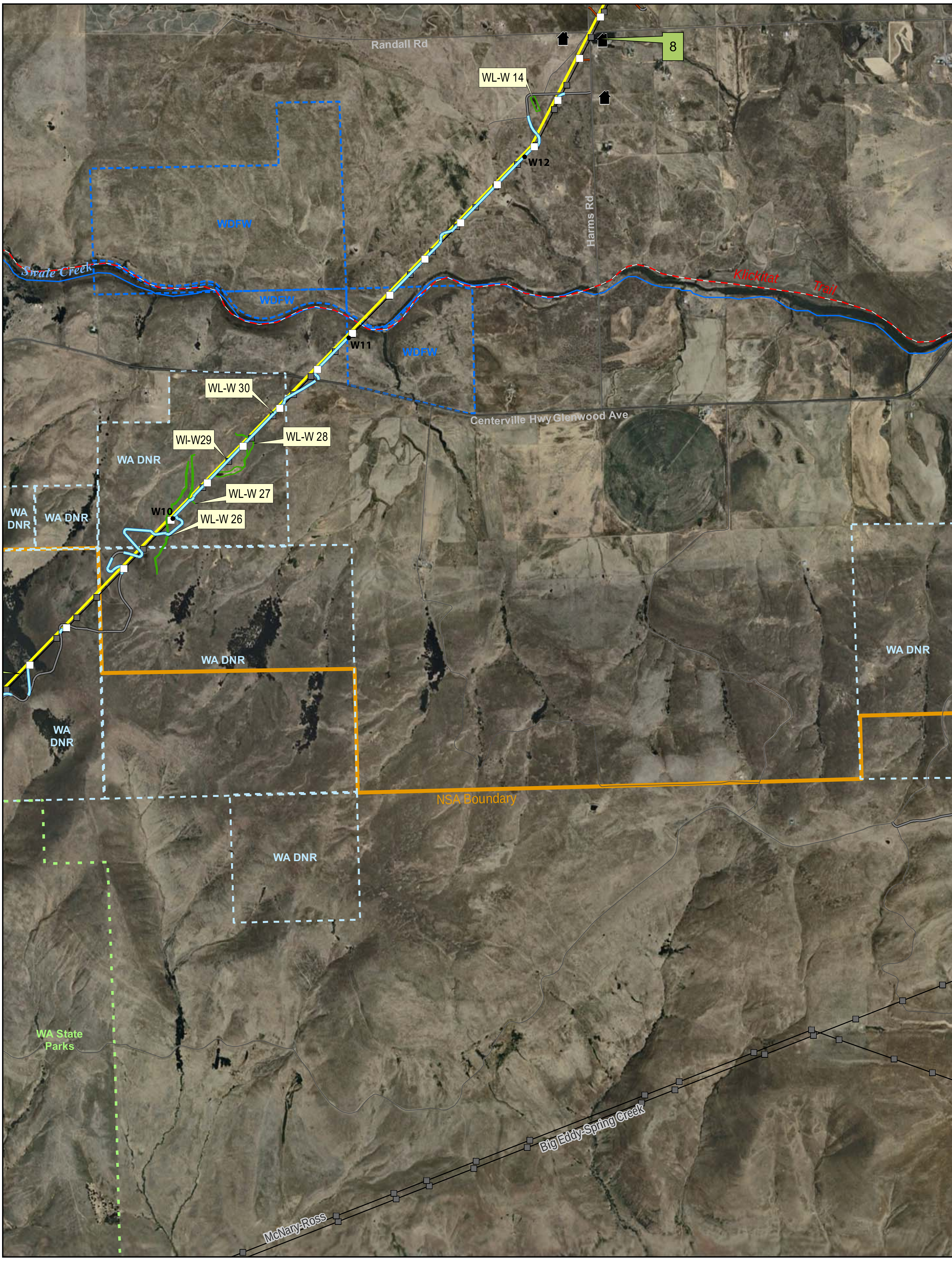
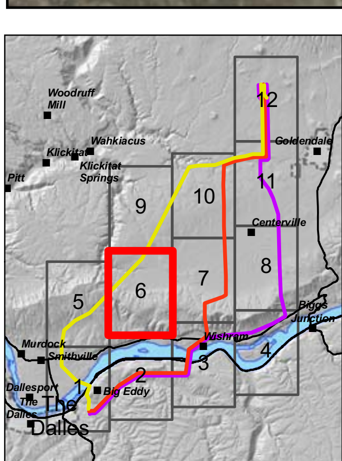
Map B-5. Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id Potentially Impacted Wetland
- Woodland #

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0 0.25 0.5 0.75 1 Miles

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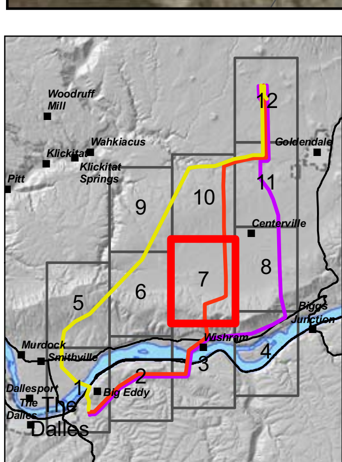
Map B-6. Aerial Photomap Series



Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

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N W E S

0 0.25 0.5 0.75 1 Miles

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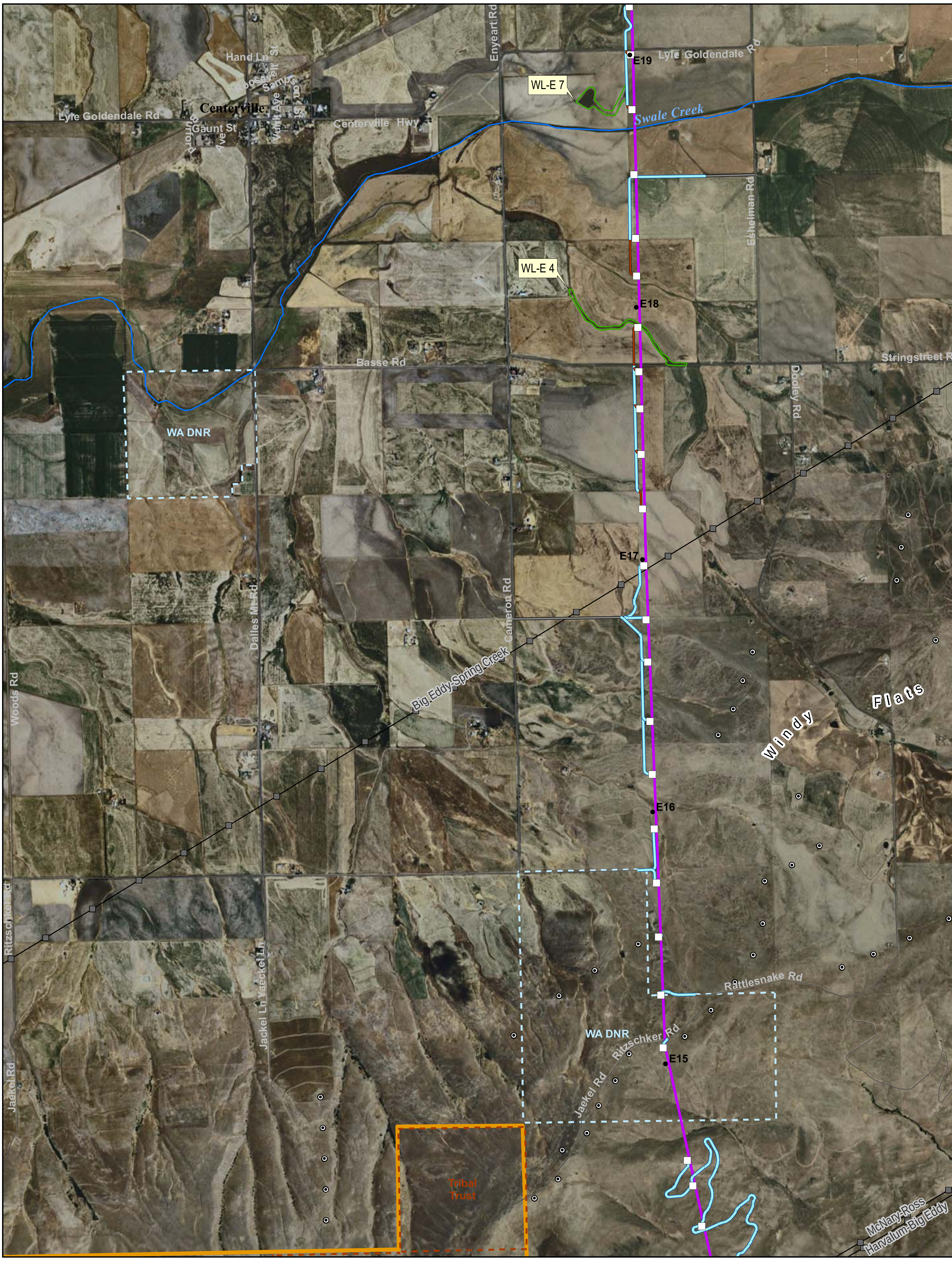
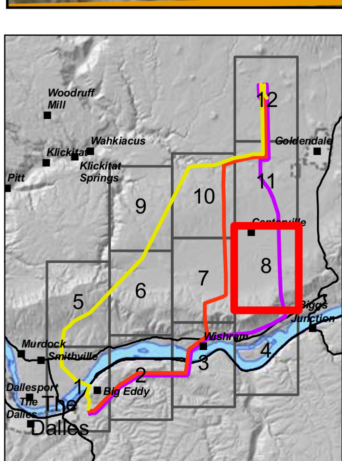
Map B-7. Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

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0 0.25 0.5 0.75 1 Miles

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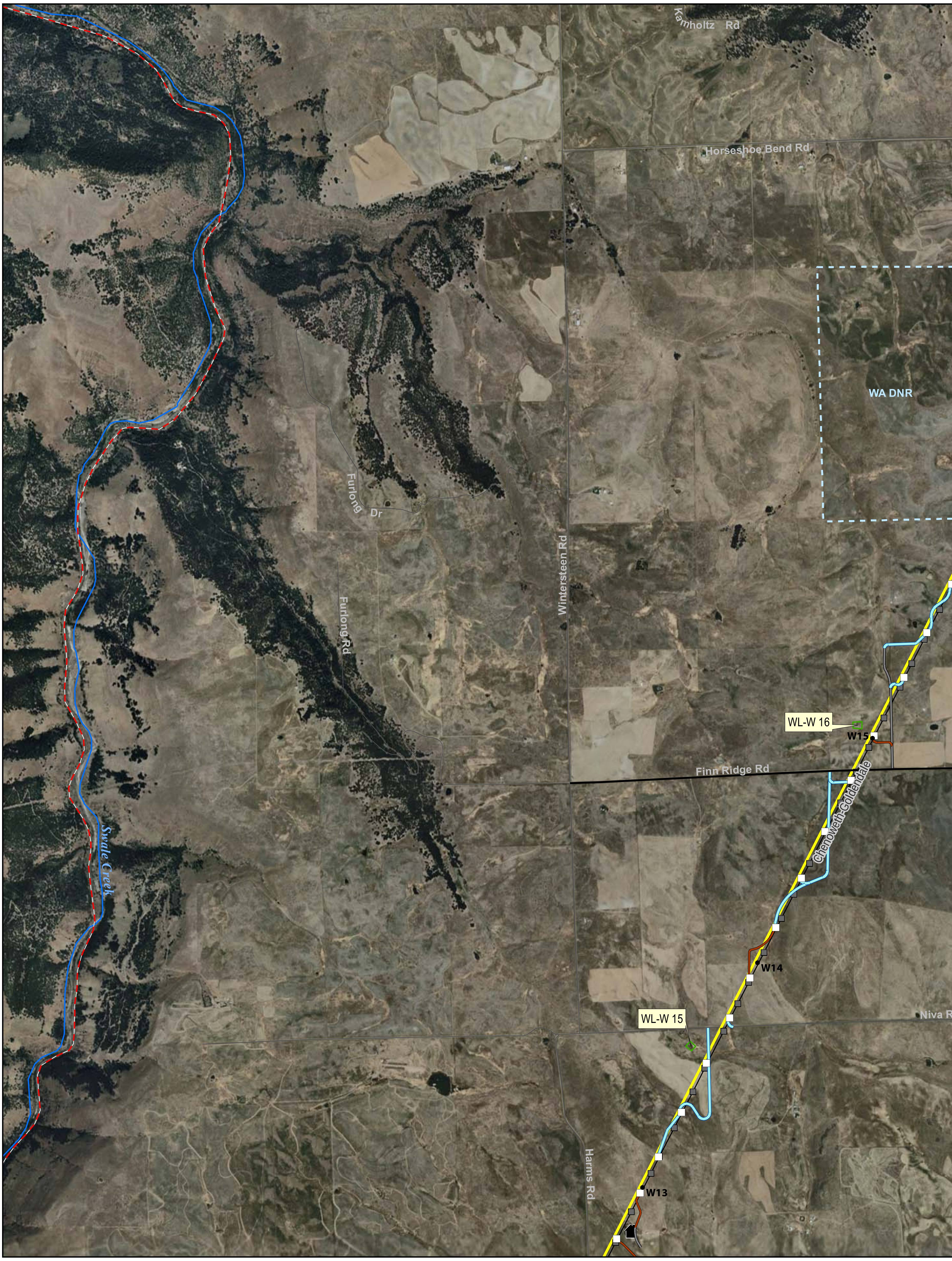
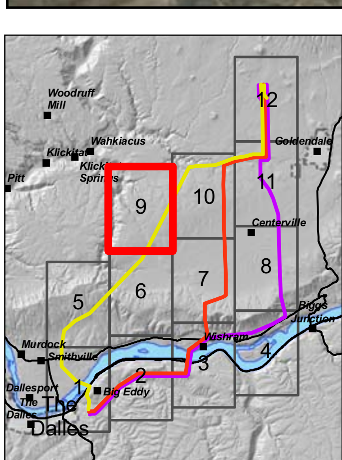
Map B-8. Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
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- Unverified Wetland*
- Wetland id Potentially Impacted Wetland
- Woodland #

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N E S W

0 0.25 0.5 0.75 1 Miles

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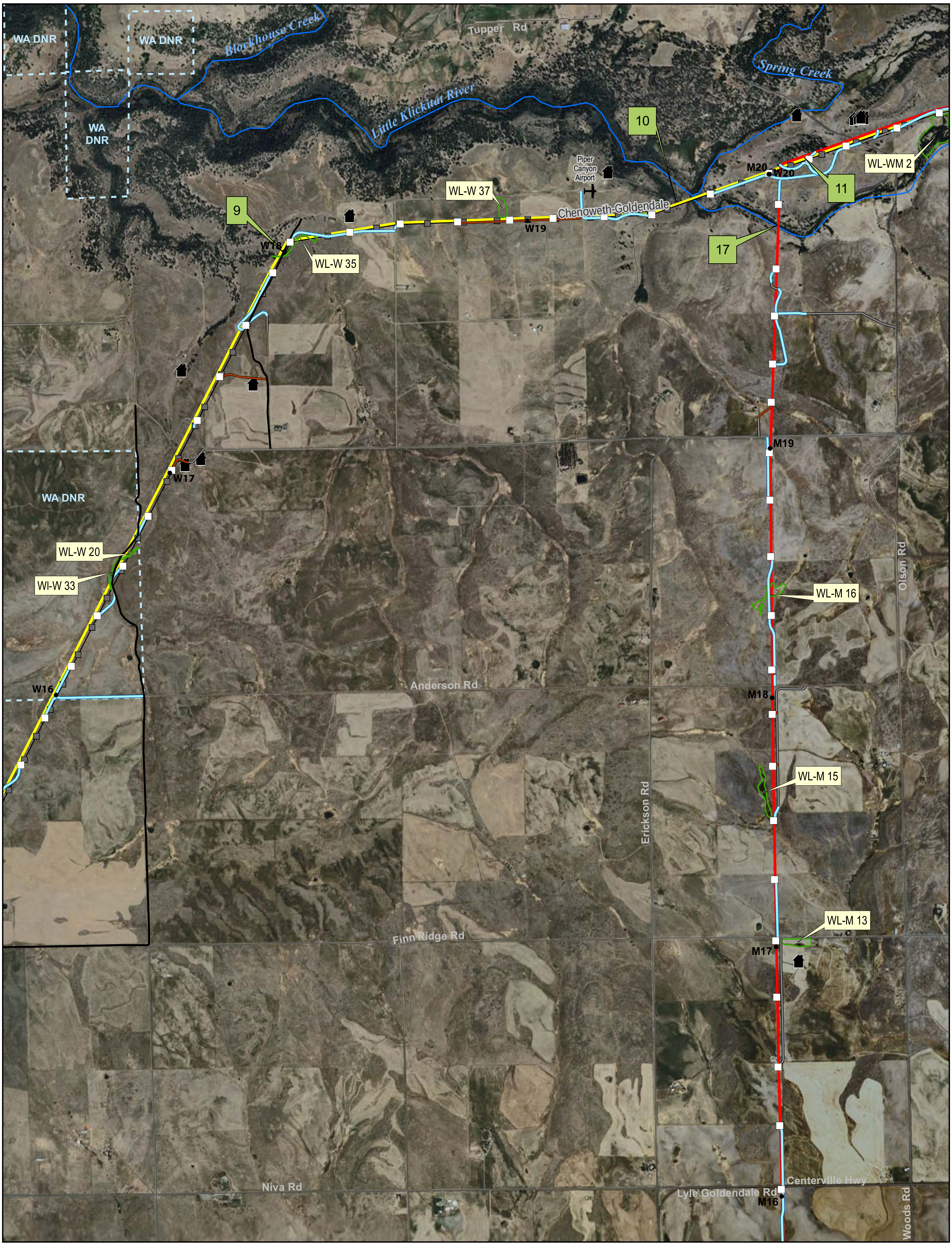
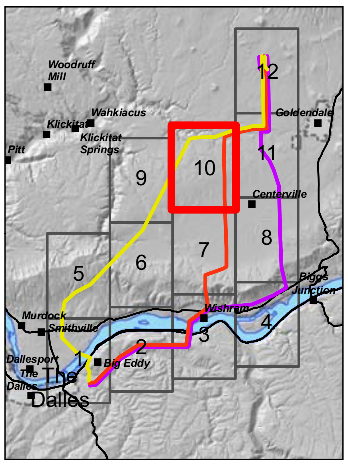
Map B-9. Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
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- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
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- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

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0 0.25 0.5 0.75 1 Miles

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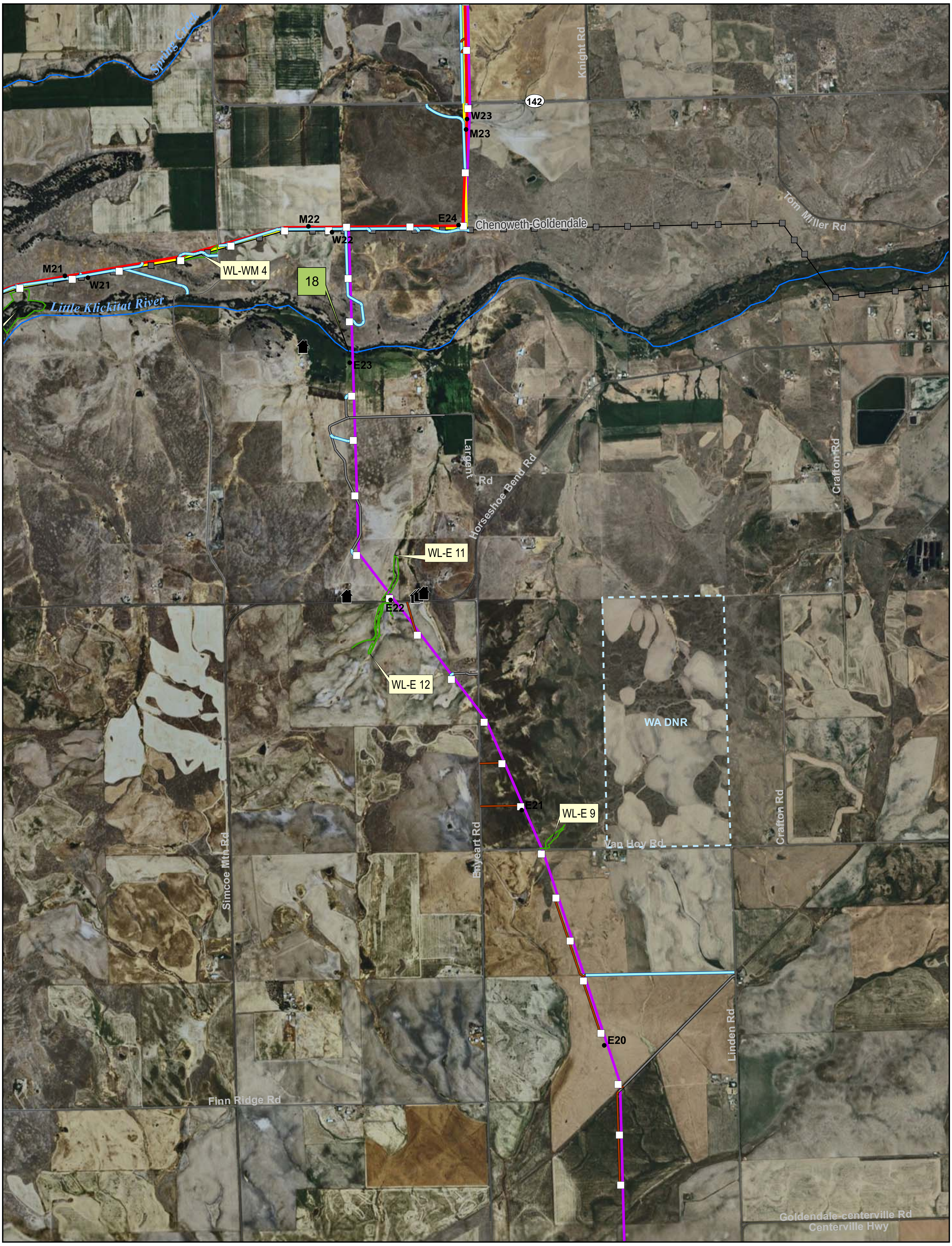
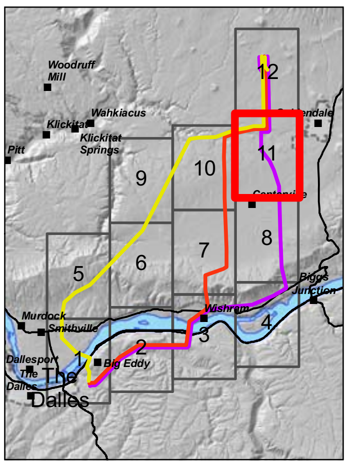
Map B-10. Aerial Photomap Series





Existing Facilities
- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities
- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads
- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey
- Confirmed Wetland*
- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

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N S E W

0 0.25 0.5 0.75 1 Miles

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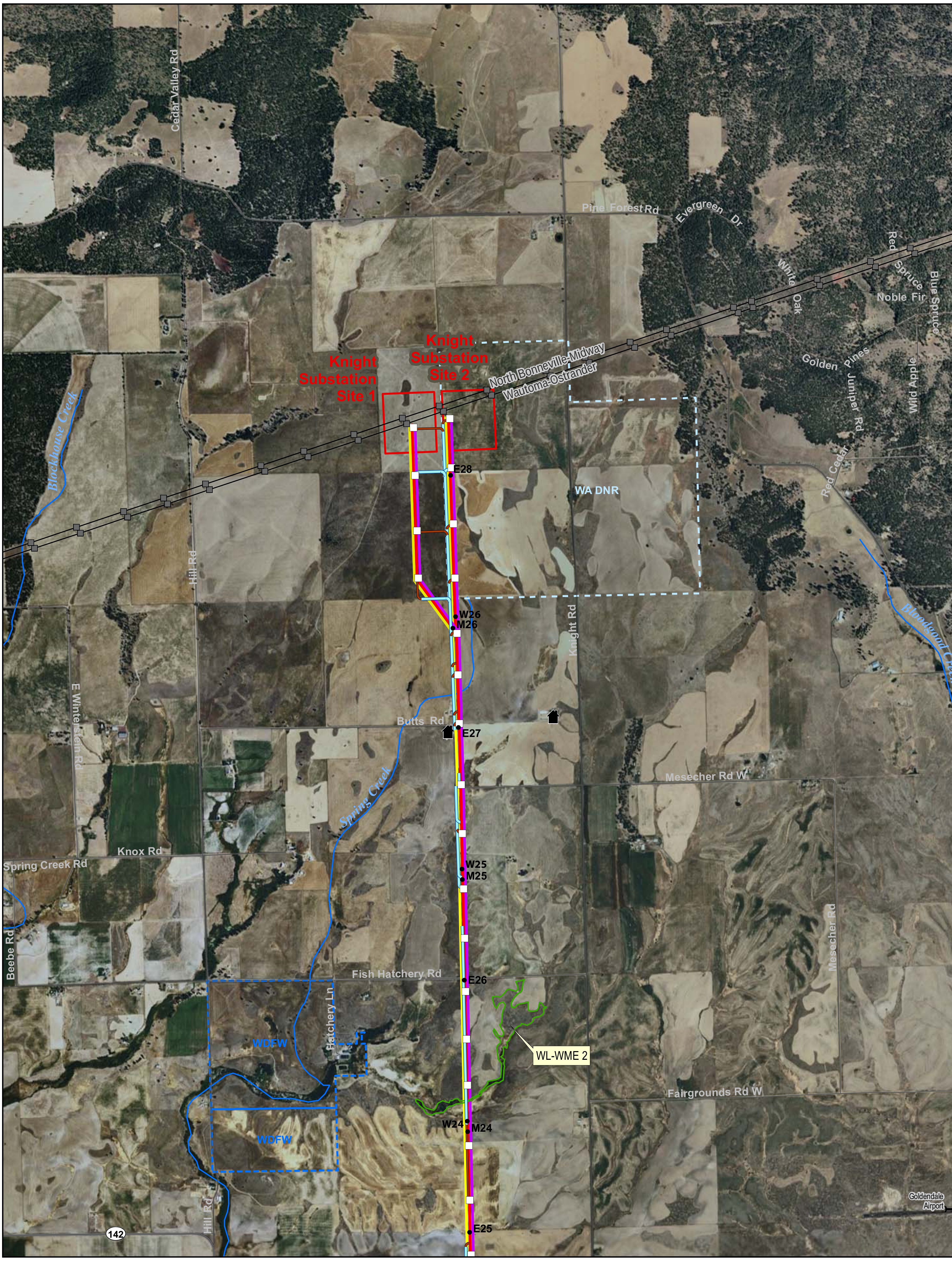
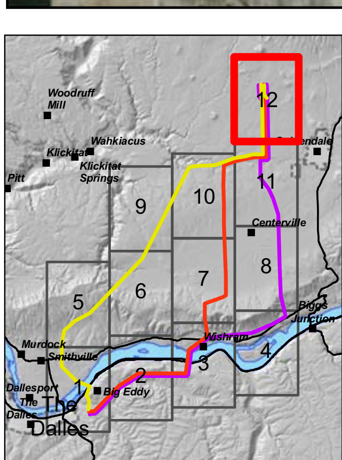
Map B-11. Aerial Photomap Series





Existing Facilities

- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities

- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads

- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey

- Confirmed Wetland*
- Unverified Wetland*
- Wetland id Potentially Impacted Wetland
- Woodland #

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N S E W

0 0.25 0.5 0.75 1 Miles

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Map B-12. Aerial Photomap Series

Appendix C

Visual Resources

Visual Resources Methodology

Terminology

The term *aesthetics* typically refers to the perceived visual impression of an area, such as a scenic view, open space, or architectural interest. The aesthetic value of an area is a measure of its *visual character* and *visual quality* combined with *viewer response* (Federal Highway Administration 1988). This combination may be affected by the components of a project (e.g., transmission towers constructed at a height that obstructs views, hillsides cut and graded, open space changed to a transmission line corridor), as well as changing elements such as light, weather, and the length and frequency of viewer exposure to the setting. Aesthetic impacts are thus defined as changes in viewer response as a result of project construction and operation.

Visual Character

Visual character is the appearance of the physical form of the landscape, composed of natural and human-made elements, including topography, water, vegetation, structures, roads, infrastructure, and utilities; and the relationships of these elements in terms of form, line, color, and texture.

Visual Quality

Visual quality is evaluated based on the relative degree of vividness, intactness, and unity as modified by the visual sensitivity of the viewer.

- *Vividness* is the visual power or memorableness of landscape components as they combine in striking or distinctive visual patterns.
- *Intactness* is the visual integrity of the natural and human-built landscape and its freedom from encroaching elements; this factor can be present in well-kept urban and rural landscapes, as well as natural settings.
- *Unity* is the visual coherence and compositional harmony of the landscape considered as a whole; it frequently attests to the careful design of individual components in the artificial landscape (Federal Highway Administration 1988).

High-quality views are highly vivid, relatively intact, and exhibit a high degree of visual unity. Low-quality views lack vividness, are not visually intact, and possess a low degree of visual unity.

Viewer Response

Viewer response is the psychological reaction of a person to visible changes in the viewshed. A viewshed is defined as all of the surface area visible from a particular location (e.g., an overlook) or sequence of locations (e.g., roadway or trail) (Federal Highway Administration 1988). The measure of the quality of a view must be tempered with the overall sensitivity of the viewer and viewer response. Viewer sensitivity is dependent on the number and type of viewers and the frequency (e.g., daily or seasonally) and duration of views (i.e., how long a scene is viewed). Visual sensitivity is also modified by viewer activity, awareness, and visual expectations in relation to the number of viewers and the viewing duration.

Visual Assessment Process

The concepts presented above are combined in a visual resource assessment process that involves identification of the following:

- visual character and quality of the project area,
- relevant policies and concerns for protection of visual resources,
- general visibility of the project area and site using descriptions and photographs, and
- viewer response and potential impacts.

Assumptions

Visual resources consist of views of the project area. Therefore, impacts are not limited to the specific alignment corridor as is often the case for other resources such as vegetation, waterways, and soils. Many viewsheds may be affected by any one given alternative, thus affecting a variety of viewer groups.

Topography plays an important role in providing and limiting views within the visual study area. Topography was evaluated using a geographic information system (GIS) viewshed analysis (Appendix A) to identify a preliminary list of vantage points from which the project could be visible. Because the GIS analysis does not include features such as vegetation or structures, it was used as a starting point to help guide the analysis and site visit.

Views of the study area were inventoried during a site visit that took place August 18 through 21, 2009, by identifying the locations and photographing views of and from the surrounding areas. Appendix B includes a map of all locations surveyed during the site visit and the photograph log for these points. Because the study area covers a large area, this analysis focuses on representative vantages from where views *of* the study area are present. Representative views are views that are representative of other views in the area, able to embody impacts on a given viewer group or number of viewer groups, and illustrative in describing the impact, nonimpact, or range in severity of impact on certain vantages.

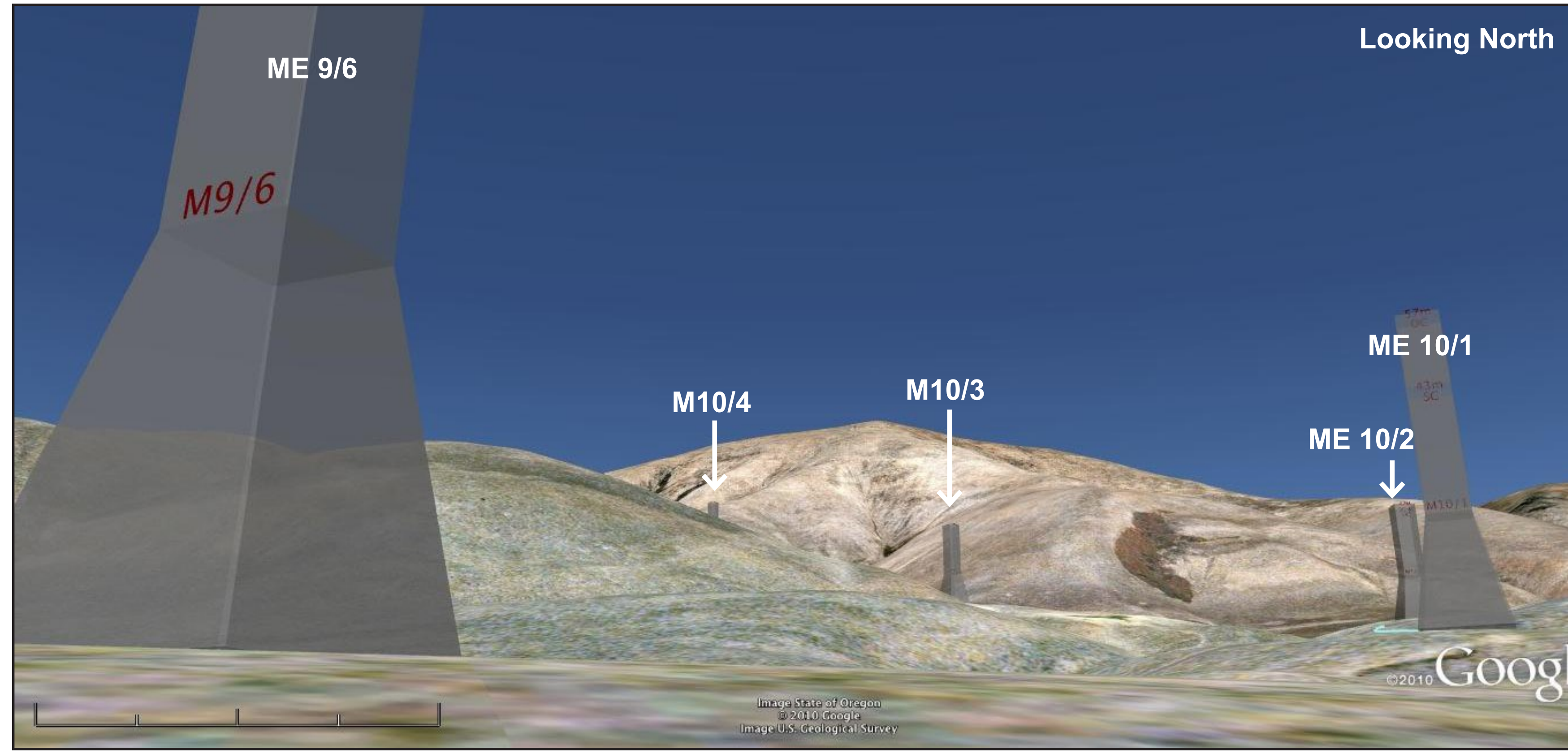
Location: State Route 14 above Wishram, approx. 2,000 feet east of Boulder Drive

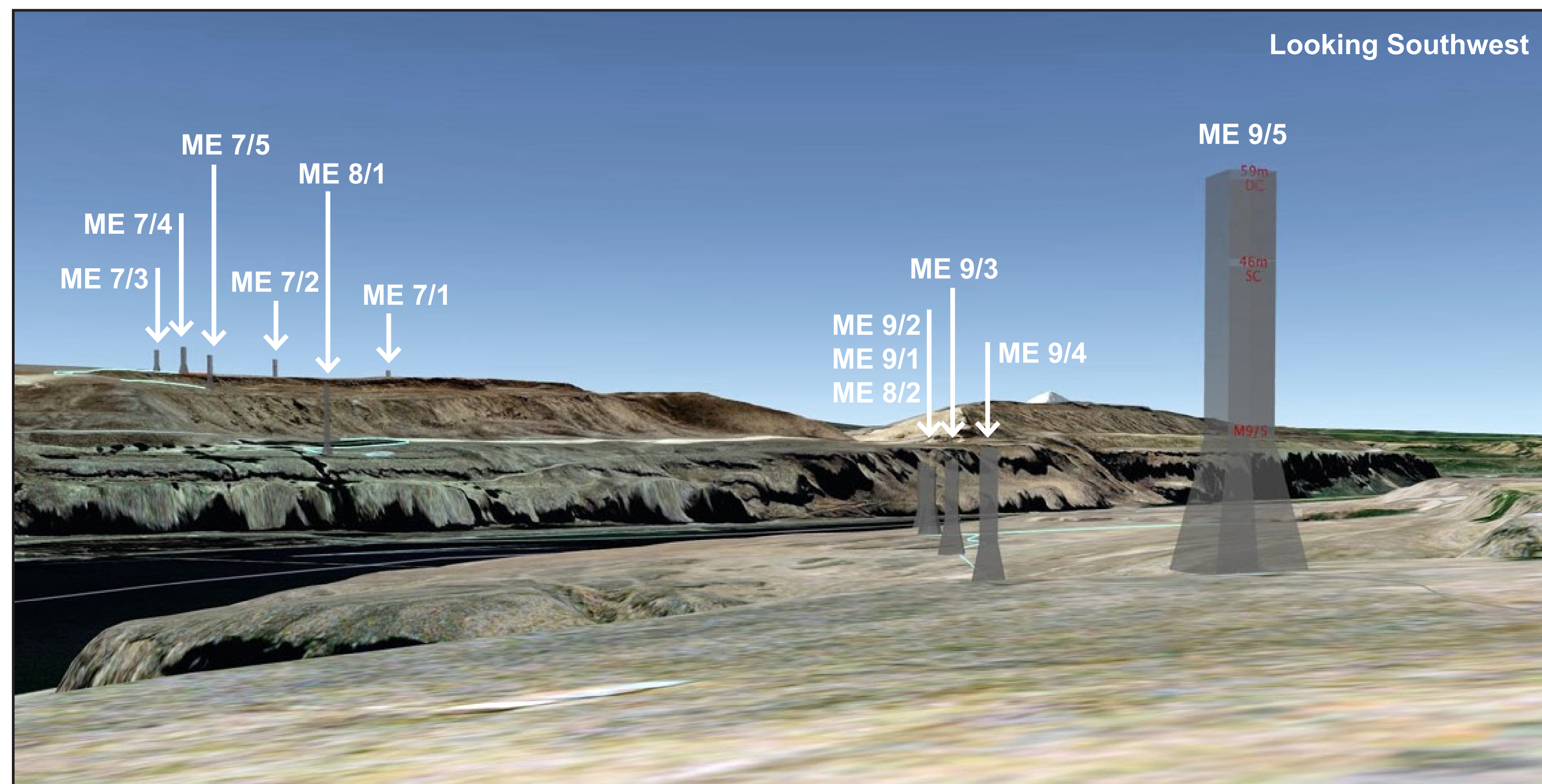
Looking north, towers M9/6 and M10/1 (single and double circuit) break the skyline. Looking southwest, M9/5 (single and double circuit) breaks the skyline. Across the river (approximately 2 miles distant) towers M7/1 through M7/5 (single and double circuit) break the skyline, but these are smaller and less visible because of their distance.

Looking North		
	Breaks Skyline?	
Visible Tower (distance)	Single Circuit	Double Circuit
M/E 9/6 (0.04 mi)	Yes	Yes
M/E 10/1 (0.16 mi)	Yes	Yes
M/E 10/2 (0.35 mi)	No	May touch skyline
M 10/3 (0.59 mi)	No	No
M 10/4 (0.80 mi)	Not visible	No

Looking Southwest		
	Breaks Skyline?	
Visible Tower (distance)	Single Circuit	Double Circuit
M/E 9/5 (0.16 mi)	Yes	Yes
M/E 9/4 (0.41 mi)	No	No
M/E 9/3 (0.55 mi)	No	No
M/E 9/2 (0.70 mi)	No	No
M/E 9/1 (0.87 mi)	No	No
M/E 8/2 (1.04 mi)	No	No
River		
M/E 8/1 (1.75 mi)	No	May touch skyline
M/E 7/5 (2.04 mi)	Yes	Yes
M/E 7/4 (2.13 mi)	Yes	Yes
M/E 7/3 (2.24 mi)	Yes	Yes
M/E 7/2 (2.33 mi)	Yes	Yes
M/E 7/1 (2.44 mi)	Maybe a little	Yes

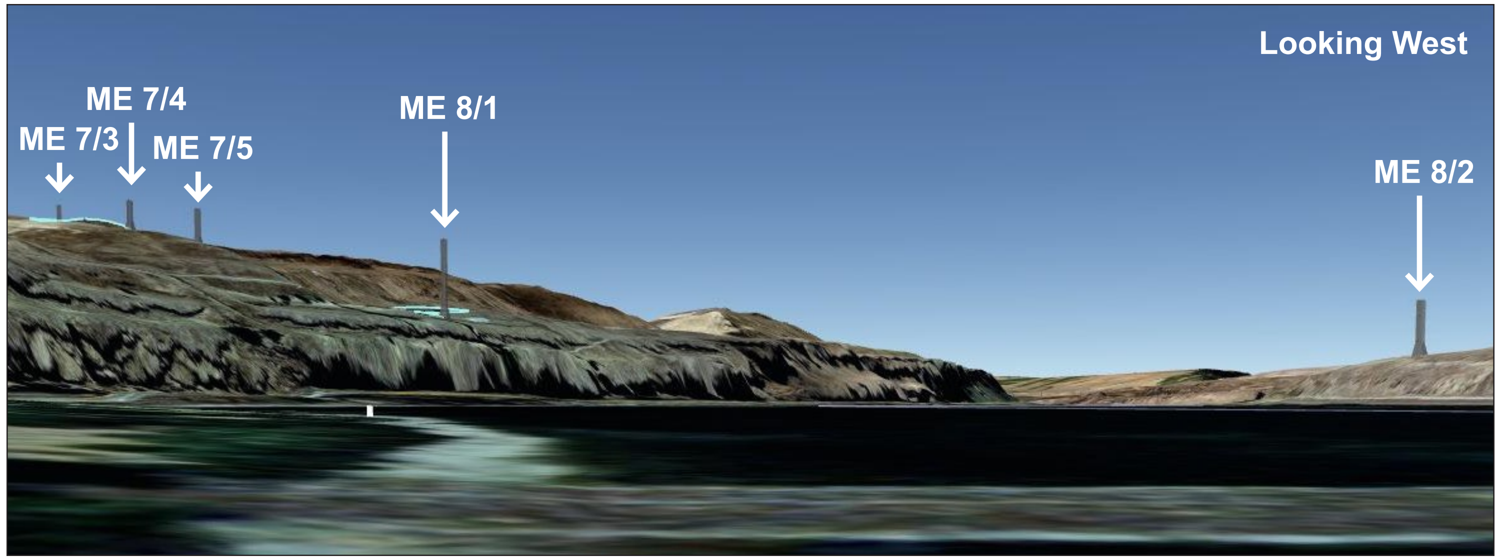
All images: Google Inc. 2010. Google Earth Pro, Version 5.2. Mountain View, CA. Accessed: September 3, 2010.





Skyline Assessment Results

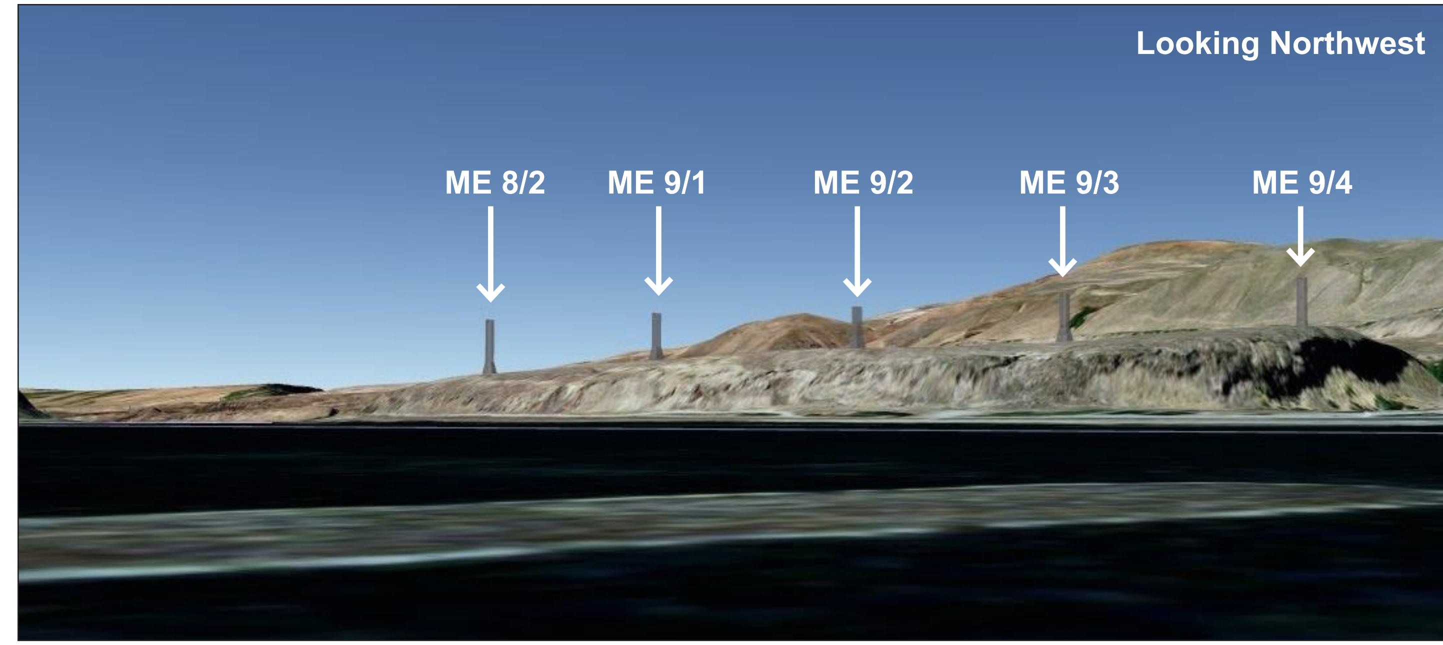
ICF INTERNATIONAL

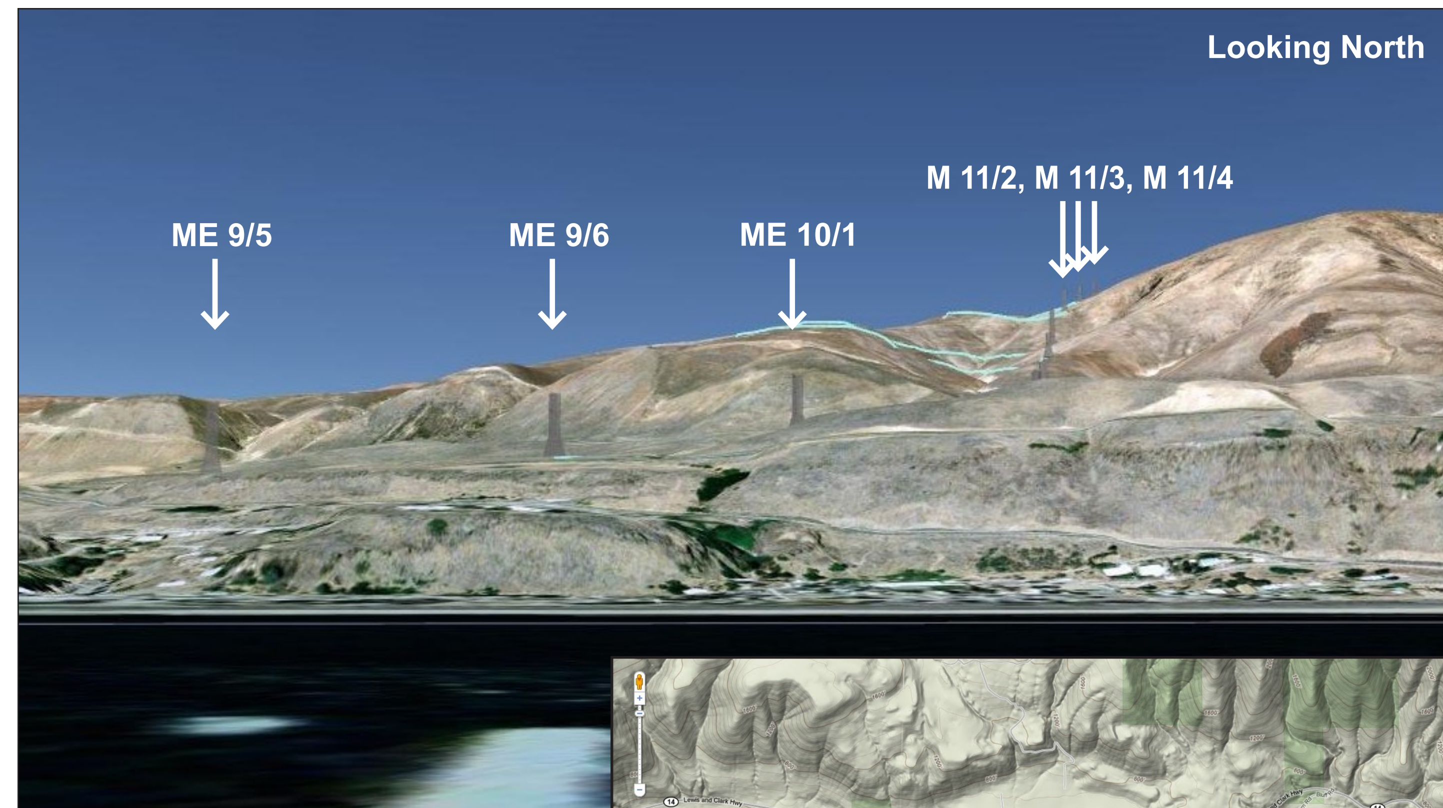


Location: Columbia River at Celilo Park Boat Ramp

Looking west, towers M7/3, M7/4, M7/5, and M8/1 (single and double circuit) break the skyline on the south side of the river. M8/2 and M9/1 (single and double circuit) and M9/2 (double circuit only) break the skyline on the north side of the river. Looking north, only towers M11/2, M11/3, and M11/4 near the top of the ridge break the skyline.

Looking West to North		
	Breaks Skyline?	
Visible Tower (distance)	**Single Circuit**	**Double Circuit**
M/E 7/3 (1.90 mi)	Yes	Yes
M/E 7/4 (1.81 mi)	Yes	Yes
M/E 7/5 (1.72 mi)	Yes	Yes
M/E 8/1 (1.52 mi)	May touch skyline	Yes
River		
M/E 8/2 (1.27 mi)	Yes	Yes
M/E 9/1 (1.14 mi)	Yes	Yes
M/E 9/2 (1.05 mi)	No	Yes
M/E 9/3 (0.96 mi)	No	No
M/E 9/4 (0.91 mi)	No	No
M/E 9/5 (0.88 mi)	No	No
M/E 9/6 (0.90 mi)	No	No
M/E 10/1 (0.94 mi)	No	No
M/E 10/2 (1.06 mi)	Not Visible	No
M 10/3 (1.29 mi)	No	No
M 10/4 (1.56 mi)	No	No
M 11/1 (1.84 mi)	No	May touch skyline
M 11/2 (2.09 mi)	Yes	Yes
M 11/3 (2.22 mi)	Yes	Yes
M 11/4 (2.36 mi)	Yes	Yes





All images: Google Inc. 2010. Google Earth Pro, Version 5.2. Mountain View, CA. Accessed: September 3, 2010.

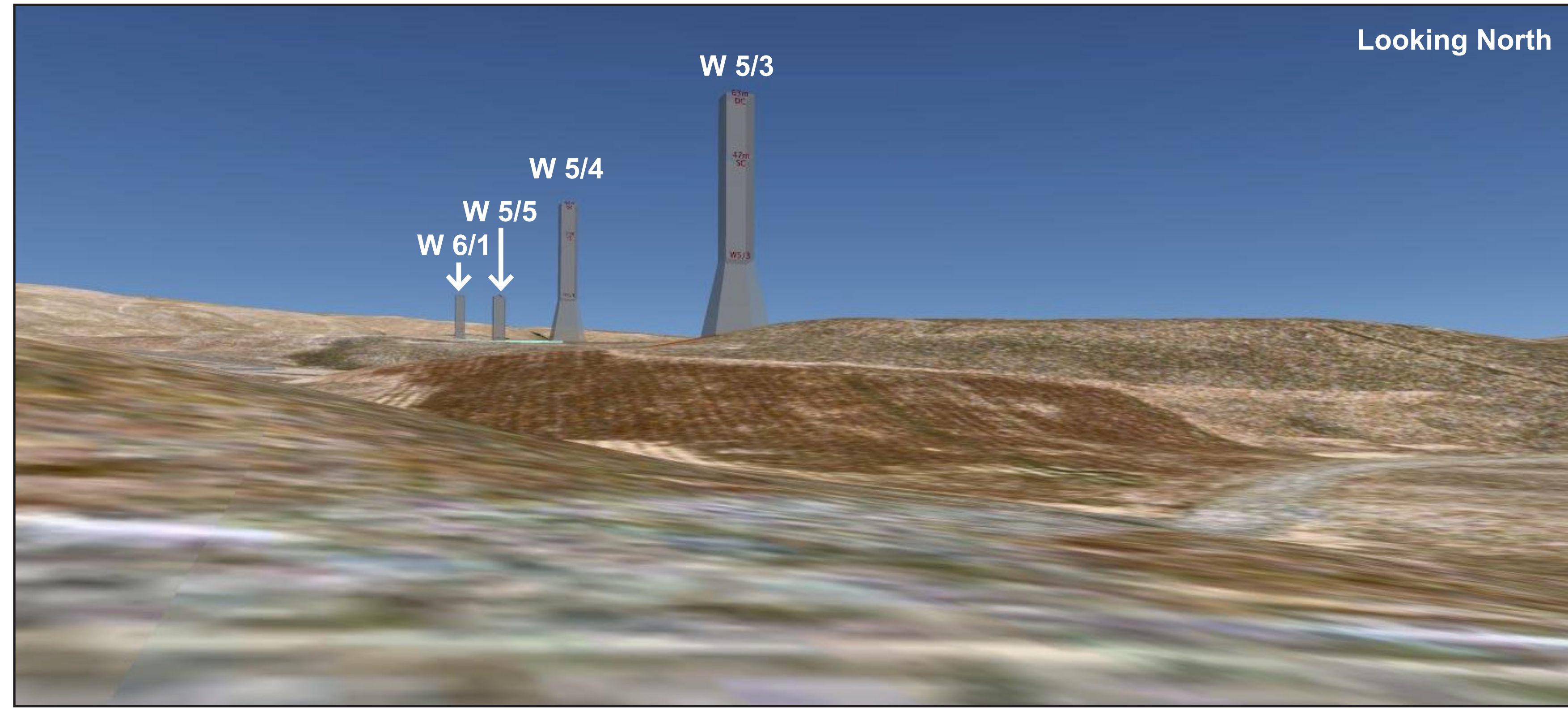
Skyline Assessment Results

Location: State Route 14 at intersection with Dalles Mountain Road

Looking north, towers W5/3, W5/4, W5/5, and W6/1 (single and double circuit) break the skyline. Looking south to southeast, tower W5/2 (single and double circuit) and W5/1(double circuit only) break the skyline.

Looking North		
	Breaks Skyline?	
Visible Tower (distance)	**Single Circuit**	**Double Circuit**
W 5/3 (0.21 mi)	Yes	Yes
W 5/4 (0.39 mi)	Yes	Yes
W 5/5 (0.56 mi)	Yes	Yes
W 6/1 (0.75 mi)	Yes	Yes

Looking Southeast		
	Breaks Skyline?	
Visible Tower (near to far)	**Single Circuit**	**Double Circuit**
W 5/2 (0.07 mi)	Yes	Yes
W 5/1 (0.20 mi)	May touch skyline	Yes
W 4/5 (0.41 mi)	No	No
W 4/4 (0.58 mi)	No	No
Others approaching river	No	No
W 2/2 (2.65 mi) (across river)	Yes	Yes



All images: Google Inc. 2010. Google Earth Pro, Version 5.2. Mountain View, CA. Accessed: September 3, 2010.

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ICF INTERNATIONAL

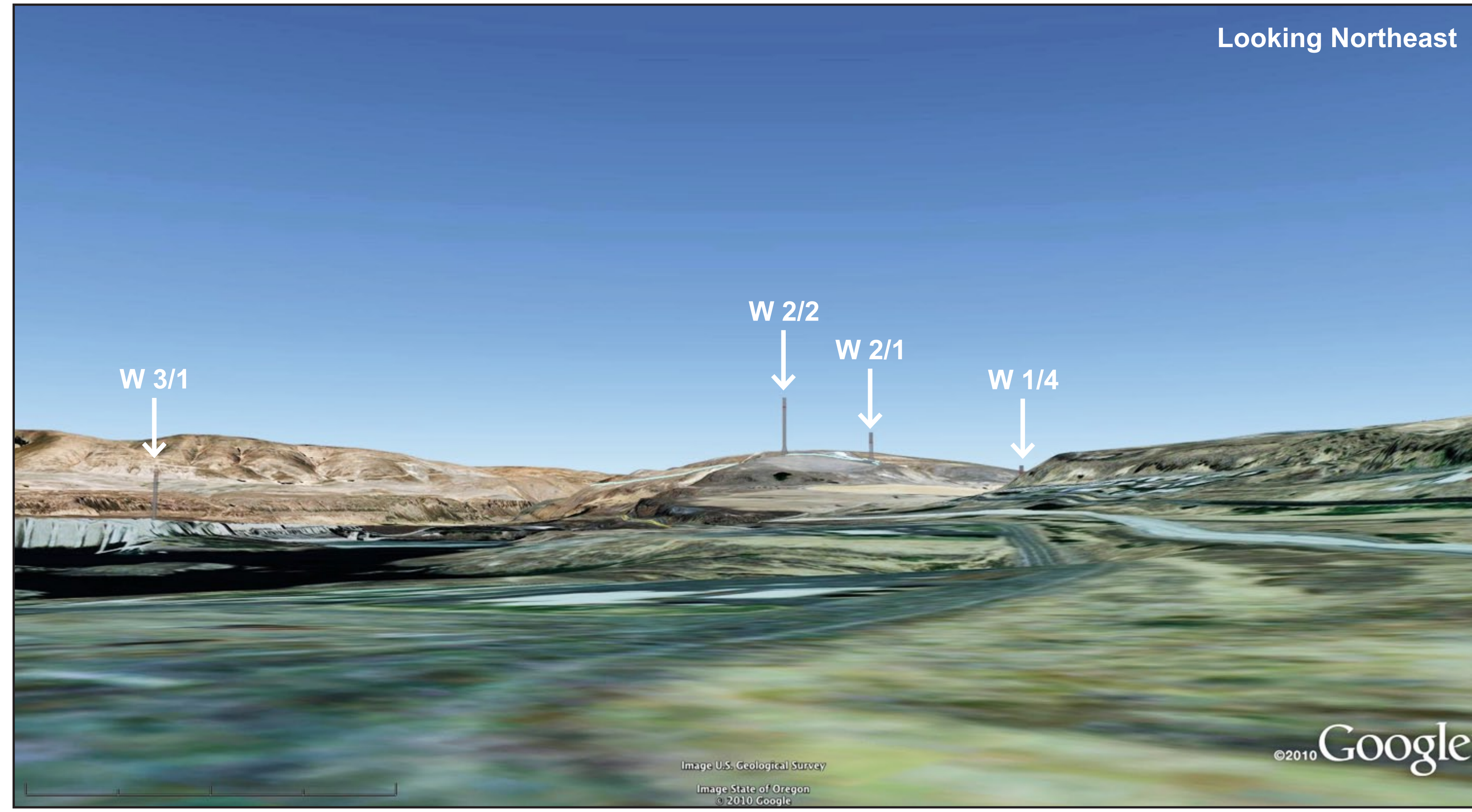
Skyline Assessment Results

Location: US Highway 197 at Interstate 84

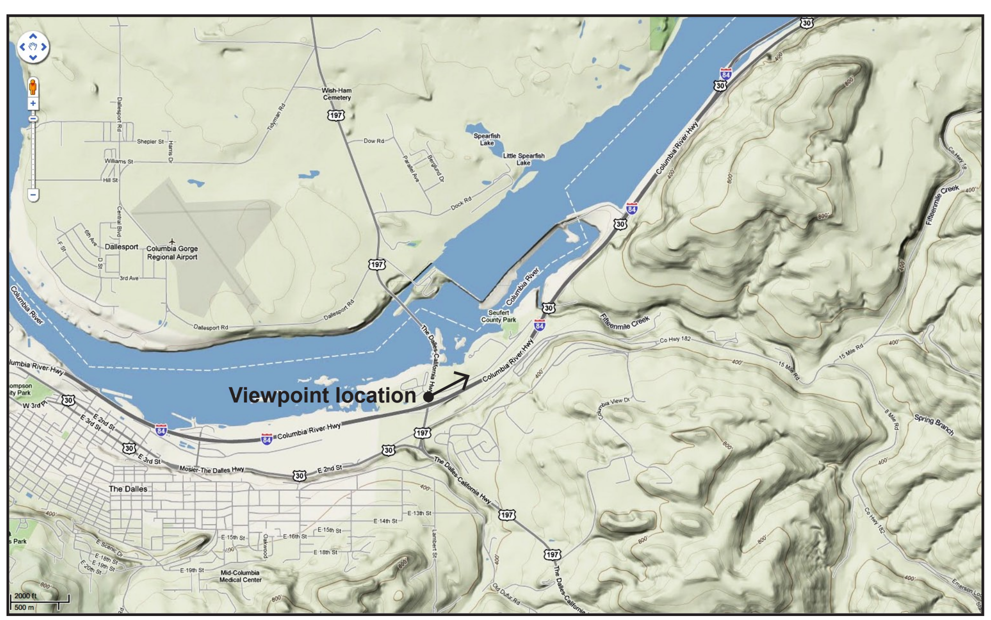
Looking northeast, towers W1/4 (double circuit only), W2/1, and W2/2 (single and double circuit) break the skyline.

Towers W1/1, W1/2, and W1/3 are hidden by terrain. Other existing towers at the substation south of Columbia View Drive are visible.

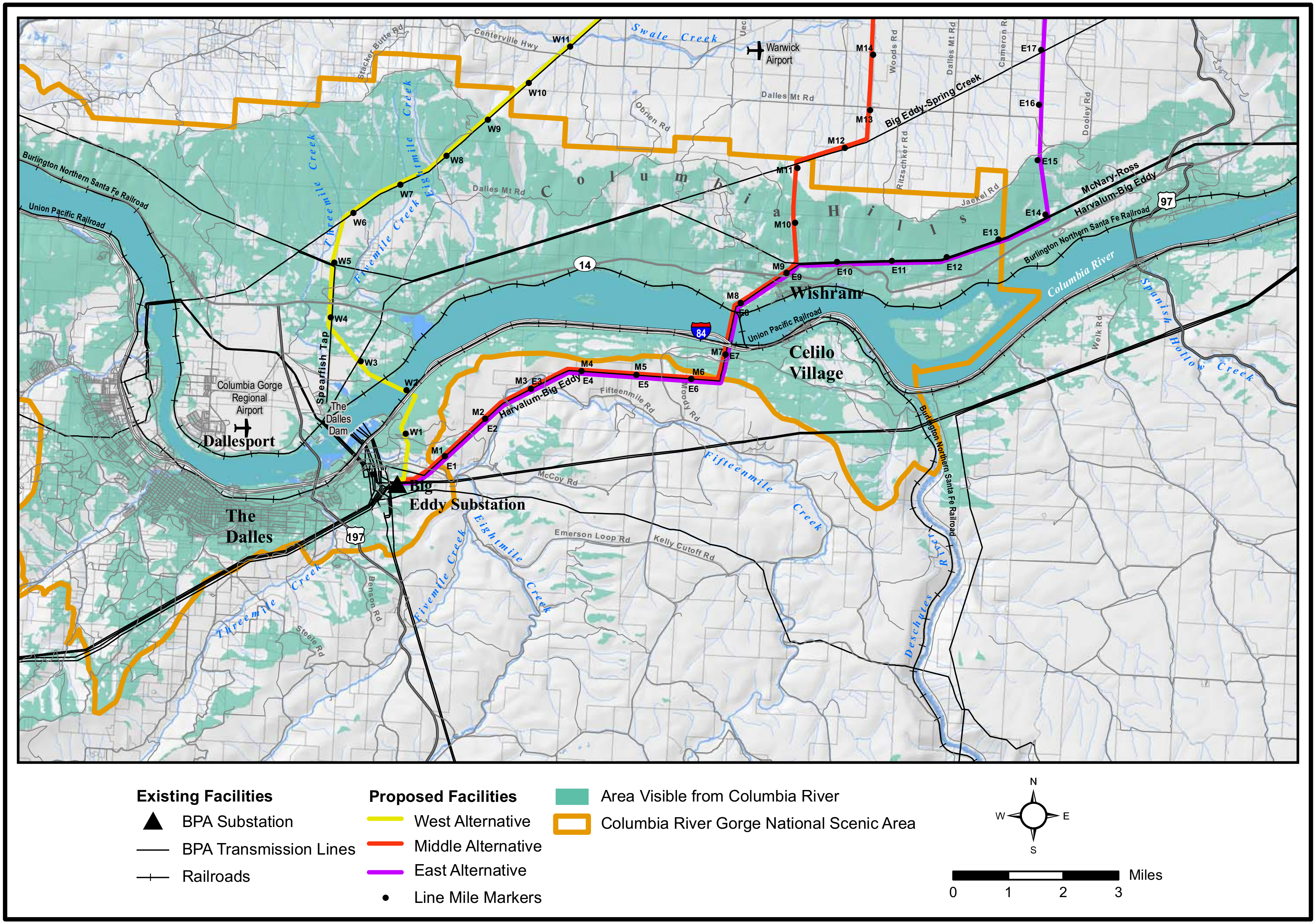
Looking East		
	Breaks Skyline?	
Visible Tower (distance)	Single Circuit	Double Circuit
W 1/4 (1.81 mi)	No	Yes
W 2/1 (1.82 mi)	Yes	Yes
W 2/2 (1.83 mi)	Yes	Yes
W 3/1 (2.18 mi)	No	No



All images: Google Inc. 2010. Google Earth Pro, Version 5.2. Mountain View, CA. Accessed: September 3, 2010.



ICF INTERNATIONAL



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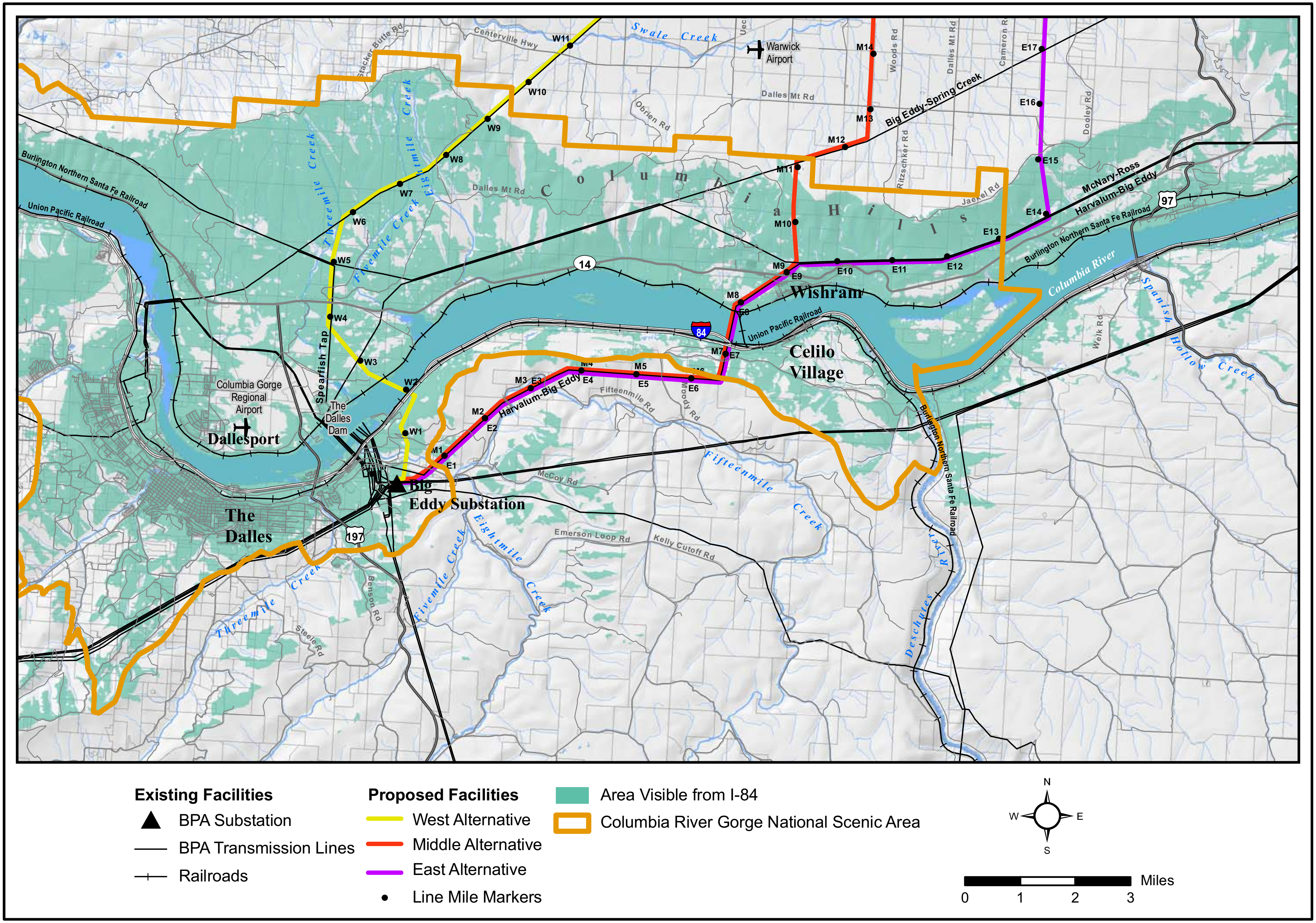
Map C-1. Columbia River Viewshed



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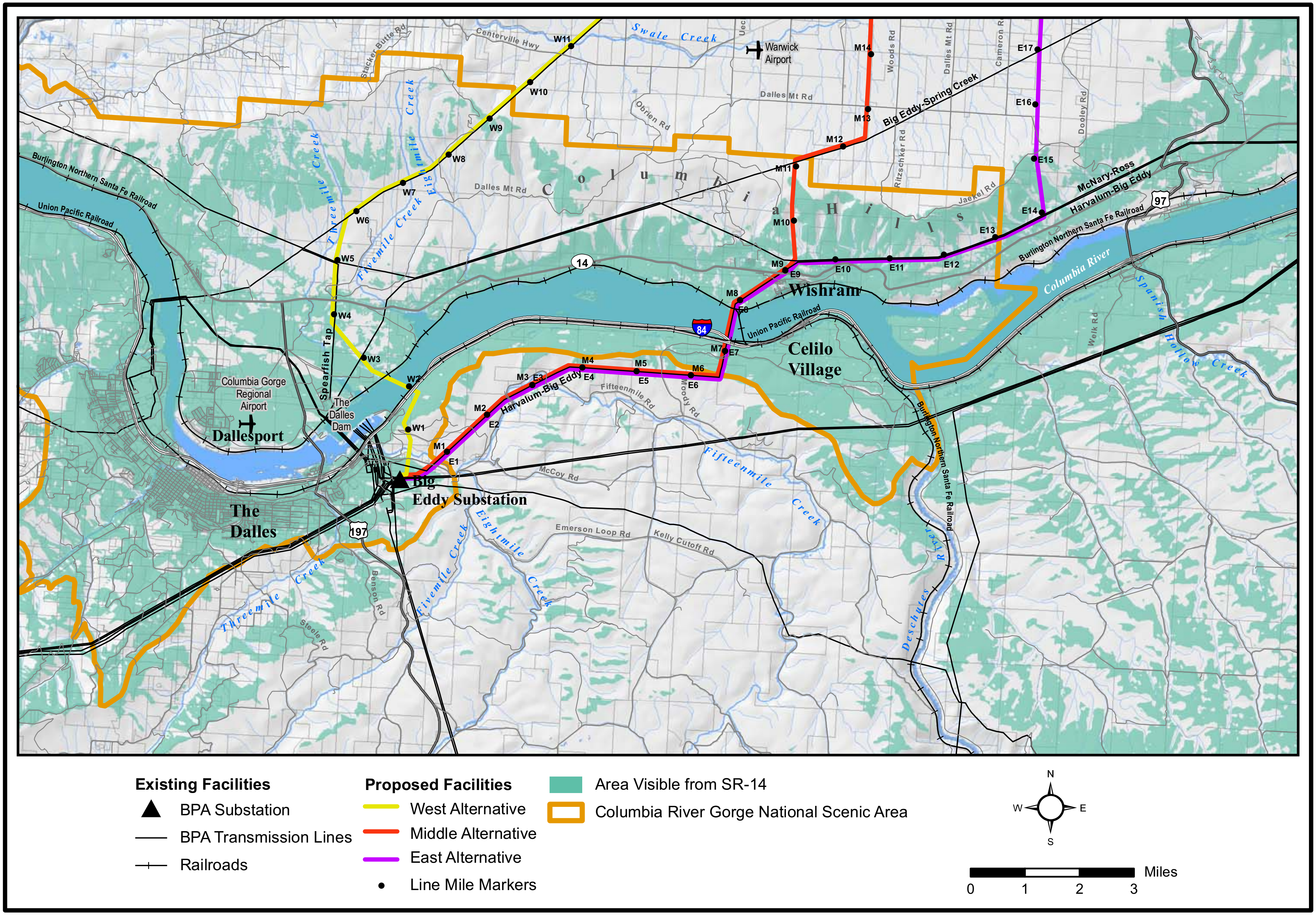
Map C-2. Interstate 84 Viewshed



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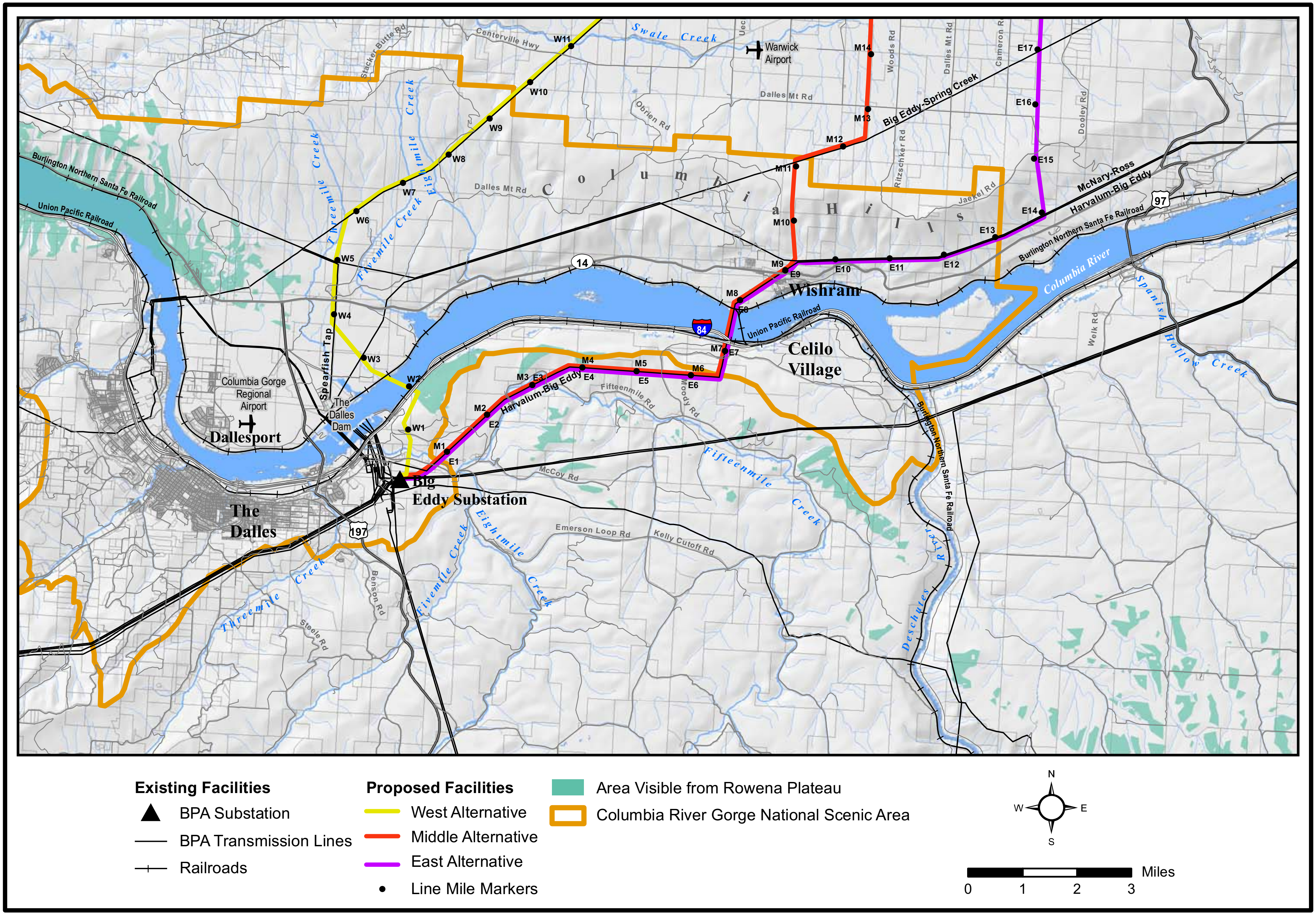
Map C-3. Washington State Route 14 Viewshed



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Map C-4. Rowena Plateau Viewshed

Appendix D

Fish and Wildlife

Species	Status	Habitat/Occurrence	Present?				
California floater mussel *(Anodonta californiensis)*	WA-C	Shallow areas of lakes, ponds, reservoirs, and large rivers with muddy or sandy substrate. Historically found throughout the western US, but presently known to occur as remnant populations in Columbia, Okanogan, and lower Willamette river systems. Intolerant of quickly fluctuating water levels that can decimate local populations. Known population in the Sandy River Delta.	No				
Western Ridged Mussel *(Gonidea angulata)*	FS	Low to mid-elevation cold clean streams and rivers of the Western US. Mainly east of the Cascades locally. Known stronghold in the larger rivers of the Snake and Columbia River systems.	No				
Giant Columbia River limpet *(Fisherola nuttalli)*	FS, WA-C	Historically in almost the entire Columbia R. basin, now restricted to a few remant sites. In WA, confirmed in Hanford Reach of the Columbia R., as well as the Okanogan, Wenatchee and Methow rivers. In OR, only documented in Deschutes R.	Maybe				
Great Columbia River spire snail *(Fluminicola columbiana)*	WA-C	Historically, widespread throughout the Lower Snake and Columbia Rivers, and their larger tribs. Now limited to a few reaches of the Columbia R. system that remain free-flowing and colder. Confirmed in a few sites along the Columbia, Okanogan, Wenatchee and Methow Rivers in WA, and the Deschutes River in OR.	Maybe				
Puget Oregonian *(Cryptomastix devia)*	FS	Western Cascade Range in Low/Mid elevations (CRGNSA, GPNF, Clackmas RD. HR RD, ZZ RD, OlympicNF, Salem BLM, Hebo RD, Wenatchee NF, MBSNF): Moist conifer forests, associated with bigleaf maple. Often found on or under hardwood logs, leaf litter, or under sword fern, moist rocks/talus. Young devia may be under mosses on trunk of big-leaf maple.	No				
Columbia Oregonian *(Cryptomastix hendersoni)*	FS, WA-C	2 known locations only: The CRG, in scattered locations near seeps and streams along both sides of the Columbia River, from near The Dalles to near Rufus, OR; and from upland locations in the Mount Hood National Forest. Within 100 m. of streams, seeps, & springs (low elev) in steppe communities. May also be in mid elev. mature closed canopy forests among moist talus, leaf litter, or shrubs, or under logs or other debris.	Maybe				
Evening Fieldslug *(Deroceras hesperium)*	FS	Low to mid-elevation from the Cascade range to the Pacific Ocean, with majority of the currently documented sites east of the Cascade crest. The Evening Fieldslug is associated with perennially wet meadows in forested habitat, microsites include a variety of low vegetation, litter and debris and rocks/talus.	No				
Malone's jumping slug *(Hemphilia malonei)*	FS(WA)	Benton Cnth northward into W OR Cascades and into SW Cascades of WA.: wet/moist conifereous forest stands, esp. where there is abundant large down wood exist. Understory typically veg species of cool shady forest, such as sword fern.	No				
Barren Juga *(Juga hemphilli hemphilli)*	FS	Limited distribution in Columbia River Gorge (Clark and Skamania Co, WA.), Johnson Creek, and Mt. Hood NF. Also suspected to occur in Gifford-Pinchot NF. Found in smaller low elevation streams, with low gradient, stable gravel substrate, moderate velocity, and highly-oxygenated, cold water.	Maybe				

Species	Status	Habitat/Occurrence	Present?				
Columbia Duskysnail *(Lyogyrus n. sp. 1)*	FS	CRGNSA, GPNF, MHNF. Counties include Klickitat, Skamania, Cowlitz, Clark, Wash, Mult, Clack, Hood R): Spring and Spring outflows in cold, clear, and well-oxygenated water. Usu. slow flow with some moss substrate.	No				
Oregon megomphix *(Megomphix hemphilli)*	FS(WA)	Puget Sound and Coast range to west foothills of Cascade range in moist coniferous forests. Often in assoc with big-leaf maple and sword fern. Photo-phobic; seldom found on surface.	No				
Dalles sideband *(Monadenia fidelis minor)*	FS, WA-C	Known from watersheds tributary to the Columbia Gorge from Hood River east to the vicinity of The Dalles (on both sides of the Columbia River) and in upland sites in watersheds tributary to the lower Deschutes River in Wasco County. Within 200 m. of streams, seeps, or springs, in steppe or dry forest plant communities (within talus and moist rocky areas). May be found among rocks, shrubs/veg. and down wood.	Maybe				
Crowned tightcoil *(Pristiloma pilsbryi)*	FS	Historic range probably from southern Alaska to southern Oregon. Currently known from Clallam and Pacific Co, WA, suspected in Grays Harbor, Wahkiakum, Cowlitz and Clark Co, WA and Multnomah, Clatsop and Columbia Co., OR. Found in very moist forests, including floodplains, in decaying leaf litter, commonly under dense salal, vine maple, waterleaf or other deciduous vegetation.	No				
Shiny Tightcoil *(Pristiloma wascoense)*	FS(WA)	Reported from many widely separate (but imprecise) historic locations; in Wasco County, Marion Co. and Wallowa County in Oregon; also reported from several counties in Idaho. The species seems to occur rarely in Oregon; surveys in recent years in these areas have failed to relocate it. It is possible that *P. wascoense* is a small form or *P. cherisnella*, or represent a species complex in the northern portion of OR Cascades. Thought to generally occur in Ponderosa Pine/Douglas fir plant associations at moderate-high elevations with likely preference for moist microsites such as basalt talus accumulations, usually with riparian influence.	No				
Pristine springsnail *(Pristinicola hemphilli)*	FS(WA)	Scattered colonies in Columbia, Snake, and Willamette River watersheds, as well as SW OR. Majority of sites are very small, undisturbed cold springs or seeps with slow to moderate flow; sometimes in larger springs and spring runs or spring-influenced portions of small streams.	Maybe				
Blue-gray taildropper *(Prophysaon coeruleum)*	FS(WA), WA-C	Western Cascades and puget trough, south to N. CA. Occurs on both sides S. OR Cascades. Suspected on E slopes of Cascades in WA: Moist conifer and mixed conifer/hardwood forest, where litter is moist and shaded. Associated with decayed logs, leaf litter, mosses and bigleaf maple/sword fern. Rare in WA, common in OR.	No				
Columbia River tiger beetle *(Cicindela columbica)*	WA-C	Known to occur only in sandbars of Snake and Columbia river riparian area, east of Cascades.	No				
Yuma skipper butterfly *(Ochlodes yuma)*	WA-C	Main pop. in Great Basin area w/outliers in central and eastern OR/WA: near freshwater marshes, streams, ponds, linked with *Phragmites* reeds. The only record within CRGNSA, in 1999, found at Maryhill on ornamental *Miscanthus)*.	No				

Species	Status	Habitat/Occurrence	Present?				
Chinquapin hairstreak butterfly *(Habrodais grunus herri)*	WA-C	North-central OR, Skamania County, WA: Obligate with *Chrysolepis chrysophylla*. One known location near Stevenson, WA.	No				
Johnson's hairstreak butterfly *(Callophry[Mitoura] johnsoni)*	FS, WA-C	Cascades, Coast, Siskiyou, Blue, Wallowas mtns: coniferous forest old-growth obligate.	No				
Mardon skipper *(Polites mardon)*	C, FS, WA-E	Historic distribution unknown. Present known distribution is disjunct: N CA, Puget sound and south Cascades of WA. Habitat of open fescue grasslands, riparian, or meadows with nectar plant source. No known populations in the NSA but surveys by NSA office continues. Species decline likely due to loss of native grass meadows and prairie habitat throughout NW.	Maybe				

Columbia River Gorge National Scenic Area Management Plan
SENSITIVE WILDLIFE AND PLANT SPECIES
Species with Historic or Suspected Range in the CRGNSA

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Abbreviations: E=Federally Endangered; Endemic=Endemic to Columbia River Gorge; FS= Forest Service Sensitive (Animals); FS-S=Forest Service Sensitive (Plants); GMA, General Management Area; MP=Management Plan; OR-E=Oregon Endangered; OR-SC=Oregon Sensitive-Critical; OR-SP=Oregon Sensitive Peripheral or Naturally Rare; OR-SU=Oregon Sensitive Undetermined; OR-SV=Sensitive Vulnerable; OR-T=Oregon Threatened; OR-1=not state-listed but on ORNHIC List 1; OR-2=not state-listed but on ORNHIC List 2; SMA, Special Management Area (*the project area does not pass through any SMAs); WA-C=Washington Candidate; WA-E=Washington Endangered; WA-S: Washington Sensitive; WA-T=Washington Threatened; T=Federally Threatened.					
FISH					
Bull trout (Columbia River) *(Salvelinus confluentus)*	T OR-SC WA-C	Spawns and rears in cold streams/lakes. Adults will disperse and/or migrate in warmer systems such as the Columbia River mainstem. Presently also documented in Hood River, Drano Lake, and suspected in Klickitat R and Sandy R within NSA.	x		Species addressed in Chapter 3
Steelhead trout (Snake River) *(Oncorhynchus mykiss)*	T WA-C	Anadromous: Presence within the NSA limited to migration corridor of the Columbia River.	x		Species addressed in Chapter 3
Steelhead trout (Mid-Columbia River) *(Oncorhynchus mykiss)*	T WA-C	Anadromous: Spawns and rears within Columbia River tributaries between Mosier and Yakima, in both O and WA.	x		Species addressed in Chapter 3
Steelhead trout (Upper Columbia River) *(Oncorhynchus mykiss)*	E WA-C	Anadromous. Presence within the NSA limited to migration corridor of the Columbia River.	x		Species addressed in Chapter 3
Steelhead trout (Lower Columbia River) *(Oncorhynchus mykiss)*	T OR-SC WA-C	Anadromous: Spawns and rears within Columbia River tributaries between the mouth of the Columbia R east to Hood River, in both OR and WA.	x		Species not in project area
Chinook (Mid-Columbia spring run)*(Oncorhynchus tshawytscha)*	FS	Anadromous: Spawns and rears within Columbia River tributaries between Mosier and Yakima, in both OR and WA.		x	Species occurs within project area in the Columbia River for all three action alternatives, and Fifteenmile Creek for the West Alternative. Typical fish impacts are addressed in Chapter 3
Chinook salmon (Snake River spring/summer/fall runs) *(O. tshawytscha)*	T OR-T WA-C	Anadromous. Presence within the NSA limited to migration corridor of the Columbia River.	x		Species addressed in Chapter 3
Chinook salmon (Lower Columbia River) *(Oncorhynchus tshawytscha)*	T OR-SC (fall run) WA-C	Anadromous: Spawns and rears within Columbia River tributaries between the mouth of the Columbia R east to Hood River, in both OR and WA.	x		Species not in project area

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Chinook salmon (Upper. Columbia R.) (*Oncorhynchus tshawytscha*)	E WA-C	Anadromous: Presence within the NSA limited to migration corridor of the Columbia River.	x		Species addressed in Chapter 3
Sockeye salmon (Snake River) (*Oncorhynchus nerka*)	E WA-C	Anadromous. Presence within NSA limited to migration corridor of the Columbia River. Spawning area typically adjacent to or within lakes, where young rear.	x		Species addressed in Chapter
Chum salmon (Columbia River) (*Oncorhynchus keta*)	T OR-SC WA-C	Anadromous: Spawns and rears in several locations on the Columbia River shoreline as well as within low gradient Columbia R tributaries, in both OR and WA. Historically documented spawning run as far east as the Umatilla/Walla Walla systems, but present pop. largely below Bonneville dam. Some incidental spawning known to occur near the mouths of White Salmon R (WA) and Eagle Creek (OR).	x		Species not in project area
Coho (lower Columbia River) (*Oncorhynchus kisutch*)	T OR-E	Anadromous: Spawns and rears within Columbia River tributaries between the mouth of the Columbia R east to Hood River, in both OR and WA.	x		Species addressed in Chapter 3
Coastal cutthroat trout (Lower Col R Anadromous form) (*Oncorhynchus clarki clarki*)	OR-SC	Anadromous: Spawns and rears within Columbia River tributaries between the mouth of the Columbia River east to the Hood River.	x		ORNHIC data indicates coastal cutthroat in the Columbia River, and a mix of sea-run and resident coastal cutthroat in Fifteenmile Creek and tributaries. Typical fish impacts are addressed in Chapter 3.
Pacific lamprey (*Lampetra tridentata*)	OR-SV	Anadromous: Found sporadically throughout Columbia River basin. Spawns in gravelly riffles in late spring/summer. Ammocoetes rear for aprox. 6 years in silt and fine sand before outmigration.	x		Species addressed in Chapter 3
River lamprey (*Lampetra ayresi*)	WA-C	Anadromous: Historically thought to occur throughout the Columbia River system, but little information on current distribution or abundance. Difficult to ID as ammocoetes. Adults not documented in OR/WA since 1980.	x		Species addressed in Chapter 3
Eulachon (*Thaleichthys pacificus*)	WA-C	Anadromous, with spawning in mainstem Columbia River & lower reaches of rivers, often within tidal influence. (Sandy River in NSA). Historically migrated as far east as Hood River prior to Bonneville Dam	x		Species not in project area
Leopard dace (*Rhinichthys falcatus*)	WA-C	Disjunct pops in Columbia River mainstem Yakima, Snake, Similkameen rivers. Habitat in large, slower flowing rivers/lakes. Lay adhesive eggs in riffles, late spring.	x		Species addressed in Chapter 3

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Mountain sucker (*Catostomus platyrhynchus*)	WA-C	Historic range in Columbia River system, largely east of Cascades, including the Columbia River mainstem & lower Klickitat River within the NSA. June/July spawner in riffles.	x		Species addressed in Chapter 3
HERPTILES					
Cope's giant salamander *(Dicamptodon copei)*	FS OR-SU	Western WA, Northwestern OR: Clear, cold mountain streams w/rocky substrate	x		Outside known range
Cascade torrent salamander *(Rhyacotriton cascadae)*	FS WA-C OR-SV	Cascade Mtns of southern WA and northern OR: in and adjacent to cold, fast, mountain streams or seeps w/rocky substrate	x		Outside known range; No suitable habitat in project area
Dunn's salamander *(Plethodon dunni)*	WA-C	Coast range only WA and Western OR: moss-covered rock rubble, shady stream banks.	x		Outside known range
Oregon slender salamander *(Batrachoseps wrighti)*	FS OR-SU	North and Central OR Cascades: Forests with large down logs and moist talus with abundant wood debris	x		Outside known range; no suitable habitat in project area
Larch mountain salamander *(Plethodon larselli)*	FS WA-S OR-SV	Cascades mountains of southern WA/northern OR: Largely in moss-covered shady talus slopes, low-mid elevation.	x		Outside known range
Columbia spotted frog *(Rana luteiventris)*	WA-C OR-SU	Columbia basin (east of Cascades Range): In or near permanent slow ponds, streams, marshes with abundant veg. (one known site at Conboy). No currents sites in NSA.	x		Outside known range
Oregon spoted frog *(Rana pretiosa)*	FS WA-E OR-SC	The Oregon spotted frog was historically found in the Puget Trough from the Canadian border to the Columbia River and east into the southern Washington Cascades. In or near large perennial lakes/marshes. Closest extant population at Crane prairie reservoir in Deschutes county.	x		Species addressed in Chapter 3
Northern leopard frog (*Rana pipiens*)	WA-E OR-SC	Lowland marsh/pondswith dense vegetation; presently found in Grant county only. Likely extirpated in Gorge.	x		Species addressed in Chapter 3
Western toad (*Bufo boreas*)	WA-C OR-SV	Widespread distribution in WA and OR: Most common near marshes and small lakes (breeding sites in midspring); can travel readily overland and be found along streams/seeps.	x		Species addressed in Chapter 3
Tailed frog (*Ascaphus truei*)	OR-SV	Clear, cold, fast forest streams with little silt and (often) cobble substrate.	x		Outside known range

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Cascades frog (*Rana cascadae*)	OR-SV	High elevation streams (1500-6000') as well as mtn meadows and moist forests	x		Outside known range
Northern red-legged frog (West Cascades) (*Rana aurora*)	OR-SU	Generally found below 3000' in moist forests and forested wetlands. Breeds in cool ponds and slow streams. Adults can be found some distance from water during wet seasons.	x		Outside known range; No suitable habitat in project area
Northwestern pond turtle (*Clemmys marmorata*)	FS WA-E OR-SC	Streams, lg rivers, slow sloughs, and quiet waters with nesting habitat (open meadow) within ½ mile. Occurs below 3000' elevation.	x		Species addressed in Chapter 3
Painted turtle (*Chrysemys picta*)	FS (OR) OR-SC	Slow water ponds, marshes, rivers below 3000' elevation. Widely introduced outside Columbia River Gorge and Columbia River basin.	x		Species addressed in Chapter 3
California Mtn king snake (*Lampropeltis zonata*)	FS(WA) WA-C OR-SV	Main population in CA and Klamath mtns, with disjunct population. in Columbia River Gorge (Klickitat, Skamania county area): oak/pine woodland, rocky riparian within logs/rocky cover. No confirmed specimens on OR side of NSA, although unconfirmed sightings have been reported at The Dalles and Maupin areas.	x		Species addressed in Chapter 3
Sharptail snake (*Contia tenuis*)	FS (WA) WA-C OR-SV	East slope of WA Cascades, Columbia River Gorge, western OR: rocky slopes often in open pine/oak woodland w/prey species of small slugs. Often in moist riparian east of Cascades. Largely subterranean during summer, appearing in spring/fall.	x		Species addressed in Chapter 3
Striped whipsnake (*Masticophis taeniatus*)	FS(WA) WA-C	South/central WA, eastern OR: dry rocky sites, oak woodland, pine forests	x		Rare, but possible along all lines. Typical impacts for snakes are addressed in Chapter 3.
BIRDS					
Bald eagle *(Haliatus leucocephalus)*	T WA-T OR-T	Shoreline (generally within 1 mile of large water bodies) with large trees and prey base of primarily fish. Diet also includes some waterfowl, turtles, and carrion.	x		Species addressed in Chapter 3
Northern spotted owl *(Strix occidentalis caurina)*	T WA-E OR-T	Mature coniferous forest generally used for nesting, roosting, and foraging. Will disperse in early or mid-seral forests.	x		Outside known range; no suitable habitat in project area
Ferruginous hawk *(Buteo regalis)*	FS(WA) WA-T OR-SC	Open prairie and shrub steppe in eastern WA and OR.	x		Rare, but possible along all lines. Typical bird impacts addressed in Chapter 3.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Peregrine falcon *(Falco peregrinus)*	FS OR-E WA-S	Tall cliff (nest) sites within 1 mile of water with sm. bird prey base.	x		Species addressed in Chapter 3
Northern goshawk *(Accipiter gentilis)*	WA-C OR-SC	Typically more common east of Cascades in a wide variety of forest ages, structural conditions, and successional stages. Uses stands of mature forest as nesting sites. Typically found between 1900 and 6100 feet in Oregon.	x		Rare, but possible winter resident along all lines. Typical bird impacts addressed in Chapter 3.
Golden eagle (*Aquila chrysaetos*)	WA-C	Generally open habitats such as shrub steppe, grassland, open pine and juniper forest and mixed conifer/deciduous forest. Nests on trees, ledges and cliffs.	x		Species addressed in Chapter 3
Merlin (*Falco columbarius*)	WA-C	Forests, grasslands, marshes. Nests in WA Cascades, northeatern WA. Winters in all northwest U.S.	x		Rare, but possible winter resident along all lines. Typical bird impacts addressed in Chapter 3.
Flammulated owl (*Otus flammeolus*)	WA-C OR-SC	East Cascades: cavity nester in mature pine and mixed conifer, at mid-elevations. Winters south of US border.	x		No suitable habitat in project area
Common loon (*Gavia immer*)	FS(WA) WA-S	Undisturbed lakes and ponds with fish/invert prey base. Spring/fall migrant and winters in NSA.	x		Possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Western Grebe (*Aechmophorus occidentalis*)	WA-C	Open lakes and marshes w/rushes and tules, winters in coastal esturaies/bays.	x		Possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Clark's grebe (*Aechmophorus clarkii*)	FS(WA)	Winters in NSA on large rivers. Breeds in large lakes with tule or rushes.		x	Rare, but possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Horned grebe (OR only) (*Podiceps grisegena*)	FS(OR) OR-SP	Common winter resident on Columbia River within NSA. Breeds on marshes and lakes in eastern WA/OR	x		Possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Red-necked grebe (*Podiceps grisegena*)	FS(OR, OR-SC	Rare winter migrant on the Columbia River. Uncommon breeder in eastern WA/OR.	x		Very rare migrant, but historically found within 1 mile of project area. Typical bird impacts addressed in Chapter 3.
Eared grebe (*Podiceps nigricollis*)	FS(WA)	Documented but uncommon winter resident of NSA. Breeds in eastern OR/WA lakes/reservoirs with rushes/cattails		x	Rare, but possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Bufflehead (*Bucephala albeola*)	FS(OR) OR-SU	Nests in tree cavities at high elevation forested lakes. Common migrant and winter resident in OR and western WA in large ponds (including Columbia River.) to coastal	x		Possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
		estuaries.			
Barrow's goldeneye (breeding population) (*Bucephala islandica*)	OR-SU	Cascade range: breeds along ponds, sloughs and lakes in mountainous areas, using tree cavities or nest boxes. Winters in large rivers or marine habitat.	x		Uncommon, but possible winter resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Harlequin Duck (*Histrionicus histrionicus*)	FS(OR) OR-SU	Swift forested streams during breeding season. Coastal estuaries in winter. Documented in Eagle Creek (OR), Hood River, and Wind, White Salmon Rivers (WA).	x		Outside known range
American white pelican (*Pelecanus erythrorhynchos*)	WA-E OR-SV	Gregarious birds that nest in large colonies on islands within shallow water and marshes free of human disturbance and mammalian predators. Post breeders sometimes seen in Columbia River (such as Klickitat Delta). Winters in southern US through Mexico.	x		Species addressed in Chapter 3
Aleutian Canada goose (*Branta canadensis leucopareia*)	WA-T	Winters at Ridgefield NWR, as well as other locations near Columbia River.	x		Very rare migrant, but historically found within 1 mile of project area. Typical bird impacts addressed in Chapter 3.
Sandhill crane (*Grus canadensis*)	WA-E	Riverine wetland, islolated mtn meadows/basins. No current breeding pops in the NSA, some migration.	x		Outside known range
Yellow-billed cuckoo (*Coccyzus americanus*)	WA-C OR-SC	Historic range in WA and OR. No reported breeding occurrences since the 1950's, although individuals have been sighted east of Cascades sporadically. Riparian forests, with cottonwood/thick willow; Neotropical migrant. Considered extirpated from WA and OR.	x		Considered extirpated.
Lewis' woodpecker (*Melanerpes lewis*)	WA-C OR-SC	Open pine/oak woodland, conifer forests, and riparian woodland; neotropical migrant. Commonly seen in east areas of NSA in dry forest types of oak and pine.	x		Species addressed in Chapter 3
White-headed woodpecker (*Picoides albolarvatus*)	WA-C OR-SC	Central/eastern. WA/OR in mature and open coniferous forests, especially ponderosa pines. Cavity nester. Not currently documented in NSA.	x		No suitable habitat in project area
Three-toed woodpecker (*Picoides tridactylus*)	OR-SC	Range in higher elevation OR Cascades in forests with Pine or Spruce component with bark beetle availability (diseased/ dying/ burned trees). Very limited habitat in NSA.	x		No suitable habitat in project area

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Black-backed woodpecker (*Picoides arcticus*)	WA-C OR-SC	Uncommon Cascades resident usu. at higher elvations (above 3000'). Eastern Cascades in WA. Scattered distribution as populations are highly associated with post-fire habitats in mature forests (stand-replacement fires with snags), dependent on high density of dead and insect-ridden trees.	x		No suitable habitat in project area
Pilieated woodpecker (*Dryocopus pileatus*)	WA-C OR-SV	Conifer/mixed conifer forests, as well as decidous stands in valley bottoms with large dead or live trees (or remnants) for foraging and nesting. Primary cavity nester.	x		No suitable habitat in project area
Williamson's sapsucker (*Sphyrapicus thyroideus*)	OR-SU	East slopes of Cascades: breeds in coniferous mountain forests at mid to high elevation. Prefers large snags for nesting. Majority of population migrate to southwestern US for winter.	x		No suitable habitat in project area
Mountain quail (E Cascades, Blue Mtns, High Plains pops.) (*Oreotryx pictus*)	OR-SU	Generally found in shrub dominated communities that can be within mixed conifer/decidous forests, generally near available water. Locally found around Seven-mile hill, Mosier, and Middle Mountain in OR. Not listed in WA, but found in southeastern Skamania and western Klickitat counties. Seasonal migrations vertically.	x		Species addressed in Chapter 3
Sharp-tailed grouse (*Tympanuchus phasianellus*)	WA-T	Grasslands/sagebrush. Historically found east of the Cascades, including much of Klickitat County, but extirpated in 1950s from most of range in WA and OR. Remnant population in northeastern WA.	x		Extirpated from its historic range in the project area.
Sage sparrow (*Amphispiza belli*)	WA-C	Eastern WA/OR; flat terrain highly associated with big sagebrush, may also use haparral, and dry foothills. On periphery of habitat in NSA; in the extreme eastern end. No known current pops.,although migrants may pass through the NSA. Winters in southern OR, and southwest US states.	x		Outside known range
Sage thrasher (*Oreoscoptes montanus*)	WA-C	Eastern WA/OR semi-arid sagebrush plains and bottomlands. May have historically been in outlying east portion of NSA, but no current populations.	x		Outside known range
Loggerhead shrike (*Lanius ludovicianus*)	WA-C	East of Cascades: dry grassland and sagebrush desert habitats. On periphery of habitat in NSA with sightings in east Klickitat county. Neotropical migrant.	x		Uncommon, but possible summer resident in shrub-steppe along all lines. Typical bird impacts addressed in Chapter 3.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Oregon vesper sparrow (*Pooecetes gramineus affinis*)	WA-C	Lowland valleys of western WA/ OR: (Willamette, Klamath, Puget sound) sparsely vegetated grasslands with scattered tall structures used for song perches, including agricultural lands. On periphery of habitat in NSA. Ground nester.	x		Possible summer resident along all lines. Typical bird impacts addressed in Chapter 3.
Pygmy nuthatch (E. Cascades population) (*Sitta pygmaea*)	OR-SV	Open mature and old growth ponderosa pine stands; although foraging may occur in younger stands. Cavity maker/nester in large snags (critical habitat component)	x		No suitable habitat in project area
Western bluebird (West slope Cascades population) (*Sialia mexicana*)	OR-SV	Secondary cavity nester. Found in open habitat that has required snags (or nest boxes). Limited habitat in Scenic Area on west slope of Cascades, except Sandy River Delta.	x		Outside known range
Gray flycatcher (*Empidonax wrightii*)	FS	Southeast WA and eastern OR: Sagebrush and pinyon juniper woodlands. On periphery of habitat in NSA. Winters in southwest US and southward.		x	Uncommon, but possible summer resident. Typical bird impacts addressed in Chapter 3.
Ash-throated flycatcher (*Myiarchus cinerascens*)	FS(WA)	Oak and juniper woodlands. Nests in natural or artificial cavities. Winters in southwest US and southward.		x	Possible summer resident in forest stands. Typical bird impacts addressed in Chapter 3.
Willow flycatcher (East Cascades population) (*Empidonax adastus*)	OR-SU	Associated with shrub habitat. Dependent on willow thickets in riparian zones for nesting and migration. Neotropical migrant.	x		Possible summer resident where suitable willow thickets are present. Typical bird impacts addressed in Chapter 3.
Black swift (*Cypseloides niger*)	FS(OR) OR-SP	Nests in waterfalls, steep cliffs, and damp caves out of direct sunlight. Highly suspected to be in NSA. Neotropical migrant.	x		No suitable habitat in project area
Vaux's swift (*Chaetura vauxi*)	WA-C	Found in forests and urban areas where their need for hollow trees/bark or chimneys for nesting sites are met; neotropical migrant	x		Possible summer resident in forest stands. Typical bird impacts addressed in Chapter 3.
Purple martin (*Progne subis*)	OR-SC WA-C	Western WA/OR up through Gorge to western Wasco County: cavity/crevice nester, often near water. Forages over open water/fields/ forest canopy. Winters in South America.	x		Outside known range
Bank swallow (*Riparia riparia*)	OR-SU	East of Cascades along waterways or roadcuts where vertical cliffs of soil are exposed adjacent to large open area. Neotropical migrant.	x		No suitable bank habitat observed
Great blue heron (*Ardea herodias*)	MP	Near water, including rivers, lake and pond edges, and wetlands, as well as dry fields and pastures. Highly adaptable to urban areas Often nests colonially, near	x		Possible year around resident. Typical bird impacts addressed in Chapter 3.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
		water.			
Osprey (*Pandion haliaetus*)	MP	Near freshwater lakes, rivers and resevoirs with fish. Nests almost always within two miles of water.	x		Possible summer resident along Columbia River. Typical bird impacts addressed in Chapter 3.
Prairie falcon (*Falco mexicanus*)	MP	Breeds in open country east of the Cascades containing cliffs and outcrops for nesting.	x		Species addressed in Chapter 3.
MAMMALS					
Grizzly bear *(Ursus arctos)*	T WA-E	Historically in lower 48 states, presently restricted to areas with low human populations, such as North Cascades Range.	x		Outside known range
Gray wolf *(Canis lupus)*	E WA-E	Historically found in almost all habitats in lower 48 states; presently in steppe, woodland, and forest where reintroduced.	E		Outside known range
California wolverine *(Gulo gulo)*	FS WA-C OR-T	Conifer Forests. Intolerant of human encounters/ disturbance. Require very large home ranges. One sighting in last several decades from road-killed juv male on I-84, near Starvation Creek., January 1990.	x		No suitable habitat in project area
Pacific fisher *(Martes pennanti)*	FS WA-E OR-SC	Optimum habitat is dense, lower elevation, mature conifer forest, with large down logs for nesting. Likely extirpated in NSA and adjacent forests.	x		No suitable habitat in project area
American marten *(Martes americana)*	OR-SV	Mature and old growth forests with large amounts of standing snags and down wood. Tend to be in mesic forests at mid to high elevation.	x		No suitable habitat in project area
Columbian white-tailed deer (Lower Columbia River population only) *(Odocoileus virginianus leucurus)*	E WA-E	Historic distribution in floodplains, bottomland riparian of Willamette and Lower Columbia Rivernow limited to these lower southwest counties: Clark, Cowliz, Pacific, Skamania, and Wahkiakum Counties, WA., and Clatsop, Columbia, and Multnomah Counties, OR..	x		Outside known range
White-tailed jackrabbit *(Lepus townsendii)*	WA-C OR-SU	East of Cascades: open areas with native bunchgrass, sagebrush plains, can also be found in coniferous forests and subalpine meadows. On periphery of habitat in NSA at the Dalles/Dallesport.	x		Species addressed in Chapter 3

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Washington ground squirrel (*Spermophilus washingtoni*)	WA-C OR-E	Presently found in Columbia basin of WA state in sagebrush/grassland w/ sandy soils; also Giliam, Morrow and Umatilla counties, OR. May have historically been within the eastern edge of NSA.	x		Outside known range
Western gray squirrel (*Sciurus griseus*)	FS(WA) OR-SU WA-T	Open mixed oak/conifer woodland, typically within ½ mile of water source. Core range for WA in Klickitat county. Known to occur in Hood River and areas east within OR. Easy to confuse with non-native and invasive Eastern gray squirrel.	x		Species addressed in Chapter 3
Gray-tailed vole (*Microtus canicaudus*)	WA-C	Endemic to Clark County, WA and OR Willamette Valley: Grassy and agricultural lands, meadows. On periphery of habitat in NSA. Common in OR.	x		Outside known range
Townsend's big-eared bat (*Corynorhinus townsendii*)	FS(WA) WA-C, OR-SC	Throughout Western US. Roost and hibernaculum sites within caves, buildings, mines and bridge undersides, with exacting temp, humidity, and physical requirements. Very intolerant of human disturbance which results in loss of critical fat reserves during torpid period.	x		Species addressed in Chapter 3
Pacific Pallid bat (*Antrozous pallidus*)	FS(OR) OR-SV	Arid area specialist. Daytime roosts in buildings and crevices, less often in caves and other shelters. Feeds primarily on the ground on large insects, scorpions, and other small prey.	x		Species addressed in Chapter 3
Pacific Fringe-tailed bat (*Myotis thysanodes vespertinus*)	FS	Nursery colonies and roosts in mines, caves, buildings and similar. Intolerant of human disturbance. Documented in Little White Salmon subbasin 1996		x	Suitable habitat unlikely. No mines, caves or buildings that could provide roosts.
Silver-haired bat (*Lasionycteris noctivagans*)	OR-SU	Found throughout Oregon: among the most common bats in forested areas of America, most closely associated with coniferous or mixed coniferous and deciduous forest types, especially in areas of Old Growth. They form maternity colonies almost exclusively in tree cavities or small hollows	x		Species addressed in Chapter 3
Western small-footed myotis (*Myotis ciliolabrum*)	OR-SU	West Cascades and eastward: Rears its young in cliff-face crevices, erosion cavities, and beneath rocks on the ground as well as hibernating in caves or mines. Relatively little is known about this species.	x		Species addressed in Chapter 3
Long-eared myotis (*Myotis evotis*)	OR-SU	Statewide: found in coniferous roost in tree cavities and beneath exfoliating bark in both living trees and dead snags.	x		Species addressed in Chapter 3

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Long-legged- myotis (*Myotis volans*)	OR-SU	Statewide: especially dependent on wooded habitats of coniferous forests, usually at elevations of 4,000 to 9,000 feet. Nursery colonies found in large mature trees that provide crevices or exfoliating bark, along openings or along forest edges where they receive a large amount of daily sun. Also found in rock crevices, cliffs, and buildings. Long-legged myotis forage over ponds, streams, water tanks, and in forest clearings, often on moths.	x		Species addressed in Chapter 3
Mountain Goat (*Oreamnos americanus*)	MP	Typically, steep slopes and cliffs and associated meadows. May travel many hundreds of miles in atypical habitat to reach suitable habitat.	x		Outside known range
INVERTEBRATES					
California floater mussel *(Anodonta californiensis)*	WA-C	Shallow areas of lakes, ponds, reservoirs, and large rivers with muddy or sandy substrate. Historically found throughout the western US, but presently known to occur as remnant populations in Columbia, Okanogan, and lower Willamette river systems. ntolerant of fluctuating water levels that decimate local populations.	x		Possible in reservoirs and streams with muddy/sandy substrates. See typical impacts on fish habitat in Chapter 3.
Giant Columbia River limpet *(Fisherola nuttalli)*	WA-C	Historically in almost the entire Columbia River basin, now restricted to a few remnant sites. In WA, confirmed in Hanford Reach of the Columbia River, as well as the Okanogan, Wenatchee and Methow rivers. In OR, only documented in Deschutes River	x		Unlikely – No suitable habitat (project area lacks free-flowing Columbia River habitat)
Great Columbia River spire snail (*Fluminicola columbiana*)	WA-C	Historically, widespread throughout the Lower Snake and Columbia Rivers, and their larger tributaries. Now limited to a few reaches of the Columbia River system that remain free-flowing and colder. Confirmed in a few sites along the Columbia, Okanogan, Wenatchee and Methow Rivers in WA, and the Deschutes River in OR.	x		Unlikely – No suitable habitat (project area lacks free-flowing Columbia River habitat)
Puget Oregonian (*Cryptomastix devia*)	FS	Western Cascade Range in Low/Mid elevations (CRGNSA, GPNF, Clackmas RD. HR RD, ZZ RD, Olympic NF, Salem BLM, Hebo RD, Wenatchee NF, MBSNF) Moist conifer forests, associated with bigleaf maple. Often found on or under hardwood logs, leaf litter, or under sword fern, moist rocks/talus. Yound devia may be under mosses on trunk of big-leaf maple.		x	Outside known range; no suitable habitat in project area
Columbia Oregonian	FS	Low to Mid elevations Gorge in Wasco, Sherman, Skamania		x	Rare but possible in riparian habitat—ORNHIC

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
(*Cryptomastix hendersoni*)		and Klickitat counties (CRGNSA, MHNF, Naches RD, Mt. Adams RD): Within 100 m. of streams, seeps, & springs (low elevation) in steppe communities. May also be in mid elevation mature closed canopy forests among moist talus, leaf litter, or shrubs, or under logs or other debris.			database records show occurrences in tributary to Fifteenmile Creek and along Columbia River. Typical riparian impacts addressed in Chapter 3
Malone's jumping slug (*Hemphilia malonei*)	FS-WA	Below 4600' elevation. Benton Cnth northward into western OR Cascades and into southwest Cascades of WA. CRGNSA, GPNF, MHNF excp Barlow, Salem BLM Cascades, Olympic NF Hood CanalRD, WillametteNF DetroitRD): Moist forest stands, generally >50 yrs, with >50% canopy cover, especiallywhere dense sword fern and LWM exist. Some found near marshy areas w/low veg cover.		x	No suitable habitat in project area
Basalt Juga (*Juga* (O) n. sp. 2)	FS-OR	CRGNSA (listed in OR only, Wasco and Hood River counties, but also found in Klickitat and Skamania County): Spring fed springs/streams in low elevation (perennial), small drainages that drain to the Columbia River in Gorge.		x	Rare but possible – low elevation springs and creeks such as Fifteenmile Creek. Typical riparian impacts addressed in Chapter 3
Columbia Duskysnail (*Lyogyrus* n. sp. 1)	FS	CRGNSA, GPNF, MHNF. Counties include Klickitat, Skamania, Cowlitz, Clark, Wash, Mult, Clack, Hood River): Spring and Spring outflows in cold, clear, and well-oxygenated water. Usu. slow flow with moss substrate.		x	Unlikely, outside known range
Dalles sideband (*Monadenia fidelis minor*)	FS	Central and East Gorge; Wasco and Klickitat Counties. CRGNSA, MHNF Barlow and Hood R RD, GPNF Mt Adams RD): Within 200 m. of streams, seeps, or springs, in steppe or dry forest plant communities (within talus and moist rocky areas). May be found among rocks, shrubs/veg. and down wood.		x	Rare, but possible in low elevation basalt talus—ORNHIC database has a record in the project area of the West Alternative. Typical riparian impacts addressed in Chapter 3
Blue-gray taildropper (*Prophysaon coeruleum*)	FS-WA	Widespread. Western Cascades and puget trough, south to northern. CA. Occurs on both sides southern OR Cascades. Suspected on east slopes of Casacdes in WA: Moist conifer and mixed conifer/hardwood forest, where litter is moist and shaded. Associated with decayed logs, leaf litter, mosses and bigleaf maple/sword fern.		x	No suitable habitat in project area
Columbia River tiger beetle (*Cicindela columbica*)	WA-C	Known to occur only in sandbars of Snake and Columbia river riparian area, east of Cascades.	x		Believed extirpated from this historic range following hydroelectric development

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Yuma skipper butterfly (*Ochlodes yuma*)	WA-C	Main population in Great Basin area w/outliers in central and eastern OR/WA: near freshwater marshes, streams, ponds, lined with Phragmites reeds. The only record within CRGNSA, in 1999, found at Maryhill on ornamental Miscanthus (Pyle, 2002).	x		Possible—Phragmites habitat observed in some wetlands; and small Maryhill population near East Alternative. Typical wetland impacts addressed in Chapter 3
Chinquapin hairstreak butterfly (*Habrodais grunus herri*)	WA-C	North-central OR, Skamania County, WA: Obligate with Chrysolepis chrysophylla. One known location near Stevenson, WA.	x		No suitable habitat in project area - no *Chrysolepis* observed
Johnson's hairstreak butterfly (*Callophry*[Mitoura] johnsoni)	WA-C	Cascades, Coast, Siskiyou, Blue, Wallowas mountains: coniferous forest old-growth obligate.	x		No suitable habitat in project area
Mardon skipper (*Polites mardon*)	WA-E	Historic distribution unknown. Present known distribution is disjunct N CA, Puget Sound and south Cascades of WA. Habitat of open fescue grasslands, riparian, or meadows with nectar plant source. No known populations in the NSA but surveys by NSA office continues. Species decline likely due to loss of native grass meadows and prairie habitat throughout NW.	x		Species addressed in Chapter 3. Outside known range
PLANTS					
Tall Agoseris *Agoseris elata*	OR-2 WA-S FS-S	Meadows and open woods to mid-elevations.	x		Not found during surveys and no records within project area with ORNHIC and WNHP; suitable habitat exists along West Alternative. Typical impacts on grasslands and woodlands addressed in Chapter 3.
Howell's Bentgrass *Agrostis howellii*	OR-1 FS-S Endemic	Moist rocks on south side of Gorge (Multnomah and Hood River counties).	x		No suitable habitat in project area
Sickle-pod Rock Cress *(Arabis sparsiflora var. atrorubens)*	OR-2 FS-S	Eastside, low elevation . Open areas.	x		Not found during surveys and no records within project area; suitable habitat along West Alternative. Typical impacts on grasslands and shrub-steppe addressed in Chapter 3.
Northern Wormwood *(Artemesia campestris spp borealis var. wormskioldii)*	OR-E OR-1 WA-E FS-S US-C	Gravely beach areas of Columbia. Miller Island in Gorge	x		Project would not impact habitat.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Hood River Milk-vetch *(Astragalus hoodianus)*	OR-2 Endemic	Dry open areas of east Gorge	x		Not found in surveys in Oregon (not listed in Washington). Records near project area, suitable habitat along all action alternatives. Typical impacts on grassland and shrub-steppe addressed in Chapter 3.
Oregon Bolandra (*Bolandra oregana*)	WA-S FS-S	Wet basalt cliffs	x		Project would not impact habitat.
Lance-leaved grape-fern (*Botrychium lanceolatum*)	OR-2 FS-S	Moist, wet areas in mountains.	x		No suitable habitat in project area
Moonwort (*Botrychium lunaria*)	OR-2 FS-S	Moist wet areas but rarely in meadows.	x		No suitable habitat in project area
Mountain grapefern (*Botrychium montanum*)	OR-2 FS-S	Forested/open areas in conifer forest zones	x		No suitable habitat in project area
Brewer reedgrass (*Calamagrostis breweri*)	OR-2 FS-S	Stream banks, lake margins, sub-alpine to alpine meadows.	x		No suitable habitat in project area
Howell's Reedgrass (*Calamagrostis howellii*)	Endemi c	Rocky banks and crevices of cliffs within the Gorge.	x		Project would not impact habitat.
Long-bearded Sego Lily *Calochortus longebarbaus var. longebarbatus*	WA-S FS-S	East slope of Cascades.	x		Suitable habitat along West Alternative. Not found during surveys. Typical impacts on grassland habitat addressed in Chapter 3.
Dense Sedge (*Carex densa*)	WA-T FS-S	Wet areas on both sides of Cascades.	x		No suitable habitat (wet meadow) in project area.
Different Nerve Sedge *Carex heteroneura* (*Carex atrata var. erecta*)	FS-S	Montaine	x		No suitable habitat in project area
Pale sedge (*Carex livida*)	OR-2 FS-S	Willamette Valley.	x		No suitable habitat in project area
Large-awn Sedge (*Carex macrochaeta*)	WA-T OR-2 FS-S	Moist open places, coastal but suspected in Gorge.	x		No suitable habitat in project area
Native sedge (*Carex vernacula*)	OR-2 FS-S	Alpine to sub-alpine. Dwarf size.	x		No suitable habitat in project area

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Golden Paintbrush (*Castilleja levisecta*)	T OR-E OR-1 WA-E FS-S	Open fields west side of Cascades.	x		No suitable habitat in project area
Cliff Paintbrush (*Castilleja rubicola*)	OR-2 FS-S	Rocky cliffs at low to moderate elevations.	x		No suitable habitat in project area: primarily west-side species and above timberline.
Golden Chinquapin (*Chrysolepis chrysophylla*)	WA-S FS-S	Open to closed forest openings Low to mid elevations.	x		No chinquapin observed in the project area of the NSA.
Bulb-bearing Water-hemlock (*Cicuta bulbifera*)	OR-2 WA-S FS-S	Wet places to standing water. Low elevations	x		No suitable habitat in project area
Tall Bugbane (*Cimicifuga elata*)	OR-1 WA-S FS-S	Hardwood and mixed forest on west side	x		No suitable habitat in project area
Few-flowered Blue-eyed Mary (*Collinsia sparaiflora var. bruceae*)	WA-S FS-S	Dry slopes with sparse vegetation on east side of Cascades. Low elevations.	x		Not found during surveys. Habitat present on all three alternatives, most likely on West Alternative. Typical impacts on grasslands and shrub-steppe addressed in Chapter 3.
Three-leaf goldthread (*Coptis trifolia*)	OR-2 WA-1 FS-S	Wasco County.	x		No habitat present in project area: needs boggy wet, higher elevation conifer forests.
Cold-water Corydalis (*Corydalis aqua-gelidae*)	OR-1 WA-S FS-S	Along cold streams on west side of Cascades.	x		No habitat present in project area within NSA.
Beaked Cryptantha (*Cryptantha rostellata*)	WA-T FS-S	Dry open areas, east side Cascades.	x		Habitat present on West Alternative. Not observed during surveys. Typical impacts on grasslands and shrub-steppe addressed in Chapter 3.
Shining cyperus (*Cyperus bipartitus*)	FS-S	Wet places. Low elevation.	x		No habitat present in project area within NSA.
Clustered lady's-slipper (*Cypripedium fasiculatum*)	OR-2 WA-S FS-S	Open to closed forested woodlands/forest. East side of Cascades.	x		Species addressed in Chapter 3. (Mapped as present on West Alternative and within the NSA. Not found during surveys of project area).

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Fringed Waterplantain (*Damasonium californicum*)	WA-T FS-S	Sloughs, marshes and other standing waters.	x		Possible habitat in vernal pool type wetlands on West Alternative, although not mapped in project area. Typical wetland impacts addressed in Chapter 3.
Pale Larkspur (*Delphinium leucophaeum*)	WA-E OR-1	West-side (Mult.)	x		No habitat present in project area of the NSA (primarily west-side species).
Nuttall's Larkspur (*Delphinium nuttallii*)	OR-2	West-side	x		Possible habit in project area. Typical impacts on grasslands addressed in Chapter 3: project would not impact possible basaltic cliff habitat.
Smooth-leaf Douglasia (*Douglasii laevigata var. laevigata*)	Endemic	Basaltic cliffs and rocky out-crops, low elevation through the Gorge.	x		Not found in project area during surveys. Possible rocky outcrop habitat impacts along West Alternative addressed in Chapter 3.
Howell's Daisy (*Erigeron howellii*)	OR-1 WA-T Endemic FS-S	Open areas on ridges and rocky areas.	x		Possible habitat in project area, although mapped primarily on west side of Cascades. Possible rocky outcrop habitat impacts along West Alternative addressed in Chapter 3.
Columbia Gorge Daisy (*Erigeron oreganus*)	OR-1 WA-T Endemic FS-S	Over hanging basalt cliffs.	x		Project would not impact habitat. Also, primarily west-side species.
Oregon Coyote-thistle (*Eryngium petiolatum*)	WA-T FS-S	Dry ephemeral wetlands in east Gorge.	x		Not found during surveys and not mapped within project area. Possible habitat in project area within the NSA along the West Alternative. Typical wetland habitat impacts addressed in Chapter 3.
Western Wahoo (*Euonymus occidentalis*)	WA-T FS-S	In woods of west Cascades.	x		No suitable habitat in project area
Black Lily (*Fritillaria camschatcensis*)	OR-2 WA-S FS-S	Moist areas west Cascades from coast to mountains.	x		No suitable habitat in project area
Currant-leaf Alumroot (*Heuchera grossularifolia var. tenuifolia*)	WA-S FS-S	Cliffs, often shaded, along streams or rivers in East Gorge.	x		Project would not impact habitat.
Long-beard Hawkweed (*Hieracium longiberbe*)	Endemic	Open areas throughout Gorge.	x		Not likely in project area: appears to be on west side of Cascades.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Howellia (*Howellia aquatilis*)	T OR-1 WA-T FS-S	Low elevation wetlands.	x		Not likely in project area: historically found in wetlands on west side of the Cascades.
Columbia Lewisia (*Lewisia columbiana var. columbiana*)	OR-2 FS-S	Open rocks areas in west Gorge, generally middle to high elevations.	x		Habitat not present in project area of the NSA in OR: historically found on west side of the Cascades.
Baker's Linanthus (*Linanthus bolanderi*)	WA-S FS-S	Dry open areas in East Gorge.	x		Potentially in project area, not found during surveys. Typical grassland and shrub-steppe habitat impacts addressed in Chapter 3.
Twayblade (*Liparis loeselii*)	WA-E FS-S	Wet or damp areas within forest	x		No suitable habitat in project area
Smooth Desert Parsley (*Lomatium laevigatum*)	OR-2 WA-T FS-S Endemic	Basalt cliffs in east Gorge	x		Species addressed in Chapter 3
Salmon River lomatium (*Lomatium salmoniflorum*)	OR-2	Wasco County	x		Potential habitat in project area within NSA (mapped historical population near the Dalles). Possible impacts on rocky outcrop habitat along West Alternative addressed in Chapter 3.
Suksdorf's Desert Parsley (*Lomatium suksdorfii*)	OR-2 WA-S FS-S Endemic	Open wooded or open areas in east Gorge	x		Suitable habitat present along all action alternatives in the project area. Not found during surveys. Typical impacts on grassland and woodland habitats addressed in Chapter 3.
Watson's desert-parsley (*Lomatium watsonii*)	OR-2 FS-S	Hood River and Wasco Counties.	x		Suitable habitat may be present along all action alternatives. Typical impacts on possible grassland, shrub-steppe, or rocky outcrop (West Alternative only) habitat addressed in Chapter 3.
Columbia Gorge Broad-leaf Lupine (*Lupinus latifoius var thompsonianus*)	Endemic	Open areas in pine/oak woodlands.	x		Present in project area. Typical impacts on woodland habitat addressed in Chapter 3.
Curved Woodrush (*Luzula arcuata*)	OR-2 WA-S FS-S	Hood River County	x		Not likely in project area. Generally found more to the west, and in high elevations.
Northeren bog clubmoss (*Lycopodiella inundata*)	OR-2 WA-S	Wet, sandy places, wetlands adjunct to lakes, and swampy ground. Westside	x		Suitable habitat not found in project area within the NSA

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
	FS-S				
Ground cedar (*Lycopodium complanatum*)	OR-2 FS-S	Westside	x		Habitat not found in project area within the NSA
White Meconella (*Meconella oregana*)	OR-1 WA-T FS-S	Oak woodlands in east Gorge.	x		Habitat present in project area, not found during surveys. Typical impacts on woodland habitats addressed in Chapter 3.
Northern Microseris (*Microseris borealis*)	WA-S FS-S	Low to mid-elevation wetlands.	x		No suitable habitat in project area within the NSA: found west of Cascades.
Columbia Monkey Flower (*Mimulus jungermannioides*)	OR-1 FS-S	Wet areas in east Cascades.	x		Not found during surveys. Potential habitat in project area, but project not likely to impact basalt cliff and river canyon habitat.
Pulsifer's Monkey-flower (*Mimulus pulsiferae*)	WA-S FS-S	Wet areas.	x		Not found during surveys. Potential habitat in project area. Typical wetland impacts addressed in Chapter 3.
Suksdorf's Monkey-flower (*Mimulus suksdorfii*)	WA-S FS-S	Open, moist, or rather dry places.	x		Not found during surveys. Potential habitat in project area. Typical grassland and shrub-steppe habitat impacts addressed in Chapter 3.
Branching Montia (*Montia diffusa*)	WA-S FS-S	Up-turned root disturbances within the forest of Cascades.	x		Not likely in project area: occurs mostly in forests on west side of Cascades.
Howell's montia (*Montia howellii*)	FS-S	Multnomah County		x	No suitable habitat in project area of NSA: primarily occurs on the west side of the Cascades.
Marigold Navarretia (*Navarretia tagetina*)	WA-T FS-S	Dry, open areas in east Gorge.	x		Not found during surveys. Suitable habitat may occur along West Alternative. Typical grassland and shrub-steppe impacts addressed in Chapter 3.
Adder's-tongue (*Ophioglossum pusillum*)	OR-2 WA-T FS-S	Meadows and woods.	x		Not found during surveys. Suitable habitat may occur in project area, but more likely at higher elevations in mountains. Typical grassland and woodland impacts addressed in Chapter 3.
Fringed Grass-of-Parnassus (*Parnassia frimbriata var. hoodiana*)	WA-T FS-S	Bogs, stream banks, wet areas (Mult., Hood, and Washington Counties, Oregon).	x		No suitable habitat in project area: occurs at mid- to high elevations in mountains.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Barrett's Penstemon (*Penstemon barrettiae*)	OR-1 WA-T FS-S Endemic	Rocky cliffs, talus slopes in east Gorge.	x		Project would not impact habitat.
Henderson phlox (*Phlox hendersonii*)	OR-2 FS-S	Hood River County	x		No suitable habitat in project area.
Pine-foot (*Pityopus californica*)	WA-T FS-S	Low elevation mixed conifer forest.	x		No suitable habitat in project area.
Coral seeded popcorn flower (*Plagiobothrys figuratus ssp. corallicarpus*)	OR-1 FS-S		x		No suitable habitat in project area.
Canyon Bog-orchid (*Platanthera sparsiflora*)	WA-T FS-S	Wet, boggy areas	x		No suitable habitat in project area.
Pacific bluegrass (*Poa gracillima var. multnomae*)	Endemic	Mostly on s. side of Columbia Gorge in rocky, shaded cliff near water falls	x		Project would not impact habitat.
Loose-flowered Bluegrass (*Poa laxiflora*)	WA-S FS-S	Moist woods to open rocky slopes up to mid-elevations	x		No suitable habitat in project area: primarily found on the west side of the Cascades.
Wheeler's Bluegrass (*Poa nervosa var. nervosa*)	WA-S FS-S	Limited to lower Columbia River and adjacent tributaries. Open slopes, ridges and talus slopes.	x		No suitable habitat in project area: project area likely too far east, and mapped in conifer forest ecotypes. Species not found in surveys.
Great Polemonium (*Polemonium carneum*)	WA-T FS-S	Mid elevation forests in west Gorge.	x		No suitable habitat in project area; occurs west of the Cascades.
Brewer's Cinquefoil (*Potentilla breweri*)	WA-T FS-S	Moist to dry and exposed areas at middle and upper elevations.	x		No suitable habitat in project area; found in higher elevations.
Diverse-leaved Cinquefoil (*Potentilla diversifolia var. perdissecta*)	WA-S FS-S	Moist, shady and open areas, gravelly soils of glacially carved areas, , ledges and rocky slopes, stream banks.	x		No suitable habitat in project area; found in higher elevations.
Villous cinquefoil (*Potentilla villosa var. parviflora*)	OR-2 FS-S	Hood River County	x		No suitable habitat in project area within NSA.
Mountain Buttercup (*Ranunculus populago*)	WA-S FS-S	Moist meadows, stream terraces, riparian corridors, adjacent to a perennial streams and bogs.	x		No suitable habitat in project area.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Obscure Buttercup (*Ranunculus reconditus*)	OR-E OR-1 WA-E FS-S Endemic	Open grasslands or open areas in pine/oak woodlands. East Gorge.	x		Species addressed in Chapter 3: referred to as *Ranunculus triternatus* in this EIS.
Thompson mistmaiden (*Romanzoffia thompsonii*)	FS-S OR-1			x	No suitable habitat in project area: mapped as occurring west of the Cascades.
Columbia Yellow Cress (*Rorippa columbiae*)	OR-1 WA-E FS-S	Mud flats along Columbia River	x		Project would not impact habitat.
Scheuchzeria (*Scheuchzeria palustris var. americana*)	OR-2 FS-S	Multnomah County	x		No suitable habitat in project area.
Water clubrush (*Scirpus subterminalis*)	OR-2	Wasco County	x		No suitable habitat in project area.
Scribner-grass (*Scribneria bolanderi*)	WA-S FS-S	Dry, sandy to rocky soil.	x		Habitat present in project area within NSA. Not found during surveys. Typical impacts on grassland and woodland habitats addressed in Chapter 3.
Hairy-stemmed Checker-mallow (*Sidalcea hirtipes*)	OR-1 WA-E FS-S	Mesic habitats associated with creeks and streams.	x		Suitable habitat not within project area (mapped as occurring primarily on west side of Cascades.
Pale Blue-eyed Grass (*Sisyrinchium sarmentosum*)	OR-1 WA-T FS-S	Wet/dry meadows at mid to high elevations	x		Suitable habitat likely not in project area.
Western Ladies' Tresses (*Spiranthes porrifolia*)	WA-S FS-S	Open moist meadows.	x		Species addressed in Chapter 3.
Kruhsea (*Streptopus streptopoides*)	OR-2	Hood River, Multnomah Counties	x		No suitable habitat in project area
Violet Suksdorfia (*Suksdorfia violacea*)	OR-2 FS-S	Moist cliffs at low elevations in Mid-Gorge.	x		Project would not impact habitat.
Oregon Sullivantia (*Sullivantia oregana*)	OR-1 WA-E FS-S Endemic	Wet basalt cliffs near waterfalls at low elevations in the west Gorge.	x		Project would not impact habitat; also, not likely to occur in project area, since primarily on west side of cascades.

Species (Population Segment)	Status	Usual Habitat in Oregon/Washington	GMA/ SMA*	SMA* Only	Potentially Affected Species in the National Scenic Area
Columbia Kittentails (*Synthyris stellata*)	Endemic	Shaded banks, cliffs and ridges in the west Gorge.	x		No suitable habitat in project area.
Strickland's Tauschia (*Tauschia stricklandii*)	OR-2 FS-S	Wet subalpine meadows in the west Gorge.	x		No suitable habitat in project area.
Flat-leaved Bladderwort (*Utricularia intermedia*)	WA-S FS-S	Slow moving water or streams.	x		Project would not impact habitat.
Lesser Bladderwort (*Utricularia minor*)	OR-2	Wasco County	x		Project would not impact habitat.
Siskiyou False Hellebore (*Veratrum insolitum*)	WA-T FS-S	Dry open woods and brush in the middle Gorge.	x		No suitable habitat in project area (Douglas fir, ceanothus, oceanspray are associated flora).
Dotted water-meal (*Wolffia borealis*)	FS-S OR-2		x		Project would not impact habitat.
Columbia Water-meal (*Wolffia columbiana*)	OR-2	Freshwater lakes, ponds, and slow streams below 650 feet.	x		Project would not impact habitat.
FUNGI					
Giant polypore fungus *Bridgeoporus nobilissimus*	OR-1	On boles of noble firs. Multnomah County	x		No suitable habitat in project area.
Helvella crassitunicata	OR-2	Fungus. Hood River County	x		No suitable habitat in project area.
Hygrophorus caeruleus	OR-2	Fungus. Hood River County	x		No suitable habitat in project area.
Macowanites mollis	OR-1	Fungus. Multnomah County	x		No suitable habitat in project area.
Phaeocollybia californica (OR only)	OR-1	Fungus. Multnomah County	x		No suitable habitat in project area.
Phaeocollybia oregonensis	OR-1	Fungus. Multnomah County	x		No suitable habitat in project area.
BRYOPHYTES					
Conostomum tetragonum	OR-2	Moss, Hood River County	x		No suitable habitat in project area.
Gymnomitrion concinnatum	OR-2	Liverwort, Hood River and Multnomah Counties	x		No suitable habitat in project area.
Polytichium sphaerothecium	OR-2	Moss, Hood River County	x		No suitable habitat in project area.
Rhizomnium nudum (OR only)	OR-2	Moss, Very moist humus or soil, typically near seepage in conifer forest. Wasco County	x		No suitable habitat in project area.
Tetraphis geniculata	OR-2	Moss OR/WA , Moist forests with large down logs	x		No suitable habitat in project area.

Appendix E

Electric Fields, Magnetic Fields, Noise, and Radio Interference

BIG EDDY – KNIGHT
500-kV TRANSMISSION PROJECT

APPENDIX E

ELECTRICAL EFFECTS

March 2010

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for

Bonneville Power Administration

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ELECTRICAL EFFECTS FROM THE PROPOSED BIG EDDY – KNIGHT 500-kV TRANSMISSION LINE PROJECT

1.0 Introduction

The Bonneville Power Administration (BPA) is proposing to build an approximately 28-mile 500-kilovolt (kV) transmission line from the existing BPA Big Eddy Substation in Wasco County, Oregon to the proposed BPA Knight Substation near Goldendale in Klickitat, County, Washington. The proposed line is designated the Big Eddy – Knight transmission line. The proposed transmission line will traverse mostly arid pasture and agricultural land that is sparsely populated. However, there are scattered structures throughout the project area. Three alternative routes – West, Middle and East - are under consideration for the proposed transmission line as shown in Figure 1.

The purpose of this report is to describe and quantify the electrical effects of the proposed Big Eddy – Knight 500-kV transmission line along the alternative routes. These effects include the following:

- the levels of 60-hertz (Hz; cycles per second) electric and magnetic fields (EMF) at 3.28 feet (ft.) or 1 meter (m) above the ground,
- the effects associated with those fields,
- the levels of audible noise produced by the line, and
- electromagnetic interference associated with the line.

Electrical effects occur near all transmission lines, including those 500-kV lines already present in the area of the proposed route for the Big Eddy – Knight line. Therefore, the levels of these quantities for the proposed line are computed and compared with those from the existing lines in Oregon, Washington and elsewhere.

The proposed line would be built on new and existing right-of-way, paralleling existing lower voltage lines along portions of the route. The length of the sections with parallel line depends on the alternative route. Electrical effects were analyzed for all segments with or without parallel lines that had constant physical and electrical characteristics for over more than one mile. Shorter segments (< 1 mile) could occur where the line changes direction, crosses a roadway or enters a substation. The electrical effects associated with these short line segments would be very similar to those for the analyzed segments. The proposed project has 13 different line configurations (physical and electrical changes that could affect the field levels) with line segments greater than one mile in length. The 13 line configurations are described in Table 1.

The voltage on the conductors of transmission lines generates an electric field in the space between the conductors and the ground. The electric field is calculated or measured in units of volts-per-meter (V/m) or kilovolts-per-meter (kV/m) at a height of 3.28 feet (ft.) (1 meter [m]) above the ground. The current flowing in the conductors of the transmission line generates a magnetic field in the air and earth near the transmission line; current is expressed in units of amperes (A). The magnetic field is expressed in milligauss (mG), and is usually measured or calculated at a height of 3.28 ft. (1 m) above the ground. The electric field at the surface of the conductors causes the phenomenon of corona. Corona is the electrical breakdown or ionization of air in very strong electric fields, and is the source of audible noise, electromagnetic radiation, and visible light.

To quantify EMF levels along the route, the electric and magnetic fields from the proposed and existing lines were calculated using the BPA Corona and Field Effects Program (USDOE, undated). In this program, the calculation of 60-Hz fields uses standard superposition techniques for vector fields from several line sources: in this case, the line sources are transmission-line conductors. (Vector fields have both magnitude and direction: these must be taken into account when combining fields from different sources.) Important input parameters to the computer program are voltage, current, and geometric configuration of the line. The transmission-line conductors are assumed to be straight, parallel to each other, and located above and parallel to an infinite flat ground plane. Although such conditions do not occur under real lines because of conductor sag and variable terrain, the validity and limitations of calculations using these assumptions have been well verified by comparisons with measurements. This approach was used to estimate fields for the proposed Big Eddy -Knight line, where minimum clearances were assumed to provide worst-case (highest) estimates for the fields.

Electric fields are calculated using an imaging method. Fields from the conductors and their images in the ground plane are superimposed with the proper magnitude and phase to produce the total field at a selected location.

The total magnetic field is calculated from the vector summation of the fields from currents in all the transmission-line conductors. Balanced currents are assumed for each three-phase circuit and the contribution of induced image currents in the conductive earth is not included. Peak current and power flow direction for the proposed line were provided by BPA and are based on the projected system normal annual peak power loads in 2013.

Electric and magnetic fields for the proposed line were calculated at the standard height (3.28 ft. or 1 m) above the ground (IEEE, 1987). Calculations were performed out to 300 ft. (91 m) from the centerline of the existing corridor. The validity and limitations of such calculations have been well verified by measurements. Because maximum voltage, maximum current, and minimum conductor height above-ground are used, ***the calculated values given here represent worst-case conditions:*** i.e., the calculated fields are higher than they would be in practice. Such worst-case conditions would seldom occur.

The corona performance of the proposed line was also predicted using the BPA Corona and Field Effects Program (USDOE, undated). Corona performance is calculated using empirical equations that have been developed over several years from the results of measurements on numerous high-voltage lines (Chartier and Stearns, 1981; Chartier, 1983). The validity of this approach for corona-generated audible noise has been demonstrated through comparisons with measurements on other lines all over the United States (IEEE Committee Report, 1982). The accuracy of this method for predicting corona-generated radio and television interference from transmission lines has also been established (Olsen et al., 1992). Important input parameters to the computer program are voltage, current, conductor size, and geometric configuration of the line.

Corona is a highly variable phenomenon that depends on conditions along a length of line. Predictions of the levels of corona effects are reported in statistical terms to account for this variability. Calculations of audible noise and electromagnetic interference levels were made under conditions of an estimated average operating voltage (536 kV for the proposed line) and with the average line height over a span of 47 ft. (14.3 m).

Levels of audible noise, radio interference, and television interference are predicted for both fair and foul weather; however, corona is basically a foul-weather phenomenon. Wet conductors can occur during periods of rain, fog, snow, or icing. Along the route of the proposed Big Eddy -Knight transmission line, such conditions are expected to occur about 1 percent of the time during a year, based on hourly precipitation records during years with complete records for Moro, Oregon (2000-2003) and Kennewick, WA (2006-2008).(NOAA, 2010) Corona activity also increases with altitude. For purposes of evaluating corona effects from the proposed line, an altitude that corresponded to the average where each line configuration would be constructed was assumed for that configuration. Assumed altitudes ranged from 350 to 1650 ft. (100 to 500 m).

2.0 Physical Description

2.1 Proposed Line

The proposed 500-kV transmission line would be a three-phase, single-circuit line. Each phase is carried on a separate set of conductors (wires). For the 500-kV line, each phase actually is carried on a bundle of three conductors (wires) and there are three bundles per circuit as shown in Figure 2.

The voltage and current waves on each phase are displaced by 120° in time (one-third of a cycle) from the waves on the other phases. The proposed line would be placed either on single-circuit towers with the phases arranged in a delta (triangular) configuration (Figure 2) or on double-circuit towers with three of six phase conductors or bundles arranged vertically on either side of the tower (Figure 8). The double-circuit towers would support both the proposed line and an existing parallel lower voltage line or just the proposed line with the proposed line located on the west side of the double-circuit tower. For some configurations, the proposed line would be operated as a split-phase line. In this case, each phase is split between two bundles, one on either side of the double-circuit tower. A total of 13 configurations were identified for the project based on parallel lines, tower type and conductors.

BPA provided the physical and operating characteristics of the proposed and existing lines. The electrical characteristics and physical dimensions for the configurations of the proposed line are shown in Table 2 and the configurations are shown in Figures 2 to 12.

The maximum phase-to-phase voltage for the proposed line would be 550 kV and the average voltage would be 536 kV. The maximum electrical current on the line would be 970 amperes (A) per phase, based on the BPA projected system annual peak load in 2013 as the base year. The load factor for this line will be about 0.50 (average load = peak load x load factor), resulting in an average current of 485 A.

For most of the configurations each bundle of the proposed 500-kV line will have three 1.300-inch diameter conductors arranged in an inverted triangle bundle configuration with approximately 17-in. (43.3 cm) spacing between conductors. Some portions of the line could have slightly larger conductors to meet a BPA design criterion for audible noise performance. In this case, the conductor bundles would be comprised of three 1.600-inch diameter conductors arranged in an inverted triangle with approximately 19-in. (48.9 cm) spacing.

For the double-circuit tower configurations the east circuit on the tower would be strung with a 1x1.300-in conductor for configurations with an existing 115-kV circuit on that side. For the two configurations where an existing 230- or 345-kV line would be placed on the double-circuit tower, then a 3x1.300-in bundle would be used. The three-conductor bundle would also be used if the proposed 500-kV line was split between the two sides of the tower.

For the single-circuit tower with the phases arranged in a triangle or delta configuration, the horizontal spacing between phases in the lower conductor positions would be 46 ft. (14 m). The vertical spacing between the conductor positions would be 31.5 ft. (9.6 m).

For the double-circuit tower the horizontal spacing between the top and bottom pairs of conductor bundles would be 36.5 ft. (11.1 m) and the spacing between the middle pair of conductor bundles would be 56.5 ft. (17.2 m). The vertical spacing between the bundles would be 36 ft. (11.0 m).

Minimum conductor-to-ground clearance would be 35 or 36 ft. (10.7 or 11.0 m) at a conductor temperature of 122°F (50°C). This temperature represents heavy operating conditions and high ambient air temperatures; clearances above ground would be greater under normal operating temperatures. The larger 36-foot clearance would be employed to ensure that the BPA criterion for maximum electric field at ground level (9 kV/m) is met along the entire route. The 35-foot clearance would be used for the single circuit towers except for Configuration 3 where it could be raised to 36 feet, depending on the relative phases of the proposed and adjacent 345-kV line. The 36-foot clearance would also be used for the double-circuit tower configurations (Configurations 7-12). The average clearance above ground along a span will be approximately 47 ft. (14.3 m); this value was used for corona calculations and to estimate average electric and magnetic fields along the line.

The minimum clearance of 35 ft (10.7-m) or greater provided by BPA exceeds the minimum distance of the conductors above ground required to meet the National Electric Safety Code (NESC) (IEEE, 2002). At road crossings, the ground clearance would be at least 50 ft. (15.2 m).

New right-of-way for the proposed line will be 150 ft. (46 m) wide. When placed on existing right-of-way the centerline of the proposed line will be at least 75 ft. (23 m) from the edge.

2.2 Existing Lines

The proposed Big Eddy – Knight 500-kV line would parallel existing transmission lines along parts of all three alternative routes. In all, there are five existing lines that could be paralleled: the Harvalum - Big Eddy 230-kV line, the McNary – Ross 345-kV line, the Chenowick – Goldendale 115-kV line, the Spearfish Tap 115-kV line and the Big Eddy – Spring Creek 230-kV line. The lines to be paralleled and lengths of their parallel segments are dependent on the route. Descriptions of the three routes and five existing lines and their associated routes are given in Tables 1 and 2.

3.0 Electric Field

3.1 Basic Concepts

An electric field is said to exist in a region of space if an electrical charge, at rest in that space, experiences a force of electrical origin (i.e., electric fields cause free charges to move). Electric field is a vector quantity: that is, it has both magnitude and direction. The direction corresponds to the direction that a positive charge would move in the field. Sources of electric fields are unbalanced electrical charges (positive or negative) and time-varying magnetic fields. Transmission lines, distribution lines, house wiring, and appliances generate electric fields in their vicinity because of the unbalanced electrical charges associated with voltage on the conductors. On the power system in North America, the voltage and charge on the energized conductors are cyclic (plus to minus to plus) at a rate of 60 times per second. This changing voltage results in electric fields near sources that are also time-varying at a frequency of 60 hertz (Hz; a frequency unit equivalent to cycles per second).

As noted earlier, electric fields are expressed in units of volts per meter (V/m) or kilovolts (thousands of volts) per meter (kV/m). Electric- and magnetic-field magnitudes in this report are expressed in root-mean-square (rms) units. For sinusoidal waves, the rms amplitude is given as the peak amplitude divided by the square root of two.

The spatial uniformity of an electric field depends on the source of the field and the distance from that source. On the ground, under a transmission line, the electric field is nearly constant in magnitude and direction over distances of several feet (1 meter). However, close to transmission- or distribution-line conductors, the field decreases rapidly with distance from the conductors. Similarly, near small sources such as appliances, the field is not uniform and falls off even more rapidly with distance from the device. If an energized conductor (source) is inside a grounded conducting enclosure, then the electric field outside the enclosure is zero, and the source is said to be shielded.

Electric fields interact with the charges in all matter, including living systems. When a conducting object, such as a vehicle or person, is located in a time-varying electric field near a transmission line, the external electric field exerts forces on the charges in the object, and electric fields and currents are induced in the object. If the object is grounded, then the total current induced in the body (the "short-circuit current") flows to earth. The distribution of the currents within, say, the human body, depends on the electrical conductivities of various parts of the body: for example, muscle and blood have higher conductivity than bone and would therefore experience higher currents.

At the boundary surface between air and the conducting object, the field in the air is perpendicular to the conductor surface and is much, much larger than the field in the conductor itself. For example, the average surface field on a human standing in a 10 kV/m field is 27 kV/m; the internal fields in the body are much smaller: approximately 0.008 V/m in the torso and 0.45 V/m in the ankles.

3.2 Transmission-line Electric Fields

The electric field created by a high-voltage transmission line extends from the energized conductors to other conducting objects such as the ground, towers, vegetation, buildings, vehicles, and people. The calculated strength of the electric field at a height of 3.28 ft. (1 m) above an unvegetated, flat earth is frequently used to describe the electric field under straight parallel transmission lines. The most important transmission-line parameters that determine the electric field at a 1-m height are conductor height above ground and line voltage.

Calculations of electric fields from transmission lines are performed with computer programs based on well-known physical principles (cf., Deno and Zaffanella, 1982). The calculated values under these conditions represent an ideal situation. When practical conditions approach this ideal model, measurements and calculations agree. Often, however, conditions are far from ideal because of variable terrain and vegetation. In these cases, fields are calculated for ideal conditions, with the lowest conductor clearances to provide upper bounds on the electric field under the transmission lines. With the use of more complex models or empirical results, it is also possible to account accurately for variations in conductor height, topography, and changes in line direction. Because the fields from different sources add vectorially, it is possible to compute the fields from several different lines if the electrical and geometrical properties of the lines are known. However, in general, electric fields near transmission lines with vegetation below are highly complex and cannot be calculated. Measured fields in such situations are highly variable.

For evaluation of EMF from transmission lines, the fields must be calculated for a specific line condition. The NESC states the condition for evaluating electric-field-induced short-circuit current for lines with voltage above 98 kV, line-to-ground, as follows: conductors are at a minimum clearance from ground corresponding to a conductor temperature of 120°F (50°C), and at a maximum voltage (IEEE, 2002). BPA has supplied the needed information for calculating electric and magnetic fields from the proposed transmission lines: the maximum operating voltage, the estimated peak current in 2013, and the minimum conductor clearances.

There are standard techniques for measuring transmission-line electric fields (IEEE, 1987). Provided that the conditions at a measurement site closely approximate those of the ideal situation assumed for calculations, measurements of electric fields agree well with the calculated values. If the ideal conditions are not approximated, the measured field can differ substantially from calculated values. Usually the actual electric field at ground level is reduced from the calculated values by various common objects that act as shields.

Maximum or peak field values occur over a small area at midspan, where conductors are closest to the ground (minimum clearance). As the location of an electric-field profile approaches a tower, the conductor clearance increases, and the peak field decreases. A grounded tower will reduce the electric field considerably by shielding.

For traditional transmission lines, such as the proposed line, where the right-of-way extends laterally well beyond the conductors, electric fields at the edge of the right-of-way are not as sensitive as the peak field to conductor height. Computed values at the edge of the right-of-way for any line height are fairly representative of what can be expected all along the transmission-line corridor. However, the presence of vegetation on and at the edge of the right-of-way will reduce actual electric-field levels below calculated values.

3.3 Calculated Values of Electric Fields

Table 3 shows the calculated values of electric field at 3.28 ft. (1 m) above ground for the proposed Big Eddy - Knight 500-kV transmission-line configurations. The maximum value on the right-of-way and the value at the edge of the right-of-way are given for the proposed configurations at minimum conductor clearance and at the estimated average clearance along a span. Both the maximum and average fields were computed with the line operating at the maximum voltage of 550 kV. Lateral profiles of the electric fields for the 13 configurations are shown in Figures 13 – 24.

The calculated maximum electric fields expected on the right-of-way of the proposed line range from 7.4 to 8.8 kV/m, depending on the configuration. For average clearance, the peak field ranges from 4.2 to 5.8 kV/m. As shown in Figures 13 to 24, the peak values would be present only at locations directly under the line, near mid-span, where the conductors are at the minimum clearance. The conditions of minimum conductor clearance at maximum current and maximum voltage occur very infrequently. The calculated peak levels are rarely reached under real-life conditions, because the actual line height is generally above the minimum value used in the computer model, because the actual voltage is below the maximum value used in the model, and because vegetation within and near the edge of the right-of-way tends to shield the field at ground level.

The average values expected at the edge of the right-of-way of the proposed line range from 2.4 to less than 0.1 kV/m. The largest field values at the edge of the right-of-way occur for configurations where the centerline of the proposed single-circuit delta tower is located 75 ft from the edge.

For comparison the electric fields along the existing corridors for the No-action alternative are also shown in Table 3. For the existing lines the maximum fields range from 0 to 4.5 kV/m and the average peak field ranges from 0 to 2.6 kV/m. Average fields at the edge of the right-of-way vary from 0 to 1.3 kV/m for the No-action alternative. The principal reason for the lower fields in the No-action alternative is the absence of a 500-kV line among the existing lines.

3.4 Environmental Electric Fields

The electric fields associated with the proposed Big Eddy - Knight transmission line can be compared with those found in other environments. Sources of 60-Hz electric (and magnetic) fields exist everywhere electricity is used; levels of these fields in the modern environment vary over a wide range. Electric-field levels associated with the use of electrical energy are orders of magnitude greater than the naturally occurring 60-Hz fields of about 0.0001 V/m, which stem from atmospheric and extraterrestrial sources.

Electric fields in outdoor, publicly accessible places range from less than 1 V/m to 12 kV/m; the large fields exist close to high-voltage transmission lines of 500 kV or higher. In remote areas without electrical service, 60-Hz field levels can be much lower than 1 V/m. Electric fields in home and work environments generally are not spatially uniform like those of transmission lines; therefore, care must be taken when making comparisons between fields from different sources such as appliances and electric lines. In addition, fields from all sources can be strongly modified by the presence of conducting objects. However, it is helpful to know the levels of electric fields generated in domestic and office environments in order to compare commonly experienced field levels with those near transmission lines.

Numerous measurements of residential electric fields have been reported for various parts of the United States, Canada, and Europe. Although there have been no large studies of residential electric fields, sufficient data are available to indicate field levels and characteristics. Measurements of domestic 60-Hz electric fields indicate that levels are highly variable and source-dependent. Electric-field levels are not easily predicted because walls and other objects act as shields, because conducting objects perturb the field, and because homes contain numerous localized sources. Internal sources (wiring, fixtures, and appliances) seem to predominate in producing electric fields inside houses. Average measured electric fields in residences are generally in the range of 5 to 20 V/m. In a large occupational exposure monitoring project that included electric-field measurements at homes, average exposures for all groups away from work were generally less than 10 V/m (Bracken, 1990).

Electric fields from household appliances are localized and decrease rapidly with distance from the source. Local electric fields measured at 1 ft. (0.3 m) from small household appliances are typically in the range of 30 to 60 V/m. In a survey, reported by Deno and Zaffanella (1982), field measurements at a 1-ft. (0.3-m) distance from common domestic and workshop sources were found to range from 3 to 70 V/m. The localized fields from appliances are not uniform, and care should be taken in comparing them with transmission-line fields.

Electric blankets can generate higher localized electric fields. Sheppard and Eisenbud (1977) reported fields of 250 V/m at a distance of approximately 1 ft. (0.3 m). Florig et al. (1987) carried out extensive empirical and theoretical analysis of electric-field exposure from electric blankets and presented results in terms of uniform equivalent fields such as those near transmission lines. Depending on what parameter was chosen to represent intensity of exposure and the grounding status of the subject, the equivalent vertical 60-Hz electric-field exposure ranged from 20 to over 3500 V/m. The largest equivalent field corresponds to the measured field on the chest with the blanket-user grounded. The average field on the chest of an ungrounded blanket-user yields an equivalent vertical field of 960 V/m. As manufacturers have become aware of the controversy surrounding EMF exposures, electric blankets have been redesigned to reduce magnetic fields. However, electric fields from these “low field” blankets are still comparable with those from older designs (Bassen et al., 1991).

Generally, people in occupations not directly related to high-voltage equipment are exposed to electric fields comparable with those of residential exposures. For example, the average electric field measured in 14 commercial and retail locations in rural Wisconsin and Michigan was 4.8 V/m (IIT Research Institute, 1984). Median electric field was about 3.4 V/m. These values are about one-third the values in residences reported in the same study. Electric-field levels in public buildings such as shops, offices, and malls appear to be comparable with levels in residences.

In a survey of 1,882 volunteers from utilities, electric-field exposures were measured for 2,082 work days and 657 non-work days (Bracken, 1990). Electric-field exposures for occupations other than those directly related to high-voltage equipment were equivalent to those for non-work exposure.

Thus, except for the relatively few occupations where high-voltage sources are prevalent, electric fields encountered in the workplace are probably similar to those of residential exposures. Even in electric utility occupations where high field sources are present, exposures to high fields are limited on average to minutes per day.

Electric fields found in publicly accessible areas near high-voltage transmission lines can typically range up to 3 kV/m for 230-kV lines, to 10 kV/m for 500-kV lines, and to 12 kV/m for 765-kV lines. Although these peak levels are considerably higher than the levels found in other public areas, they are present only in limited areas on rights-of-way.

The calculated electric fields for the proposed Big Eddy – Knight 500-kV transmission line are consistent with the levels reported for other 500-kV transmission lines in Washington, Oregon and elsewhere. The calculated electric fields on the right-of-way of the proposed transmission line would be much higher than levels normally encountered in residences and offices.

4.0 Magnetic Field

4.1 Basic Concepts

Magnetic fields can be characterized by the force they exert on a moving charge or on an electrical current. As with the electric field, the magnetic field is a vector quantity characterized by both magnitude and direction. Electrical currents generate magnetic fields. In the case of transmission lines, distribution lines, house wiring, and appliances, the 60-Hz electric current flowing in the conductors generates a time-varying, 60-Hz magnetic field in the vicinity of these sources. The strength of a magnetic field is measured in terms of magnetic lines of force per unit area, or magnetic flux density. The term "magnetic field," as used here, is synonymous with magnetic flux density and is expressed in units of gauss (G) or milligauss (mG). (The tesla (T) is the unit of magnetic flux density preferred in scientific publications, where 1.0 gauss equals one ten-thousandth of a tesla (0.1 mT) and 1.0 mG equals 0.1 microtesla [µT]).

The uniformity of a magnetic field depends on the nature and proximity of the source, just as the uniformity of an electric field does. Transmission-line-generated magnetic fields are quite uniform over horizontal and vertical distances of several feet near the ground. However, for small sources such as appliances, the magnetic field decreases rapidly over distances comparable with the size of the device.

The interaction of a time-varying magnetic field with conducting objects results in induced electric fields and currents in the object. A changing magnetic field through an area generates a voltage around any conducting loop enclosing the area (Faraday's law). This is the physical basis for the operation of an electrical transformer. For a time-varying sinusoidal magnetic field, the magnitude of the induced voltage around the loop is proportional to the area of the loop, the frequency of the field, and the magnitude of the field. The induced voltage around the loop results in an induced electric field and current flow in the loop material. The induced current that flows in the loop depends on the conductivity of the loop as well as its area.

4.2 Transmission-line Magnetic Fields

The magnetic field generated by currents on transmission-line conductors extends from the conductors through the air and into the ground. The magnitude of the field at a height of 3.28 ft. (1 m) is frequently used to describe the magnetic field under transmission lines. Because the magnetic field is not affected by non-ferrous materials, the field is not influenced by normal objects on the ground under the line. The direction of the maximum field varies with location. (The electric field, by contrast, is essentially vertical near the ground.) The most important transmission-line parameters that determine the magnetic field at 3.28 ft. (1 m) height are conductor height above ground and magnitude of the currents flowing in the conductors. As distance from the transmission-line conductors increases, the magnetic field decreases.

Calculations of magnetic fields from transmission lines are performed using well-known physical principles (cf., Deno and Zaffanella, 1982). The calculated values usually represent the ideal straight parallel-conductor configuration. For simplicity, a flat earth is usually assumed. Balanced currents (currents of the same magnitude for each phase) are also assumed. This is usually valid for transmission lines, where loads on all three phases are maintained in balance during operation. Induced image currents in the earth are usually ignored for calculations of magnetic field under or near the right-of-way. The resulting error is negligible. Only at distances greater than 300 ft. (91 m) from a line do such contributions become significant (Deno and Zaffanella, 1982). The clearance for magnetic-field calculations for the proposed line was the same as that used for electric-field evaluations.

Standard techniques for measuring magnetic fields near transmission lines are described in ANSI IEEE Standard No. 644-1994 (1994). Measured magnetic fields agree well with calculated values, provided the currents and line heights that go into the calculation correspond to the actual values for the line. To realize such agreement, it is necessary to get accurate current readings during field measurements (because currents on transmission lines can vary considerably over short periods of time) and also to account for all field sources in the vicinity of the measurements.

As with electric fields, the maximum or peak magnetic fields occur in areas near the centerline and at midspan where the conductors are the lowest. The magnetic field at the edge of the right-of-way is not very dependent on line height. If more than one line is present, the peak field will depend on the relative electrical phasing of the conductors and the relative direction of power flow in the lines.

4.3 Calculated Values for Magnetic Fields

Table 4 gives the calculated values of the magnetic field at 3.28 ft. (1 m) height for the proposed 500-kV transmission-line configurations. Field values on the right-of-way and at the edge of the right-of-way are given for projected maximum currents and minimum clearance during system annual peak load in 2013. Field levels at the same locations for average current and average conductor clearance are also given. The projected maximum currents are 970 A on each of the three phases of the proposed line. For double-circuit configurations where the phases are split between two sets of conductors, the maximum current on each set of conductors would be 485 A. Average currents over the year would be about 50 percent of the maximum values.

Figures 25 to 38 show lateral profiles of magnetic fields under these same current and clearance conditions for the proposed 500-kV transmission line and the existing adjacent lines. The levels for maximum current and minimum clearance shown in the figures represent the highest magnetic fields under the proposed Big Eddy – Knight 500-kV line except under extreme temperature conditions. The actual day-to-day magnetic-field levels would be lower. They would vary as currents change daily and seasonally and as clearances change with ambient temperature. As shown in the figures, the average fields along the line over a year would be considerably reduced from the maximum values, as a result of increased clearances and reduced current.

The maximum calculated 60-Hz magnetic fields expected at 3.28 ft. (1 m) above ground for the proposed line range from 219mG to 60 mG for the 13 configurations of the proposed line. The highest fields would occur for single and double circuit towers that are adjacent to the existing Harvalum - Big Eddy 230-kV line (Configurations 2, 3 and 9). The lowest maximum fields would occur for the double-circuit tower configurations with split-phasing (Configurations 7 and 12). Maximum fields on the existing rights-of-way would range from 176 to 0 mG should the proposed line not be built – the No-action alternative. The maximum fields in this case would occur under the existing Big Eddy – Spring Creek and Harvalum - Big Eddy 230-kV lines.

The estimated average peak fields on the right-of-way for the proposed line would range from 65 to 17 mG. The average peak field on the existing rights-of-way would range from 48 to 0 mG for the No-action alternative.

At the edge of the right-of-way of the proposed line (on new right-of-way with no adjacent lines), estimated maximum fields would be 42 mG for the single-circuit tower (Configuration 1), 14 mG for the double-circuit tower with split phasing (Configurations 7) and 52 mG for the double-circuit tower with a single circuit on one side (Configurations 7A and 10). The peak average fields at the edge of the right-of-way for these configurations would be 18, 6, and 21 mG, respectively.

On existing rights-of-way with parallel adjacent lines, the calculated levels at the edge of the right-of-way obviously depend on the width of the right-of-way and the current on the existing line. Consequently, on existing rights-of-way, the maximum magnetic field at the edge of the right-of-way for maximum current conditions would range from 67 to less than 1 mG, while the average field at the edge would range from 23 to less than 1 mG. The maximum edge of right-of-way values for the No-action alternative would range from 67 to 0 mG, while the average values range from 23 to 0 mG. The highest edge of right-of-way levels for the No-action alternative occur adjacent to the Harvalum - Big Eddy and Big Eddy - Spring Creek 230-kV lines.

The magnetic field falls off rapidly as distance from the line increases. At a distance of 200 ft. (61 m) from the centerline of the proposed single-circuit tower line with maximum current, the field would be 6.4 mG and the average field would be about 3 mG. At the same current and distance from the double-circuit tower with the split phase configuration, the maximum and average fields would be less than 2 mG. For the double-circuit tower with only a single-circuit on one side, the maximum and average fields at 200 feet would be about 10 and 3 mG, respectively. The largest maximum and average fields at 200 feet from the existing lines for the No-action alternative would be 6-7 mG and 2-4 mG, respectively. These largest values for existing lines would occur adjacent to the Harvalum - Big Eddy 230-kV line, the Big Eddy – Spring Creek 230-kV line, and the McNary – Ross 345-kV line.

There would 2 to 5 houses within 300 feet of the proposed centerline and 10 to 12 houses within 500 ft, depending on which route and line designs are selected (Table 5). The average magnetic fields at these houses would range from 0.5 to 22.3 mG for the single-circuit configuration routes and from 0.1 to 3.5 mG for the double circuit routes. The range of maximum fields would be from 1.1 to 45 mG for the single-circuit routes and from 0.2 to 7 mG for the double circuit routes. (Note: A single house at 71 ft from the centerline of the proposed single-circuit configuration contributes the high upper ranges of average and maximum fields for the East and Middle alternatives shown in Table 5.)

In general, magnetic fields at houses would be higher for the East and Middle alternatives than for the West alternative when single circuit configurations are used. The opposite would be true if double-circuit configurations were used: in this case, magnetic fields would be higher at houses along the West alternative than along the other two routes.

4.4 Environmental Magnetic Fields

Transmission lines are not the only source of magnetic fields; as with 60-Hz electric fields, 60-Hz magnetic fields are present throughout the environment of a society that relies on electricity as a principal energy source. The magnetic fields associated with the proposed Big Eddy - Knight 500 kV line can be compared with fields from other sources. The range of 60-Hz magnetic-field exposures in publicly accessible locations such as open spaces, transmission-line rights-of-way, streets, pedestrian walkways, parks, shopping malls, parking lots, shops, hotels, public transportation, and so on range from less than 0.1 mG to about 1 G, with the highest values occurring near small appliances with electric motors. In occupational settings in electric utilities, where high currents are present, magnetic-field exposures for workers can be above 1 G. At 60 Hz, the magnitude of the natural magnetic field is approximately 0.0005 mG.

Several investigations of residential fields have been conducted. In a large study to identify and quantify significant sources of 60-Hz magnetic fields in residences, measurements were made in 996 houses, randomly selected throughout the country (Zaffanella, 1993). The most common sources of residential fields were power lines, the grounding system of residences, and appliances. Field levels were characterized by both point-in-time (spot) measurements and 24-hour measurements. Spot measurements averaged over all rooms in a house exceeded 0.6 mG in 50 percent of the houses and 2.9 mG in 5 percent of houses. Power lines generally produced the largest average fields in a house over a 24-hour period. On the other hand, grounding system currents proved to be a more significant source of the highest fields in a house. Appliances were found to produce the highest local fields; however, fields fell off rapidly with increased distance. For example, the median field near microwave ovens was 36.9 mG at a distance of 10.5 in (0.27 m) and 2.1 mG at 46 in (1.17 m). Across the entire sample of 996 houses, higher magnetic fields were found in, among others, urban areas (vs. rural); multi-unit dwellings (vs. single-family); old houses (vs. new); and houses with grounding to a municipal water system.

In an extensive measurement project to characterize the magnetic-field exposure of the general population, over 1000 randomly selected persons in the United States wore a personal exposure meter for 24 hours and recorded their location in a simple diary (Zaffanella and Kalton, 1998). Based on the measurements of 853 persons, the estimated 24-hour average exposure for the general population is 1.24 mG and the estimated median exposure is 0.88 mG. The average field “at home, not in bed” is 1.27 mG and “at home, in bed” is 1.11 mG. Average personal exposures were found to be largest “at work” (mean of 1.79 mG and median of 1.01 mG) and lowest “at home, in bed” (mean of 1.11 mG and median of 0.49 mG). Average fields in school were also low (mean of 0.88 mG and median of 0.69 mG). Factors associated with higher exposures at home were smaller residences, duplexes and apartments, metallic rather than plastic water pipes, and nearby overhead distribution lines.

As noted above, magnetic fields from appliances are localized and decrease rapidly with distance from the source. Localized 60-Hz magnetic fields have been measured near about 100 household appliances such as ranges, refrigerators, electric drills, food mixers, and shavers (Gauger, 1985). At a distance of 1 ft. (0.3 m), the maximum magnetic field ranged from 0.3 to 270 mG, with 95 percent of the measurements below 100 mG. Ninety-five percent of the levels at a distance of 4.9 ft. (1.5 m) were less than 1 mG. Devices that use light-weight, high-torque motors with little magnetic shielding exhibited the largest fields. These included vacuum cleaners and small hand-held appliances and tools. Microwave ovens with large power transformers also exhibited relatively large fields. Electric blankets have been a much-studied source of magnetic-field exposure because of the length of time they are used and because of the close proximity to the body. Florig and Hoburg (1988) estimated that the average magnetic field in a person using an electric blanket was 15 mG, and that the maximum field could be 100 mG. New "low-field" blankets have magnetic fields at least 10 times lower than those from conventional blankets (Bassen et al., 1991).

In a domestic magnetic-field survey, Silva et al. (1989) measured fields near different appliances at locations typifying normal use (e.g., sitting at a typewriter or standing at a stove). Specific appliances with relatively large fields included can openers (n = 9), with typical fields ranging from 30 to 225 mG and a maximum value up to 2.7 G; shavers (n = 4), with typical fields from 50 to 300 mG and maximum fields up to 6.9 G; and electric drills (n = 2), with typical fields from 56 to 190 mG and maximum fields up to 1.5 G. The fields from such appliances fall off very rapidly with distance and are only present for short periods. Thus, although instantaneous magnetic-field levels close to small hand-held appliances can be quite large, they do not contribute to average area levels in residences. The technology of newer energy-efficient appliances is likely to reduce fields from appliances further.

Although studies of residential magnetic fields have not all considered the same independent parameters, the following consistent characterization of residential magnetic fields emerges from the data:

(1) External sources play a large role in determining residential magnetic-field levels. Transmission lines, when nearby, are an important external source. Unbalanced ground currents on neutral conductors and other conductors, such as water pipes in and near a house, can represent a significant source of magnetic field. Distribution lines per se, unless they are quite close to a residence, do not appear to be a traditional distance-dependent source.

(2) Homes with overhead electrical service appear to have higher average fields than those with underground service.

(3) Appliances represent a localized source of magnetic fields that can be much higher than average or area fields. However, fields from appliances approach area levels at distances greater than 3 ft. (1 m) from the device.

Although important variables in determining residential magnetic fields have been identified, quantification and modeling of their influence on fields at specific locations is not yet possible. However, a general characterization of residential magnetic-field level is possible: average levels in the United States are in the range of 0.5 to 1.0 mG, with the average field in a small number of homes exceeding this range by as much as a factor of 10 or more. Average personal exposure levels are slightly higher, possibly due to use of appliances and varying distances to other sources. Maximum fields can be much higher.

Magnetic fields in commercial and retail locations are comparable with those in residences. As with appliances, certain equipment or machines can be a local source of higher magnetic fields. Utility workers who work close to transformers, generators, cables, transmission lines, and distribution systems clearly experience high-level fields. Other sources of fields in the workplace include motors, welding machines, computers, and office equipment. In publicly accessible indoor areas, such as offices and stores, field levels are generally comparable with residential levels, unless a high-current source is nearby.

Because high-current sources of magnetic field are more prevalent than high-voltage sources, occupational environments with relatively high magnetic fields encompass a more diverse set of occupations than do those with high electric fields. For example, in occupational magnetic-field measurements reported by Bowman et al. (1988), the geometric mean field from 105 measurements of magnetic field in "electrical worker" job locations was 5.0 mG. "Electrical worker" environments showed the following elevated magnetic-field levels (geometric mean greater than 20 mG): industrial power supplies, alternating current (ac) welding machines, and sputtering systems for electronic assembly.

Measurements of personal exposure to magnetic fields were made for 1,882 volunteer utility workers for a total of 4,411 workdays (Bracken, 1990). Median workday mean exposures ranged from 0.5 mG for clerical workers without computers to 7.2 mG for substation operators. Occupations not specifically associated with transmission and distribution facilities had median workday exposures less than 1.5 mG, while those associated with such facilities had median exposures above 2.3 mG. Magnetic-field exposures measured in homes during this study were comparable with those recorded in offices.

Magnetic fields in publicly accessible outdoor areas seem to be, as expected, directly related to proximity to electric-power transmission and distribution facilities. Near such facilities, magnetic fields are generally higher than indoors (residential). Higher-voltage facilities tend to have higher fields. Typical maximum magnetic fields in publicly accessible areas near transmission facilities can range from less than a few milligauss up to 300 mG or more, near heavily loaded lines operated at 230 to 765 kV. The levels depend on the line load, conductor height, and location on the right-of-way. Because magnetic fields near high-voltage transmission lines depend on the current in the line, they can vary daily and seasonally.

Fields near distribution lines and equipment are generally lower than those near transmission lines. Measurements in Montreal indicated that typical fields directly above underground distribution systems were 5 to 19 mG (Heroux, 1987). Beneath overhead distribution lines, typical fields were 1.5 to 5 mG on the primary side of the transformer, and 4 to 10 mG on the secondary side. Near ground-based transformers used in residential areas, fields were 80 to 1000 mG at the surface and 10 to 100 mG at a distance of 1 ft. (0.3 m).

The magnetic fields from the proposed line would be comparable to or less than those from existing 500-kV lines in Washington and elsewhere. On and near the right-of-way of the proposed line, magnetic fields would be well above average residential levels. However, the fields from the line would decrease rapidly and approach common ambient levels at distances greater than a few hundred feet from the line. Furthermore, the fields at the edge of the right-of-way would not be above those encountered during normal activities near common sources such as hand-held appliances.

5.0 Electric and Magnetic Field (EMF) Effects

Possible effects associated with the interaction of EMF from transmission lines with people on and near a right-of-way fall into two categories: short-term effects that can be perceived and may represent a nuisance, and possible long-term health effects. Only short-term effects are discussed here. The issue of whether there are long-term health effects associated with transmission-line fields is controversial. In recent years, considerable research on possible biological effects of EMF has been conducted. A review of these studies and their implications for health-related effects is provided in a separate technical report for the environmental assessment for the proposed Big Eddy – Knight 500-kV transmission line (Exponent, 2009).

5.1 Electric Fields: Short-term Effects

Short-term effects from transmission-line electric fields are associated with perception of induced currents and voltages or perception of the field. Induced current or spark discharge shocks can be experienced under certain conditions when a person contacts objects in an electric field. Such effects occur in the fields associated with transmission lines that have voltages of 230-kV or higher. These effects could occur infrequently under the proposed Big Eddy - Knight 500-kV line.

Steady-state currents are those that flow continuously after a person contacts an object and provides a path to ground for the induced current. The amplitude of the steady-state current depends on the induced current to the object in question and on the grounding path. The magnitude of the induced current to vehicles and objects under the proposed line will depend on the electric-field strength and the size and shape of the object. When an object is electrically grounded, the voltage on the object is reduced to zero, and it is not a source of current or voltage shocks. If the object is poorly grounded or not grounded at all, then it acquires some voltage relative to earth and is a possible source of current or voltage shocks.

The responses of persons to steady-state current shocks have been extensively studied, and levels of response documented (Keesey and Letcher, 1969; IEEE, 1978). Primary shocks are those that can result in direct physiological harm. Such shocks will not be possible from induced currents under the existing or proposed lines, because clearances above ground required by the NESC preclude such shocks from large vehicles and grounding practices eliminate large stationary objects as sources of such shocks.

Secondary shocks are defined as those that could cause an involuntary and potentially harmful movement, but no direct physiological harm. Secondary shocks could occur under the proposed 500-kV line when making contact with ungrounded conducting objects such as vehicles or equipment. However, such occurrences are anticipated to be very infrequent. Shocks, when they occur under the 500-kV line, are most likely to be below the nuisance level. Induced currents are extremely unlikely to be perceived off the right-of-way of the proposed line.

Induced currents are always present in electric fields under transmission lines and will be present near the proposed line. However, during initial construction, BPA routinely grounds metal objects that are located on or near the right-of-way. The grounding eliminates these objects as sources of induced current and voltage shocks. Multiple grounding points are used to provide redundant paths for induced current flow. After construction, BPA would respond to any complaints and install or repair grounding to mitigate nuisance shocks.

Unlike fences or buildings, mobile objects such as vehicles and farm machinery cannot be grounded permanently. Limiting the possibility of induced currents from such objects to persons is accomplished in several ways. First, required clearances for above-ground conductors tend to limit field strengths to levels that do not represent a hazard or nuisance. The NESC (2002) requires that, for lines with voltage exceeding 98 kV line-to-ground (170 kV line-to-line), sufficient conductor clearance be maintained to limit the induced short-circuit current in the largest anticipated vehicle under the line to 5 milliamperes (mA) or less. This can be accomplished by limiting access or by increasing conductor clearances in areas where large vehicles could be present. BPA and other utilities design and operate lines to be in compliance with the NESC.

For the proposed line, conductor clearances at 50°C conductor temperature would be increased to at least 50 ft. (15.2 m) over road crossings along the route to meet the BPA requirement that electric fields be less than 5.0 kV/m at road crossings. The actual clearance to meet the criterion would depend on the configuration and parallel lines. For example, in order for Configuration 3 to meet the 5.0 kV/m criterion at a clearance of 50 feet, adjacent phases of the proposed Big Eddy – Knight 500-kV line and the existing McNary – Ross 345-kV line could not be the same; for Configurations 7A and 10 clearance would have to be increased to 54 feet to meet the 5.0 kV/m criterion. In any case, the conductor clearance at each road crossing would be checked during the line design stage to ensure that the BPA 5-kV/m and NESC 5-mA criteria are met. Line clearances would also be increased in accordance with the NESC, such as over railroads and water areas suitable for sailboating.

The largest truck allowed on roads in Oregon and Washington without a special permit is 14 feet high by 8.5 feet wide by 75 feet long (4.3 x 2.6 x 22.9 m). The induced currents to such a vehicle oriented perpendicular to the line in a maximum field of 5 kV/m (at 3.28-foot height) would be 4.5 mA (Reilly, 1979). For smaller trucks, the maximum induced currents for perpendicular orientation to the proposed line would be less than this value. (Larger special-permitted trucks, such as triple trailers, can be up to 105 feet in length, but are not expected on the roads crossed by the proposed line. However, because they average the field over such a long distance, the maximum induced current to a 105-foot vehicle oriented perpendicular to the 500-kV line at a road crossing would be less than 4.5 mA.) Thus, the NESC 5-mA criterion would be met for perpendicular road crossings of the proposed line. These large vehicles are not anticipated to be off highways or oriented parallel and on the right –of-way of the proposed line. As discussed below, these are worst-case estimates of induced currents at road crossings; conditions for their occurrence are rare.

Several factors tend to reduce the levels of induced current shocks from vehicles:

(1) Activities are distributed over the whole right-of-way, and only a small percentage of time is spent in areas where the field is at or close to the maximum value.

(2) At road crossings, vehicles are aligned perpendicular to the conductors, resulting in a substantial reduction in induced current.

(3) The conductor clearance at road crossings may not be at minimum values because of lower conductor temperatures and/or location of the road crossing away from midspan.

(4) The largest vehicles are permitted only on certain highways.

(5) Off-road vehicles are in contact with soil or vegetation, which reduces shock currents substantially.

Induced voltages occur on objects, such as vehicles, in an electric field where there is an inadequate electrical ground. If the voltage is sufficiently high, then a spark discharge shock can occur as contact is made with the object. Such shocks are similar to "carpet" shocks that occur, for example, when a person touches a doorknob after walking across a carpet on a dry day. The number and severity of spark discharge shocks depend on electric-field strength. Based on the low frequency of complaints reported by Glasgow and Carstensen (1981) for 500-kV ac transmission lines (one complaint per year for each 1,500 mi. or 2400 km of 500-kV line), nuisance shocks, which are primarily spark discharges, do not appear to be a serious impediment to allowed activities under 500-kV lines. Recommended safety practices and restricted activities on BPA transmission line rights-of-way are described in the BPA booklet "Living and Working Safely Around High-Voltage Transmission Lines" (USDOE, 2007).

In electric fields higher than will occur under the proposed line, it is theoretically possible for a spark discharge from the induced voltage on a large vehicle to ignite gasoline vapor during refueling. The probability for exactly the right conditions to occur for ignition is extremely remote. The additional clearance of conductors provided at road crossings reduces the electric field in areas where vehicles are prevalent and reduces the chances for such events. Even so, BPA recommends that vehicles should not be refueled under the proposed line unless specific precautions are taken to ground the vehicle and the fueling source (USDOE, 2007).

Under certain conditions, the electric field can be perceived through hair movement on an upraised hand or arm of a person standing on the ground under high-voltage transmission lines. The median field for perception in this manner was 7 kV/m for 136 persons; only about 12 percent could perceive fields of 2 kV/m or less (Deno and Zaffanella, 1982). In areas under the conductors at midspan, the fields at ground level would exceed the levels where field perception normally occurs. In these instances, field perception could occur on the right-of-way of the proposed line. It is unlikely that the field would be perceived beyond the edge of the right-of-way. Where vegetation provides shielding, the field would not be perceived.

Conductive shielding reduces both the electric field and induced effects such as shocks. Persons inside a vehicle cab or canopy are shielded from the electric field. Similarly, a row of trees or a lower-voltage distribution line reduces the field on the ground in the vicinity. Metal pipes, wiring, and other conductors in a residence or building shield the interior from the transmission-line electric field.

The electric fields from the proposed 500-kV line would be comparable to those from existing 500-kV lines in the project area and elsewhere. Potential impacts of electric fields can be mitigated through grounding policies, adherence to the NESC, and increased clearances above the minimums specified by the NESC. Worst-case levels are used for safety analyses but, in practice, induced currents and voltages are reduced considerably by unintentional grounding. Shielding by conducting objects, such as vehicles and vegetation, also reduces the potential for electric-field effects.

5.2 Magnetic Field: Short-term Effects

Magnetic fields associated with transmission and distribution systems can induce voltage and current in long conducting objects that are parallel to the transmission line. As with electric-field induction, these induced voltages and currents are a potential source of shocks. A fence, irrigation pipe, pipeline, electrical distribution line, or telephone line forms a conducting loop when it is grounded at both ends. The earth forms the other portion of the loop. The magnetic field from a transmission line can induce a current to flow in such a loop if it is oriented parallel to the line. If only one end of the fence is grounded, then an induced voltage appears across the open end of the loop. The possibility for a shock exists if a person closes the loop at the open end by contacting both the ground and the conductor. The magnitude of this potential shock depends on the following factors: the magnitude of the field; the length of the object (the longer the object, the larger the induced voltage); the orientation of the object with respect to the transmission line (parallel as opposed to perpendicular, where no induction would occur); and the amount of electrical resistance in the loop (high resistance limits the current flow).

Magnetically induced currents from power lines have been investigated for many years; calculation methods and mitigating measures are available. A comprehensive study of gas pipelines near transmission lines developed prediction methods and mitigation techniques specifically for induced voltages on pipelines (Dabkowski and Taflove, 1979; Taflove and Dabkowski, 1979). Similar techniques and procedures are available for irrigation pipes and fences. Grounding policies employed by utilities for long fences reduce the potential magnitude of induced voltage.

The magnitude of the coupling with both pipes and fences is very dependent on the electrical unbalance (unequal currents) among the three phases of the line. Thus, a distribution line where a phase outage may go unnoticed for long periods of time can represent a larger source of induced currents than a transmission line where the loads are well-balanced (Jaffa and Stewart, 1981).

Knowledge of the phenomenon, grounding practices, and the availability of mitigation measures mean that magnetic-induction effects from the proposed 500-kV transmission line will be minimal.

Magnetic fields from transmission and distribution facilities can interfere with certain electronic equipment. Magnetic fields have been observed to cause distortion of the image on older VDTs and computer monitors that employ cathode ray tubes. This can occur in fields as low as 10 mG, depending on the type and size of the monitor (Baishiki et al., 1990; Banfai et al., 2000). Generally, the problem arose when computer monitors were in use near electrical distribution facilities in large office buildings. Contemporary display devices using flat-panel technologies, such as liquid-crystal or plasma displays are not affected.

Interference from magnetic fields can be eliminated by shielding the affected device or moving it to an area with lower fields. Interference from 60-Hz fields with computers and control circuits in vehicles and other equipment is not anticipated at the field levels found under and near the proposed 500-kV transmission line.

The magnetic fields from the proposed line will be comparable to those from existing 500-kV lines in the area of the proposed line.

6.0 Regulations

Regulations that apply to transmission-line electric and magnetic fields fall into two categories. Safety standards or codes are intended to limit or eliminate electric shocks that could seriously injure or kill persons. Field limits or guidelines are intended to limit electric- and magnetic-field exposures that can cause nuisance shocks or might cause health effects. In no case has a limit or standard been established because of a known or demonstrated health effect.

The proposed line would be designed to meet the NESC (IEEE, 2002), which specifies how far transmission-line conductors must be from the ground and other objects. The clearances specified in the code provide safe distances that prevent harmful shocks to workers and the public. In addition, people who live and work near transmission lines must be aware of safety precautions to avoid electrical (which is not necessarily physical) contact with the conductors. For example, farmers should not up-end irrigation pipes under a transmission or other electrical line. In addition, as a matter of safety, the NESC specifies that electric-field-induced currents from transmission lines to vehicles must be below the 5 mA ("let go") threshold deemed a lower limit for primary shock. BPA publishes and distributes a booklet that describes safe practices to protect against shock hazards around power lines (USDOE, 2007).

Field limits or guidelines have been adopted in several states and countries and by national and international organizations (Maddock, 1992). Electric-field limits have generally been based on minimizing nuisance shocks or field perception. The intent of magnetic-field limits has been to limit exposures to existing levels, given the uncertainty of their potential for health effects.

General guidelines for EMF exposure have been established for occupational and public exposure by national and international organizations. The limits established by three such guidelines are described in Table 5.

The American Conference of Governmental Industrial Hygienists (ACGIH) sets guidelines (Threshold Limit Values or TLVs) for occupational exposures to environmental agents (ACGIH, 2008). In general, a TLV represents the level below which it is believed that nearly all workers may be exposed repeatedly without adverse health effects. For EMF, the TLVs represent ceiling levels. For 60-Hz electric fields, occupational exposures should not exceed the TLV of 25 kV/m. However, the ACGIH also recognizes the potential for startle reactions from spark discharges and short-circuit currents in fields greater than 5-7 kV/m, and recommends implementing grounding practices. They recommend the use of conductive clothing for work in fields exceeding 15 kV/m. The TLV for occupational exposure to 60-Hz magnetic fields is a ceiling level of 10 G (10,000 mG) (ACGIH, 2008).

The International Committee on Non-ionizing Radiation Protection (ICNIRP), working in cooperation with the World Health Organization (WHO) has developed guidelines for occupational and public exposures to EMF (ICNIRP, 1998). For occupational exposures at 60 Hz, the recommended limits to exposure are 8.3 kV/m for electric fields and 4.2 G (4,200 mG) for magnetic fields. The electric-field level can be exceeded, provided precautions are taken to prevent spark discharge and induced current shocks. For the general public, the ICNIRP guidelines recommend exposure limits of 4.2 kV/m for electric fields and 0.83 G (830 mG) for magnetic fields (ICNIRP, 1998).

More recently the International Committee on Electromagnetic Safety (ICES) under the auspices of the IEEE has established exposure guidelines for 60-Hz electric and magnetic fields (ICES, 2002). The ICES recommended limits for occupational exposures are 20 kV/m for electric fields and 27,100 mG for magnetic fields. The recommended limits for the general public are lower: 5 kV/m for the general public, except on power line rights-of-way where the limit is 10 kV/m; and 9,040 mG for magnetic fields.

Electric and magnetic fields from various sources (including automobile ignitions, appliances and, possibly, transmission lines) can interfere with implanted cardiac pacemakers. In light of this potential problem, manufacturers design devices to be immune from such interference. However, research has shown that these efforts have not been completely successful and that a few models of older pacemakers still in use could be affected by 60-Hz fields from transmission lines. There were also numerous models of pacemakers that were not affected by fields larger than those found under transmission lines. Because of the known potential for interference with pacemakers by 60-Hz fields, field limits for pacemaker wearers have been established by the ACGIH. They recommend that, lacking additional information about their pacemaker, wearers of pacemakers and similar medical-assist devices limit their exposure to electric fields of 1 kV/m or less and to magnetic fields to 1 G (1,000 mG) or less (ACGIH, 2008). Additional discussion of interference with implanted devices is given in the accompanying technical report on health effects (Exponent, 2009).

There are currently no national standards in the United States for 60-Hz electric and magnetic fields. The state of Washington does not have guidelines for electric or magnetic fields from transmission lines. However, several states have been active in establishing mandatory or suggested limits on 60-Hz electric and (in two cases) magnetic fields. Six states have specific electric-field limits that apply to transmission lines: Florida, Minnesota, Montana, New Jersey, New York, and Oregon. Florida and New York have established regulations for magnetic fields. These regulations are summarized in Table 6.

Government agencies and utilities operating transmission systems have established design criteria that include EMF levels. BPA has maximum allowable electric fields of 9 and 5 kV/m on and at the edge of the right-of-way, respectively (USDOE, 1996). BPA also has maximum-allowable electric field strengths of 5 kV/m, 3.5 kV/m, and 2.5 kV/m for road crossings, shopping center parking lots, and commercial/ industrial parking lots, respectively. The latter levels are based on limiting the maximum short-circuit currents from anticipated vehicles to less than 1 mA in shopping center lots and to less than 2 mA in commercial parking lots.

The electric fields from the proposed 500-kV line would meet the ACGIH standards, provided wearers of pacemakers and similar medical-assist devices are discouraged from unshielded right-of-way use. (A passenger in an automobile under the line would be shielded from the electric field.) The electric fields in limited areas on the right-of-way would exceed the ICNIRP guideline for public exposure, but would be below IEEE guideline limits. The magnetic fields from the proposed line would be below the ACGIH, ICNIRP, and IEEE limits.

The estimated peak electric fields on the right-of-way of the proposed transmission line would meet limits set in Florida, New York and Oregon, but not those of Minnesota and Montana (see Table 6). The BPA maximum allowable electric field limit would be met for all configurations of the proposed line. The edge of right-of-way electric fields from the proposed line would be below limits set in Florida and New Jersey, but above those in Montana and New York.

The magnetic field at the edge of the right-of-way from the proposed line would be below the regulatory levels of states where such regulations exist.

7.0 Audible Noise

7.1 Basic Concepts

Audible noise (AN), as defined here, represents an unwanted sound, as from a transmission line, transformer, airport, or vehicle traffic. Sound is a pressure wave caused by a sound source vibrating or displacing air. The ear converts the pressure fluctuations into auditory sensations. AN from a source is superimposed on the background or ambient noise that is present before the source is introduced.

The amplitude of a sound wave is the incremental pressure resulting from sound above atmospheric pressure. The sound-pressure level is the fundamental measure of AN; it is generally measured on a logarithmic scale with respect to a reference pressure. The sound-pressure level (SPL) in decibels (dB) is given by:

$$SPL = 20 \log (P/P_o) dB$$

where P is the effective rms (root-mean-square) sound pressure, P_o is the reference pressure, and the logarithm (log) is to the base 10. The reference pressure for measurements concerned with hearing is usually taken as 20 micropascals (Pa), which is the approximate threshold of hearing for the human ear. A logarithmic scale is used to encompass the wide range of sound levels present in the environment. The range of human hearing is from 0 dB up to about 140 dB, a ratio of 10 million in pressure (EPA, 1978).

Logarithmic scales, such as the decibel scale, are not directly additive: to combine decibel levels, the dB values must be converted back to their respective equivalent pressure values, the total rms pressure level found, and the dB value of the total recalculated. For example, adding two sounds of equal level on the dB scale results in a 3 dB increase in sound level. Such an increase in sound pressure level of 3 dB, which corresponds to a doubling of the energy in the sound wave, is barely discernible by the human ear. It requires an increase of about 10 dB in SPL to produce a subjective doubling of sound level for humans. The upper range of hearing for humans (140 dB) corresponds to a sharply painful response (EPA, 1978).

Humans respond to sounds in the frequency range of 16 to 20,000 Hz. The human response depends on frequency, with the most sensitive range roughly between 2000 and 4000 Hz. The frequency-dependent sensitivity is reflected in various weighting scales for measuring audible noise. The A-weighted scale weights the various frequency components of a noise in approximately the same way that the human ear responds. This scale is generally used to measure and describe levels of environmental sounds such as those from vehicles or occupational sources. The A-weighted scale is also used to characterize transmission-line noise. Sound levels measured on the A-scale are expressed in units of dB(A) or dBA.

AN levels and, in particular, corona-generated audible noise (see below) vary in time. In order to account for fluctuating sound levels, statistical descriptors have been developed for environmental noise. Exceedence levels (L levels) refer to the A-weighted sound level that is exceeded for a specified percentage of the time. Thus, the L_5 level refers to the noise level that is exceeded only 5 percent of the time. L_{50} refers to the sound level exceeded 50 percent of the time. Sound-level measurements and predictions for transmission lines are often expressed in terms of exceedence levels, with the L_5 level representing the maximum level and the L_{50} level representing a median level.

Table 7 shows AN levels from various common sources. Clearly, there is wide variation. Noise exposure depends on how much time an individual spends in different locations. Outdoor noise generally does not contribute to indoor levels (EPA, 1974). Activities in a building or residence generally dominate interior AN levels.

BPA has established a transmission-line design criterion for corona-generated audible noise (L_{50}, foul weather) of 50 dBA at the edge of the right-of-way (USDOE, 2006). This criterion applies to new line construction and is under typical conditions of foul weather, altitude, and system voltage for the line. It is generally only of concern for 500-kV lines. This criterion has been interpreted by the state and BPA to meet Oregon Noise Control Regulations (Perry, 1982).

The Washington Administrative Code provides noise limitations by class of property, residential, commercial or industrial (Washington State, 1975). Transmission lines are classified as industrial and may cause a maximum permissible noise level of 60 dBA to intrude into residential property. During nighttime hours (10:00 pm to 7:00 am), the maximum permissible limit for noise from industrial to residential areas is reduced to 50 dBA. This latter level applies to transmission lines that operate continuously. The state of Washington Department of Ecology accepts the 50 dBA level at the edge of the right-of-way for transmission lines, but encouraged BPA to design lines with lower audible noise levels (WDOE, 1981).

Audible noise from substations is generated predominantly by equipment such as transformers, reactors and other wire-wound equipment. It is characterized by a 120 Hz hum that is associated with magnetic-field caused vibrations in the equipment. Noise from such equipment varies by voltage and other operating conditions. The BPA design level for substation noise is 50 dBA at the substation property line for new construction (USDOE, 2006). The design level is met by obtaining equipment that meets specified noise limits and, for new substations, by securing a no-built buffer beyond the substation perimeter fence.

In industrial, business, commercial, or mixed use zones the AN level from substations may exceed 50 dBA but must still meet any state or local AN requirements. The design criteria also allows the 50 dBA design level to be exceeded in remote areas where development of noise sensitive properties is highly unlikely.

The EPA has established a guideline of 55 dBA for the annual average day-night level (L_{dn}) in outdoor areas [EPA, 1978]. In computing this value, a 10 dB correction (penalty) is added to night-time noise between the hours of 10 p.m. and 7 a.m.

7.2 Transmission-line Audible Noise

Corona is the partial electrical breakdown of the insulating properties of air around the conductors of a transmission line. In a small volume near the surface of the conductors, energy and heat are dissipated. Part of this energy is in the form of small local pressure changes that result in audible noise. Corona-generated audible noise can be characterized as a hissing, crackling sound that, under certain conditions, is accompanied by a 120-Hz hum. Corona-generated audible noise is of concern primarily for contemporary lines operating at voltages of 345 kV and higher during foul weather. The proposed 500-kV line will produce some noise under foul weather conditions.

The conductors of high-voltage transmission lines are designed to be corona-free under ideal conditions. However, protrusions on the conductor surface—particularly water droplets on or dripping off the conductors—cause electric fields near the conductor surface to exceed corona onset levels, and corona occurs. Therefore, audible noise from transmission lines is generally a foul-weather (wet-conductor) phenomenon. Wet conductors can occur during periods of rain, fog, snow, or icing. Based on hourly meteorologic records over several years from Kennewick, WA and Moro, OR , such conditions are expected to occur about 1 percent of the time during the year in the vicinity of the proposed line.

For a few months after line construction, residual grease or oil on the conductors can cause water to bead up on the surface. This results in more corona sources and slightly higher levels of audible noise and electromagnetic interference if the line is energized. However, the new conductors "age" in a few months, and the level of corona activity decreases to the predicted equilibrium value. During fair weather, insects and dust on the conductor can also serve as sources of corona.

All except Configuration 7 would use three 1.30-inch diameter conductors per phase to yield acceptable corona levels. However, Configuration 7 with split-phase 500-kV circuits on either side of the double circuit tower would employ three 1.60-inch diameter conductors per phase to achieve the required 50 dBA or less at the edge of the right-of-way.

7.3 Predicted Audible Noise Levels

Audible noise levels are calculated for average voltage of 536 kV and average conductor heights for fair- and foul-weather conditions. The predicted levels of corona-generated audible noise at the edge of the right-of-way for the proposed line configurations are given in Table 8. The L_{50} foul-weather levels for the proposed configurations range from 40 to 49 dBA. The highest levels would generally occur when the new 500-kV circuit is at the minimum distance of 75 feet from the edge of the right-of-way. This occurs for Configurations 1, 4, 6, 7, and 10. Predicted profiles of the L_{50} foul-weather levels for Configurations 1 and 7 are shown in Figure 37.

The audible noise levels for the No-action alternative are generally lower than the levels at the same locations with the proposed configurations. For the No-action alternative, the levels at the edges of existing rights-of-way range from ambient to 48 dBA. In this case, the existing McNary – Ross 345-kV and parallel Harvalum - Big Eddy 230-kV lines produce the highest noise levels.

During fair-weather conditions, which occur about 99 percent of the time, audible noise levels at the edge of the right-of-way would be about 20 dBA lower (if corona were present). These lower levels could be masked by ambient noise on and off the right-of-way.

7.4 Discussion

Along much of the proposed routes there would be increases in the perceived noise above ambient levels during foul weather at the edges of the right-of-way. This would be especially true in areas where the centerline of the proposed 500-kV line is at 75 feet from the edge of the right-of-way. However, even there, the corona-generated noise during foul weather would be masked to some extent by naturally occurring sounds such as wind and rain on foliage. The calculated foul-weather corona noise levels for the proposed line would be comparable to, or less, than those from existing 500-kV lines in Oregon and Washington. Relatively lower levels would be especially prevalent in line segments with existing wide rights-of-way where the proposed 500-kV line would be placed well away from the edge of the right-of-way.

Off the right-of-way corona-generated noise during fair weather will likely be masked or so low as to not be perceived even in fair weather. During foul-weather ambient noise levels can be high due to rain hitting foliage or buildings and wind. These sounds can mask corona noise both on and off the right-of-way. Furthermore people tend to be inside with windows closed, providing additional attenuation when corona noise is present.

Off the right-of-way, the foul-weather levels of audible noise from the proposed line would be well below the 55 dBA level that can produce interference with speech outdoors. Residential buildings provide significant sound attenuation (-12 dBA with windows open; -24 dBA with windows closed). Therefore indoor noise levels off the right-of-way would be well below the 45 dBA level where interference with speech indoors can occur and below the 35 dBA level where sleep interference can occur (EPA, 1973; EPA, 1978).

The highest noise level of 49-dBA for the configurations would meet the BPA design criterion and, hence, the statutory limits established in both Oregon and Washington. The computed annual L_{dn} level for transmission lines operating in areas with 1 to 2 percent foul weather is about $L_{dn} = L_{50} - 6$ dB (Bracken, 1987). Therefore, assuming such conditions in the Big Eddy Transmission Line Project area, the estimated worst case L_{dn} at the edge of the right-of-way would be approximately 43 dBA, which is below the EPA L_{dn} guideline of 55 dBA.

No transformers will be installed at the new Knight Substation so that the audible noise at the edge of the substation will be due to the transmission lines entering the substation. Since the proposed transmission line will meet the 50 dBA criterion at the edge of the right-of-way, this criterion as it applies to substations will also be met (USDOE, 2006).

At the existing Big Eddy substation audible noise levels will also be predominantly due to foul weather corona noise from incoming and outgoing transmission lines. Noise levels produced from the new transformers will be lower than that from the existing equipment and unnoticeable when added to the existing noise levels at the edge of the substation property.

Thus all applicable federal, state, and local regulations will be met by the proposed transmission line and substation addition and modification.

8.0 Electromagnetic Interference

8.1 Basic Concepts

Corona on transmission-line conductors can also generate electromagnetic noise in the frequency bands used for radio and television signals. The noise can cause radio and television interference (RI and TVI). In certain circumstances, corona-generated electromagnetic interference (EMI) can also affect communications systems and other sensitive receivers. Interference with electromagnetic signals by corona-generated noise is generally associated with lines operating at voltages of 345 kV or higher. This is especially true of interference with television signals. The bundle of three 1.3-inch (or 1.6-inch) diameter conductors used in the design of the proposed 500-kV line will mitigate corona generation and thus keep radio and television interference levels at acceptable levels.

Spark gaps on distribution lines and on low-voltage wood-pole transmission lines are a more common source of RI/TVI than is corona from high-voltage electrical systems. This gap-type interference is primarily a fair-weather phenomenon caused by loose hardware and wires. The proposed transmission line would be constructed with modern hardware that eliminates such problems and therefore minimizes gap noise. Consequently, this source of EMI is not anticipated for the proposed line.

No state has limits for either RI or TVI. In the United States, electromagnetic interference from power transmission systems is governed by the Federal Communications Commission (FCC) Rules and Regulations presently in existence (Federal Communications Commission, 1988). A power transmission system falls into the FCC category of "incidental radiation device," which is defined as "a device that radiates radio frequency energy during the course of its operation although the device is not intentionally designed to generate radio frequency energy." Such a device "shall be operated so that the radio frequency energy that is emitted does not cause harmful interference. In the event that harmful interference is caused, the operator of the device shall promptly take steps to eliminate the harmful interference." For purposes of these regulations, harmful interference is defined as: "any emission, radiation or induction which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radio communication service operating in accordance with this chapter" (Federal Communications Commission, 1988: Vol II, part 15. 47CFR, Ch. 1).

Electric power companies have been able to work quite well under the present FCC rule because harmful interference can generally be eliminated. It has been estimated that more than 95 percent of power-line sources that caused interference were due to gap-type discharges. These can be found and completely eliminated, when required to prevent interference (USDOE, 1980). Complaints related to corona-generated interference occur infrequently. This is especially true due to increased use of FM radio, cable television and satellite television, which are not subject to corona-generated interference. Mitigation of corona-generated interference with conventional broadcast radio and television receivers can be accomplished in several ways, such as use of a directional antenna or relocation of an existing antenna (USDOE, 1977; USDOE, 1980; Loftness et al., 1981).

8.2 Radio Interference (RI)

Radio reception in the AM broadcast band (535 to 1605 kilohertz (kHz)) is most often affected by corona-generated EMI. FM radio reception is rarely affected. Generally, only residences very near to transmission lines can be affected by RI. The IEEE Radio Noise Design Guide identifies an acceptable limit of fair-weather RI as expressed in decibels above 1 microvolt per meter (dBµV/m) of about 40 dB(µV/m) at 1 megahertz (MHz) (IEEE Committee Report, 1971). This limit applies at 100 ft. (30 m) from the outside conductor. As a general rule, average levels during foul weather (when the conductors are wet) are 16 to 22 dBµV/m higher than average fair-weather levels.

8.3 Predicted RI Levels

The L_{50} fair-weather RI levels were predicted for all configurations at the furthest of 100 ft. (30 m) from the outside conductor or the edge of the right-of-way. The results are shown in Table 9. The L_{50} levels for all configurations are at or below the acceptable limit of about 40 dBµV/m and are therefore compliant with the IEEE guideline level. The RI levels for the proposed 500-kV configurations would exceed those from the existing lower voltage lines.

8.4 Television Interference (TVI)

Corona-caused TVI occurs during foul weather and is generally of concern for transmission lines with voltages of 345 kV or above, and only for conventional receivers within about 600 ft. (183 m) of a line. As is the case for RI, gap sources on distribution and low-voltage transmission lines are the principal observed sources of TVI. The use of modern hardware and construction practices for the proposed line would minimize such sources.

8.5 Predicted TVI Levels

The predicted foul-weather TVI levels at 75MHz from the proposed configurations operating at 536 kV are shown in Table 9. These levels are given for the further of 100 ft. (30 m) from the outside conductor or the edge of the right-of-way. The levels at these points range from 2 to 24 dBμV/m depending primarily on the distance from of the proposed 500-kV line. These levels are comparable to or lower than than those from existing 500-kV lines in Oregon and Washington. As with RI the largest values occur when the proposed 500-kV line is directly adjacent to the edge of the right-of-way.

At the highest predicted levels, there is a potential for interference with television signals at locations very near the proposed line in fringe reception areas. However, several factors reduce the likelihood of occurrence. Corona-generated TVI occurs only in foul weather; consequently, signals will not be interfered with most of the time, which is characterized by fair weather. Because television antennas are directional, the impact of TVI is related to the location and orientation of the antenna relative to the transmission line. If the antenna were pointed away from the line, then TVI from the line would affect reception much less than if the antenna were pointed towards the line. Since the level of TVI falls off with distance, the potential for interference becomes minimal at distances greater than several hundred feet from the centerline.

Other forms of TVI from transmission lines are signal reflection (ghosting) and signal blocking caused by the relative locations of the transmission structure and the receiving antenna with respect to the incoming television signal. Again only houses within several hundred feet of the proposed line would possibly be affected.

Television systems that operate at higher frequencies, such as satellite receivers, are not affected by corona-generated TVI. Cable television systems are also not affected.

Interference with television reception can be corrected by any of several approaches: improving the receiving antenna system; installing a remote antenna; installing an antenna for TV stations less vulnerable to interference; connecting to an existing cable system; or installing a translator (cf. USDOE, 1977). BPA has an active program to identify, investigate, and mitigate legitimate RI and TVI complaints. It is anticipated that any instances of TVI caused by the proposed line could be effectively mitigated.

8.6 Interference with Other Devices

Corona-generated interference can conceivably cause disruption on other communications bands such as the citizen's (CB) and mobile bands. However, mobile-radio communications are not susceptible to transmission-line interference because they are generally frequency modulated (FM). Similarly, cellular telephones operate at a frequency of about 900 MHz or higher, which is above the frequency where corona-generated interference is prevalent. In the unlikely event that interference occurs with these or other communications, mitigation can be achieved with the same techniques used for television and AM radio interference.

8.7 Conclusion

Predicted EMI levels for the proposed 500-kV transmission line are comparable to, or lower, than those that already exist near 500-kV lines and no impacts of corona-generated interference on radio, television, or other reception are anticipated. Based on land use surveys approximately 10 to 12 houses could be within 500 feet of the proposed line (Table 5) and possibly affected by interference. Whether interference occurs will depend on which 28-mile route alternative and line designs are selected as well as the type of television or radio receiver. Furthermore, if interference should occur, there are various methods for correcting it; BPA has a program to respond to legitimate complaints.

9.0 Other Corona Effects

Corona is visible as a bluish glow or as bluish plumes. On the proposed 500-kV line, corona levels would be very low, so that corona on the conductors would be observable only under the darkest conditions and only with the aid of binoculars, if at all. Without a period of adaptation for the eyes and without intentional looking for the corona, it would probably not be noticeable.

When corona is present, the air surrounding the conductors is ionized and many chemical reactions take place, producing small amounts of ozone and other oxidants. Ozone is approximately 90 percent of the oxidants, while the remaining 10 percent is composed principally of nitrogen oxides. The national primary ambient air quality standard for photochemical oxidants, of which ozone is the principal component, is 235 micrograms/cubic meter) or 120 parts per billion. The maximum incremental ozone levels at ground level produced by corona activity on the proposed transmission line during foul weather would be much less than 1 part per billion. This level is insignificant when compared with natural levels and fluctuations in natural levels.

10.0 Summary

The number of nearby houses/businesses that could be impacted by field or corona effects is small and fairly consistent among the three line route alternatives: ranging from 2 to 5 within 300 feet of centerline and from 10 to 12 within 500 feet.

Electric and magnetic fields from the proposed transmission line have been characterized using well-known techniques accepted within the scientific and engineering community. The expected electric-field levels from the proposed line at minimum design clearance would be comparable to those from existing 500-kV lines in Washington and elsewhere. The expected magnetic-field levels from the proposed line would be comparable to, or less than, those from other 500-kV lines in Washington, Oregon and elsewhere.

The peak electric field expected under the proposed line would be 8.8 kV/m; the maximum value at the edge of the right-of-way would be about 2.4 kV/m. Clearances at road crossings would be increased to reduce the peak electric-field value to 5 kV/m or less.

Under maximum current conditions, the maximum magnetic fields on and at the edge of the right-of-way vary considerably among configurations: ranging from 219 to 60 mG on the right-of-way and from 82 to less than 1 mG at the edge of the right-of-way. Average values of the fields are much reduced and also vary widely between configurations. The average field value at the edge of the right-of way adjacent to the proposed line ranges from 21 to less than 1 mG depending on right-of-way width and the presence of other lines.

For the No-action alternative, maximum magnetic fields would range from 163 to 0 mG on the right-of-way and from 67 to 0 mG at the edge. For this alternative average fields would be reduced to a maximum of 48 on the right-of-way and 23 at the edge.

The electric fields from the proposed line would meet regulatory limits for public exposure in some states and guidelines set established by IEEE. However, the electric fields from the line could exceed the regulatory limits or guidelines for peak fields established in some states and by ICNIRP. The magnetic fields from the proposed line would be within the regulatory limits of the two states that have established such limits and below the guidelines for public exposure established by ICNIRP and IEEE. Washington does not have any electric- or magnetic-field regulatory limits or guidelines.

Short-term effects from transmission-line fields are well understood and can be mitigated. Nuisance shocks arising from electric-field induced currents and voltages could be perceivable on the right-of-way of the proposed line. It is common practice to ground permanent conducting objects during and after construction to mitigate against such occurrences.

Corona-generated audible noise from the line would be perceivable during foul weather. The levels would be comparable to or less those near existing 500-kV transmission lines in Oregon and Washington, would be in compliance with noise regulations in Oregon and Washington, and would be below levels specified in EPA guidelines.

Corona-generated electromagnetic interference from the proposed line would be comparable to or less than that from existing 500-kV lines in Washington. Radio interference levels would be at or below limits identified as acceptable. Television interference, a foul-weather phenomenon, is anticipated to be comparable to or less than that from existing 500-kV lines in Washington. The presence of only 10 to 12 residences/businesses closer than 500 feet (183 m) to the line and the rarity of precipitation conditions when TVI occurs (about 1% of time) make it unlikely that television reception will be affected. However, if legitimate complaints arise, BPA has a mitigation program.

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Table 1: Description of line configurations and associated segments along the proposed Big-Eddy– Knight 500-kV transmission line alternative routes.

Configuration		Line segments[2]	Segment length, miles	Total configuration length by alternative, miles		
No.	**Description[1]**			**West**	**Middle**	**East**
1	BE-KN SglCkt	W-1 thru W-3 W-5 W-8 M-3 M-5 M-7 E-4	3.9 0.8 4.9 1.9 7.6 4.9 14.0	9.6	14.0	14.4
2	BE-KN SglCkt & || HARV-BE	M-1 and M-2 E-1 and E-2	9.2 9.2	-	9.2	9.2
3	BE-KN SglCkt & || McN-RO & || HARV-BE	E-3	4.8	-	-	4.8
4	BE-KN SglCkt & || CHE-GOL	W-6 and W-7 M-6	16.4 2.1	16.4	2.1	-
5	BE-KN SglCkt & || Spearfish Tap	W-4	1.1	1.1	-	-
6	BE-KN SglCkt & ||BE-SPR	M-4	1.3	-	1.3	-
7	BE-KN DblCkt split-phase w/ 3x1.6" bundles	W-1 thru W-3	3.9	3.9	-	-
7A	BE-KN DblCkt tower with SglCkt w/ 3x1.3" bundles on one side	W-1 thru W-3	3.9	3.9	-	-
8	BE-KN DblCkt w/ HARV-BE	M-1 and M-2 E-1 and E-2	9.2 9.2	-	9.2	9.2
9	BE-KN DblCkt w/ McN-RO & ||HARV-BE	E-3	4.8	-	-	4.8
10	BE-KN DblCkt w/ CHE-GOL	W-6 and W-7 M-6	16.4 2.1	16.4	2.1	-
11	BE-KN DblCkt w/ Spearfish Tap	W-4	1.1	1.1	-	-
12	BE-KN DblCkt split phase & || Spearfish Tap	W-4	1.1	1.1	-	-

Notes for Table 1:

1 BE-KN = Big Eddy-Knight; HARV-BE = Harvalum-Big Eddy; McN-RO = McNary-Ross; CHE-GOL = Chenoweth-Goldendale; BE-SPR = Big Eddy Spring Creek; SglCkt = Single circuit; DblCkt = Double circuit; || = parallel to.

2 Physical locations of alternative routes and segments are shown in Figure 1. Segments are numbered from Big Eddy to Knight by route: W = West alternative, M = Middle alternative; E = East alternative

Table 2: Physical and electrical characteristics of transmission lines in the Big Eddy – Knight 500-kV Transmission Line Project corridor.

Line Characteristics	Proposed Line		Existing Lines				
	Big Eddy – Knight 500-kV[2]		Harvalum-Big Eddy 230-kV	McNary-Ross 345-kV	Chenoweth-Goldendale 115-kV[5]	Spearfish Tap 115-kV	Big Eddy-Spring Creek 230 kV
Voltage, kV Maximum/Average[1]	550/536		241.5/232	362/350	0/0	121/118	241.5/237
Circuit Configuration[2]	Single	Double	Single	Single	Single	Single	Single
Proposed Current, A Peak/Average	970/485	485/243	1075/505	630/380	0/0	35/9	872/244
No-action Current, A Peak/Average	-	-	820/410	520/244	0/0	35/9	950/266
Electric Phasing (looking towards Knight)	B A C	A C B B C A	C B A	C A B	B C A	C B A	B A C
Clearance, ft. Minimum/Average[1, 3]	35/47	36/47	32.5/45.4	33.8/47.6	25.9/34.4	25.9/29.5	33.8/46.7
Tower configuration	Delta	DC-Vert	Flat	Flat	Flat	Flat	Flat
Phase spacing, ft.	46H, 31.5V	36.5, 56.5H 36V	27	32	12	12	27
Conductor: #/Diameter, in.	3/1.3	3/1.3 or 3x1.6[2]	1/1.382	1/1.602	1/0.563	1/0.642	1/1.382
Centerline distance to edge of ROW, ft.[4]	75	75	187.5/62.5	312.5/187.5	50	425/50	62.5
Centerline distance to proposed line, ft.	-	-	125	125	125	125	125
Average altitude, ft.	1500	1500	600	600	1600	350	1650

Notes for Table 2:

1. Average voltage and average clearance used for corona calculations.
2. When the proposed Big Eddy – Knight 500-kV line is energized on all six 3x1.6" phase bundles on a double circuit tower (Configuration 7), the three phases of the line will be split between six conductor bundles with each carrying one half of the single-circuit current. When the proposed Big Eddy – Knight 500-kV line is energized with only three 3x1.3" phase bundles on the double circuit tower (Configuration 7A), the non-energized phases will be left ungrounded. In Configuration 7A the energized circuit of the proposed line could be on either the west or east side of the tower. When the proposed Big-Eddy – Knight 500-kV line is on a double circuit tower with one of the existing parallel lines, the respective circuits will have the same voltages and currents as the individual single-circuit lines. When the existing Harvalum - Big Eddy or McNary – Ross line is the parallel line, they will have a 3x1.3" bundle (Configurations 8 and 9). The Chenoweth – Goldendale and Spearfish Tap lines would have a single 1.3" conductor when placed on the double circuit tower (Configurations 10 and 11).
3. To meet the BPA 9 kV/m limit for peak electric field and use consistent design clearances, the minimum clearance for all proposed double-circuit tower configurations was increased to 36 feet.
4. The distance to the west and east) edges of the right-of-way depends on the configuration as shown in Figures 2 – 10.
5. The Chenoweth – Goldendale 115-kV line is normally open at both ends with no current.

Table 3: Calculated maximum and average electric fields for the proposed Big Eddy – Knight 500-kV line operated at maximum voltage by configuration. Configurations are described in Tables 1 and 2. [Note: all 1.3" bundles except Config. 7]

Configuration		Electric Field, kV/m Proposed Alternative				Electric Field, kV/m No-action Alternative			
No.	Location	Peak on ROW		At Edge of ROW[2]		Peak on ROW		At Edge of ROW[2]	
	Field Description	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	BE-KN SglCkt	8.6	5.4	2.4, 2.4	2.3, 2.3	-	-	-	-
2	BE-KN SglCkt & HARV-BE	8.6	5.4	2.4, 1.5	2.4, 1.2	2.9	1.7	0.1, 1.3	0.1, 1.1
3	BE-KN SglCkt & McN-RO & HARV-BE[3] Use CAB phasing	8.8	5.8	0.2, 1.3	0.2, 1.1	4.5	2.6	<0.1, 1.3	<0.1, 1.1
4	BE-KN SglCkt & CHE-GOL	8.6	5.4	2.4, 0.3	2.3, 0.3	0.0	0.0	0.0	0.0
5	BE-KN SglCkt & Spearfish Tap	8.6	5.4	0.1, 0.2	0.1, 0.2	1.2	1.0	0.1, 0.4	0.2, 0.4
6	BE-KN SglCkt & BE-SPR	8.6	5.4	2.4, 1.4	2.3, 1.2	2.7	1.6	1.3, 1.3	1.1, 1.1
7	BE-KN DblCkt w/ 3x1.6" bundles[3]	7.3	4.3	1.3, 1.3	1.3, 1.3	-	-	-	-
7A	BE-KN DblCkt w/ only 1 circuit[3]	8.8	5.8	1.3, 0.1	1.4, 0.3	-	-	-	-
8	BE-KN DblCkt w/ HARV-BE[3]	7.9	4.9	0.3, 0.5	0.2, 0.4	2.9	1.7	1.3, 0.1	1.1, 0.1
9	BE-KN DblCkt w/ McN-RO & HARV-BE[3]	7.6	4.6	0.1, 1.3	0.1, 1.1	4.5	2.6	<0.1, 1.3	<0.1, 1.1
10	BE-KN DblCkt w/ CHE-GOL[3]	8.7	5.7	1.3, 0.1	1.4, 0.2	0.0	0.0	0.0	0.0
11	BE-KN DblCkt w/ Spearfish Tap[3]	8.5	5.6	0.1, 0.2	0.1, <0.1	1.2	1.0	0.0, 0.4	0.2, 0.4
12	BE-KN DblCkt & Spearfish Tap[3]	7.0	4.2	0.1, 0.3	0.1, 0.3	1.2	1.0	0.0, 0.4	0.2, 0.4

Notes for Table 3:

1 BE-KN = Big Eddy-Knight; HARV-BE = Harvalum- Big Eddy; McN-RO = McNary-Ross; CHE-GOL = Chenoweth-Goldendale; BE-SPR = Big Eddy Spring Creek; SngCkt = Single circuit; DblCkt = Double circuit

2 Field at west (north) edge of ROW shown first.

3 To meet the BPA 9 kV/m limit for peak electric field and use consistent design clearances, the minimum clearance for all proposed double-circuit tower configurations was increased to 36 feet.

Table 4: Calculated maximum and average magnetic fields for the proposed Big Eddy – Knight 500-kV line operated at maximum current/minimum clearance and average current/average clearance. Configurations are described in Tables 1 and 2.

Configuration[1]		Magnetic Field, mG Proposed Alternative				Magnetic Field, mG No-action Alternative			
No.	Location Field Description	Peak on ROW		At Edge of ROW[2]		Peak on ROW		At Edge of ROW[2]	
		Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	BE-KN SglCkt	159	50	42, 42	18, 18	-	-	-	-
2	BE-KN SglCkt & HARV-BE	219	65	49, 82	21, 31	163	48	7, 60	3, 22
3	BE-KN SglCkt & McN-RO & HARV-BE	214	62	7, 78	3, 29	161	46	3, 61	2, 23
4	BE-KN SglCkt & CHE-GOL	159	50	42, 8	18, 4	0	0	0	0
5	BE-KN SglCkt & Spearfish Tap	160	50	3, 8	1, 4	7	2	0, 2	0, <1
6	BE-KN SglCkt & BE-SPR	155	49	43, 64	18, 14	176	31	67, 67	15, 15
7	BE-KN DblCkt w/ 3x1.6” bundles	60	17	14, 14	6, 6	-	-	-	-
7A	BE-KN DblCkt w/ only 3 bundles	118	38	52, 29	21, 13	-	-	-	-
8	BE-KN DblCkt w/ HARV-BE	128	35	3, 33	2, 12	163	48	7, 60	3, 22
9	BE-KN DblCkt w/ McN-RO & HARV-BE	212	61	3, 79	1, 29	161	46	3, 61	2, 23
10	BE-KN DblCkt w/ CHE-GOL 36’	117	38	52, 29	21, 13	0	0	0	0
11	BE-KN DblCkt w/ Spearfish Tap 36’	116	38	3, 27	1, 13	7	2	0, 2	0, <1
12	BE-KN DblCkt & Spearfish Tap	60	17	<1, 3	<1, 1	7	2	0, 2	0, <1

Notes for Table 4:

1 BE-KN = Big Eddy-Knight; HARV-BE = Harvalum- Big Eddy; McN-RO = McNary-Ross; CHE-GOL = Chenoweth-Goldendale; BE-SPR = Big Eddy Spring Creek; SngCkt = Single circuit; DblCkt = Double circuit

2 Field at west (north) edge of ROW shown first.

3 To meet the BPA 9 kV/m limit for peak electric field and use consistent design clearances, the minimum clearance for all proposed double-circuit tower configurations was increased to 36 feet.

Table 5: Locations and ranges of average and maximum magnetic fields at residences and businesses near proposed line by primary circuit configuration and line route.

Primary Configuration	Single Circuit			Double Circuit+		
Route Alternative	**East***	**Middle***	**West**	**East**	**Middle**	**West**
Houses < 300 ft	3	2	4	5	4	4
Houses < 500 ft	12	11	10	10	10	10
Range of Distances from Centerline, ft	71 - 484	71 - 425	203 - 486	191 - 484	191 - 495	203 - 486
Range of Average Magnetic Field, mG	0.5 - 22.3	0.7 - 22.3	0.5 - 3.1	0.3 - 1.8	0.1 - 1.8	0.1 - 3.5
Range of Maximum Magnetic Field, mG	1.1 - 45	1.4 - 45	1.1 - 6.2	0.7 - 4.6	0.2 - 4.5	0.2 - 7

* A single house at 71 feet from the proposed centerline contributes the high field levels along the East and Middle alternatives.

+ Double circuit configuration counts include houses from single circuit sections E-4 and M-5, where no double circuit is planned.

Table 6: Electric- and magnetic-field exposure guidelines.

ORGANIZATION	TYPE OF EXPOSURE	ELECTRIC FIELD, kV/m	MAGNETIC FIELD, mG
ACGIH	Occupational	25[1]	10,000
ICNIRP	Occupational	8.3[2]	4,200
	General Public	4.2	833
IEEE	Occupational	20	27,100
	General Public	5[3]	9,040

1 Grounding is recommended above 5 –7 kV/m and conductive clothing is recommended above 15 kV/m.
2 Increased to 16.7 kV/m if nuisance shocks are eliminated.
3 Within power line rights-of-way, the guideline is 10 kV/m.

Sources: ACGIH, 2008; ICNIRP, 1998; ICES, 2002

Table 7: States with transmission-line field limits.

STATE AGENCY	WITHIN RIGHT-OF-WAY	AT EDGE OF RIGHT-OF-WAY	COMMENTS
a. 60-Hz ELECTRIC-FIELD LIMIT, kV/m			
Florida Department of Environmental Regulation	8 (230 kV) 10 (500 kV)	2	Codified regulation, adopted after a public rulemaking hearing in 1989.
Minnesota Environmental Quality Board	8	–	12-kV/m limit on the high voltage direct current (HVDC) nominal electric field.
Montana Board of Natural Resources and Conservation	7[1]	1[2]	Codified regulation, adopted after a public rulemaking hearing in 1984.
New Jersey Department of Environmental Protection	–	3	Used only as a guideline for evaluating complaints.
New York State Public Service Commission	11.8 (7,11)[3]	1.6	Explicitly implemented in terms of a specified right-of-way width.
Oregon Facility Siting Council	9	–	Codified regulation, adopted after a public rulemaking hearing in 1980.
b. 60-Hz MAGNETIC-FIELD LIMIT, mG			
Florida Department of Environmental Regulation	–	150 (230 kV) 200 (500 kV)	Codified regulations, adopted after a public rulemaking hearing in 1989.
New York State Public Service Commission	–	200	Adopted August 29, 1990.

Notes for Table 6:
1 At road crossings
2 Landowner may waive limit
3 At highway and private road crossings, respectively

Source: USDOE, 1996

Table 8: Common noise levels.

Sound Level, dBA	Noise Source or Effect
130	Threshold of pain
110	Rock-and-roll band
80	Truck at 50 ft. (15.2 m)
70	Gas lawnmower at 100 ft. (30 m)
60	Normal conversation indoors
50	Moderate rainfall on foliage
49	Highest foul-weather L_{50} at edge of proposed 500-kV right-of-way
40	Refrigerator
25	Bedroom at night
0	Hearing threshold

Adapted from: USDOE, 1985; USDOE, 1996.

Table 9: Calculated median (L_{50}) foul-weather audible noise levels at the edge of the right-of-way for the proposed Big Eddy – Knight 500-kV line operated at average voltage. Configurations are described in Table 1.

Configuration		**Foul weather L50 Audible Noise, dBA**	
No.	**Description**[1]	**Proposed Alternative**[2]	**No-action Alternative**[2]
1	BE-KN SglCkt	49, 49	-
2	BE-KN SglCkt & HARV-BE	48, 45	30, 35
3	BE-KN SglCkt & McN-RO & HARV-BE	48, 49	45, 48
4	BE-KN SglCkt & CHE-GOL	49, 46	-
5	BE-KN SglCkt & Spearfish Tap	42, 45	13, 23
6	BE-KN SglCkt & BE-SPR	49, 46	37, 37
7	BE-KN DblCkt w/ 3x1.6” bundles	49, 49	-
7A	BE-KN DblCkt w/ only SglCkt on west side	48, 46	-
8	BE-KN DblCkt w/ HARV-BE	45, 47	30, 35
9	BE-KN DblCkt w/ McN-RO & HARV-BE	43, 44	45, 48
10	BE-KN DblCkt w/ CHE-GOL	49, 47	-
11	BE-KN DblCkt w/ Spearfish Tap	40, 46	13, 23
12	BE-KN DblCkt & Spearfish Tap	46, 48	13, 23

Notes for Table 8:

1 BE-KN = Big Eddy-Knight; HARV-BE = Harvalum-Big Eddy; McN-RO = McNary-Ross; CHE-GOL = Chenoweth-Goldendale; BE-SPR = Big Eddy Spring Creek; SglCkt = Single circuit; DblCkt = Double circuit

2 Field at west (north) edge of ROW shown first.

Table 10 Calculated median (L_{50}) fair-weather radio interference level and foul weather television level for the proposed Big Eddy – Knight 500-kV line operated at average voltage. Configurations are described in Table 1.

Configuration		L50 Fair-Weather RI Level at 1 MHz, dB(µV/m)[2]	Foul-Weather TVI at 75 MHz, dB(µV/m)[2]
No.	Description[1]		
1	BE-KN SglCkt	39, 39	24, 24
2	BE-KN SglCkt & HARV-BE	39, 31	23, 10
3	BE-KN SglCkt & McN-RO & HARV-BE	34, 31	16, 13
4	BE-KN SglCkt & CHE-GOL	39, 36	24, 17
5	BE-KN SglCkt & Spearfish Tap	29, 35	6, 16
6	BE-KN SglCkt & BE-SPR	39, 32	24, 11
7	BE-KN DblCkt w/ 3x1.6" bundles	38, 38	21, 21
7A	BE-KN DblCkt w/ only 3 bundles	41, 37	23, 18
8	BE-KN DblCkt w/ HARV-BE	37, 38	17, 18
9	BE-KN DblCkt w/ McN-RO & HARV-BE	33, 33	7, 8
10	BE-KN DblCkt w/ CHE-GOL	41, 37	23, 18
11	BE-KN DblCkt w/ Spearfish Tap	25, 36	2, 17
12	BE-KN DblCkt & Spearfish Tap	34, 36	8, 13

Notes for Table 9:
1 BE-KN = Big Eddy-Knight; HARV-BE = Harvalum- Big Eddy; McN-RO = McNary-Ross; CHE-GOL = Chenoweth-Goldendale; BE-SPR = Big Eddy Spring Creek; SglCkt = Single circuit; DblCkt = Double circuit
2 Field at west (north) side of ROW shown first. Calculated levels shown at 100 feet (30 m) from the outside conductor or at the edge of the right-of-way, whichever is further from the conductor.

Figure 1: Alternative Routes and Segments for the Proposed Big Eddy – Knight 500-kV Transmission Line.

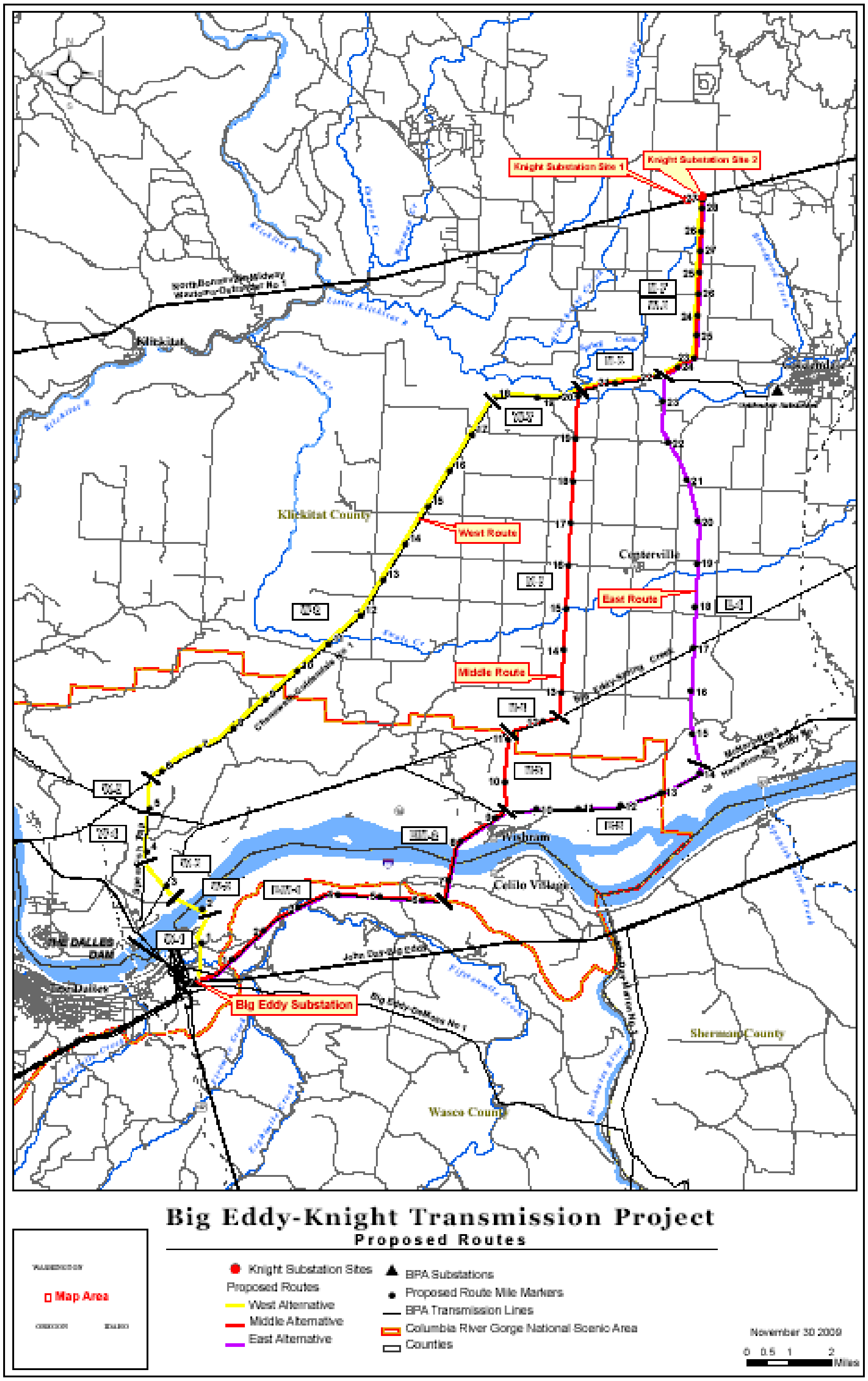


Figure 2: Single-circuit Configuration 1 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

Configuration 1

Big Eddy-Knight Proposed Single Circuit
Voltage: 536 kV (ave.), 550 kV (max.)
Current: 485 A (ave.), 970 A (max.)
Conductors: 3 x 1.3 in., 17 in. bundle spacing

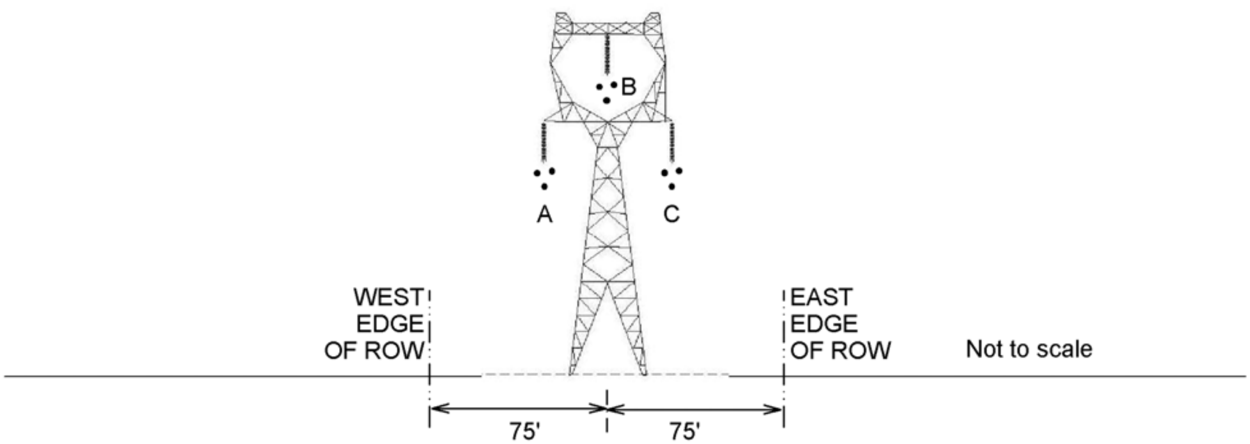


Figure 3: Single-circuit Configuration 2 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

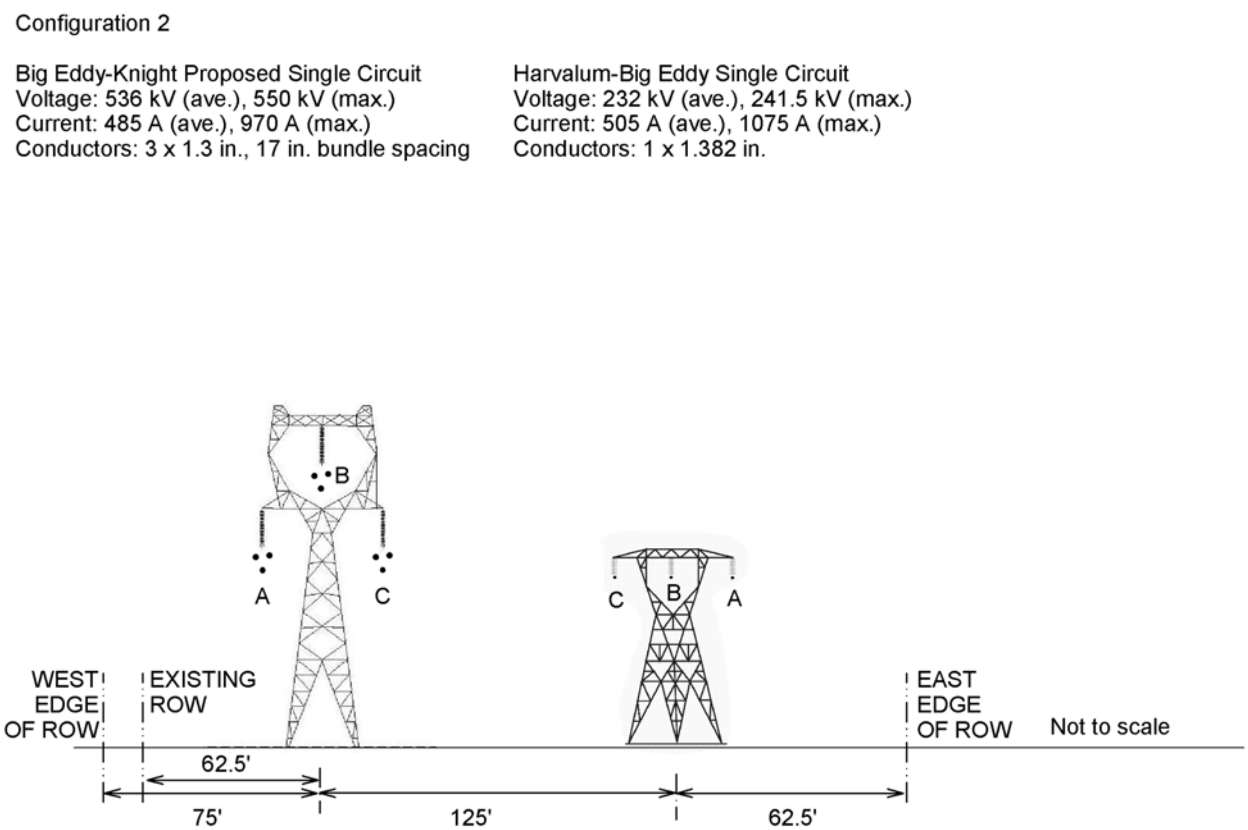


Figure 4: Single-circuit Configuration 3 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

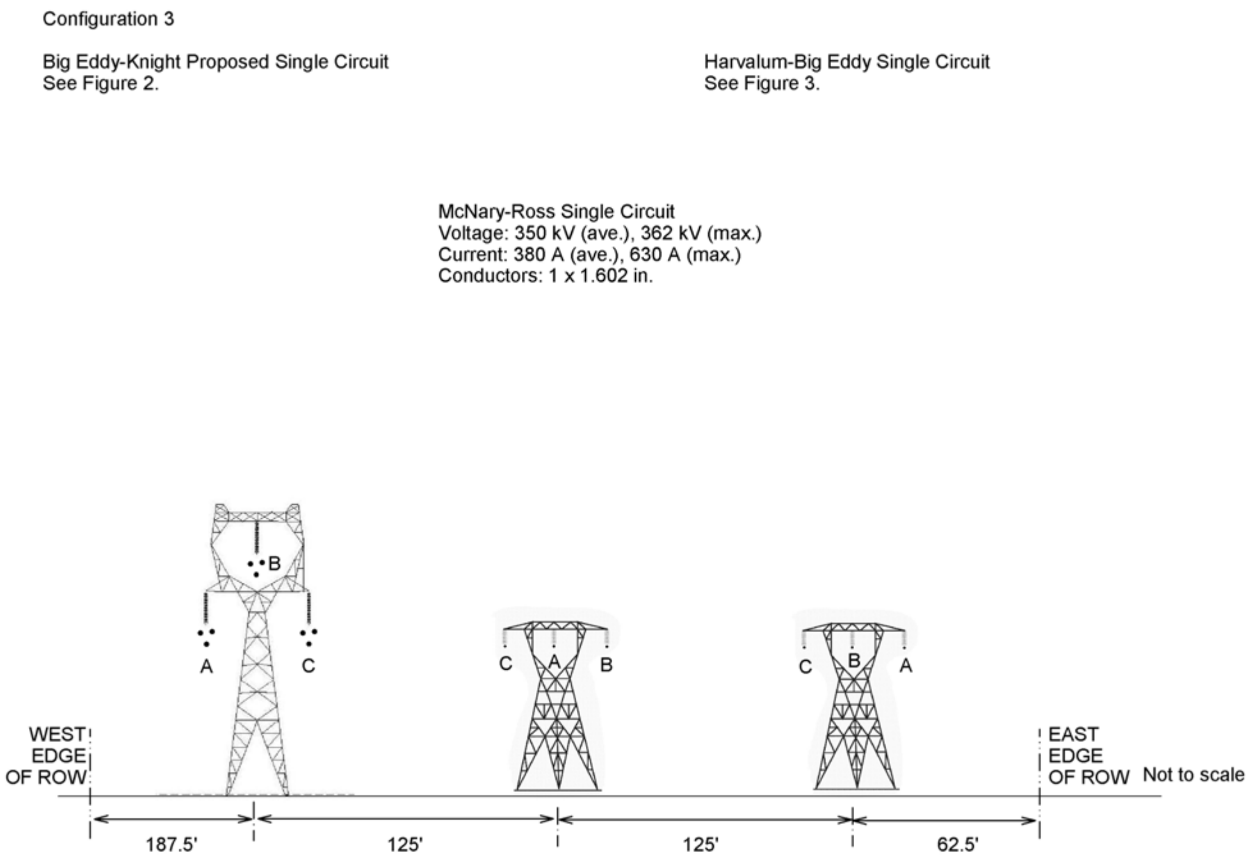


Figure 5: Single-circuit Configuration 4 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

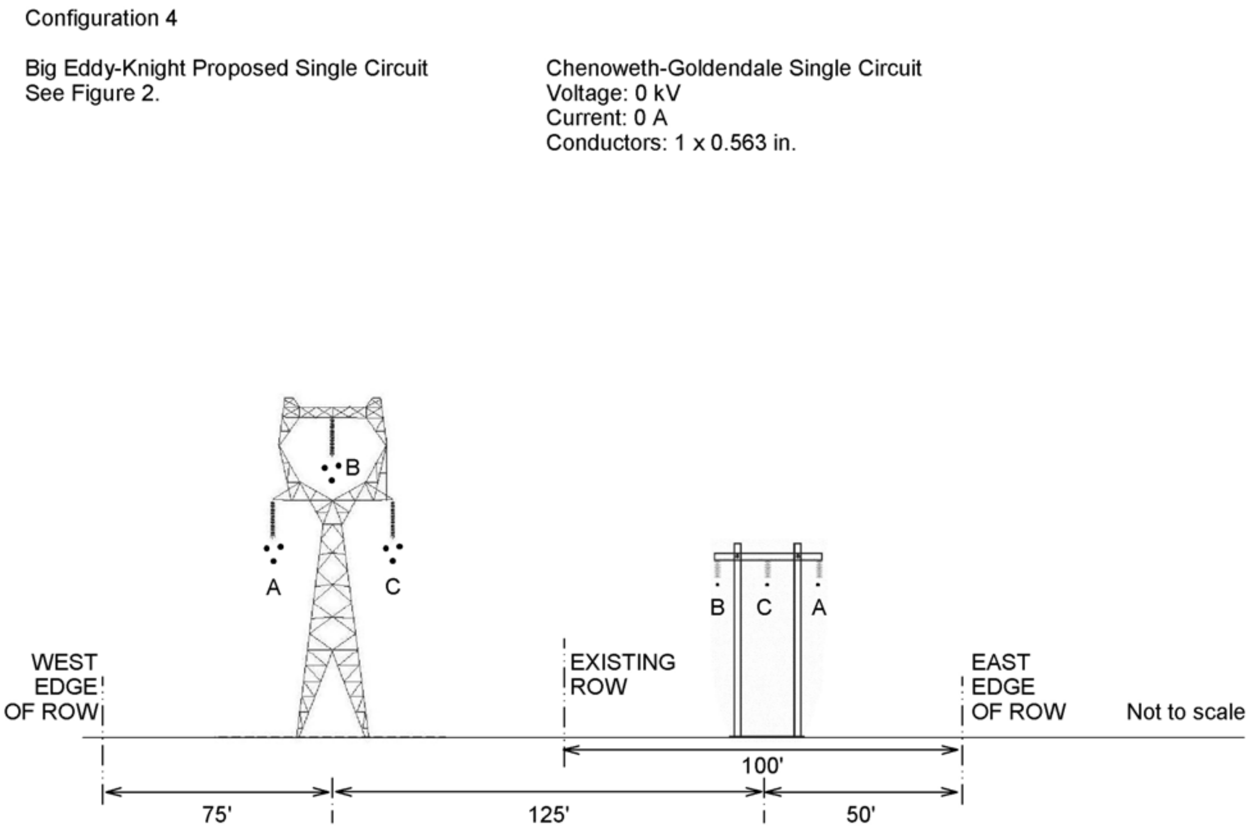


Figure 6: Single-circuit Configuration 5 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

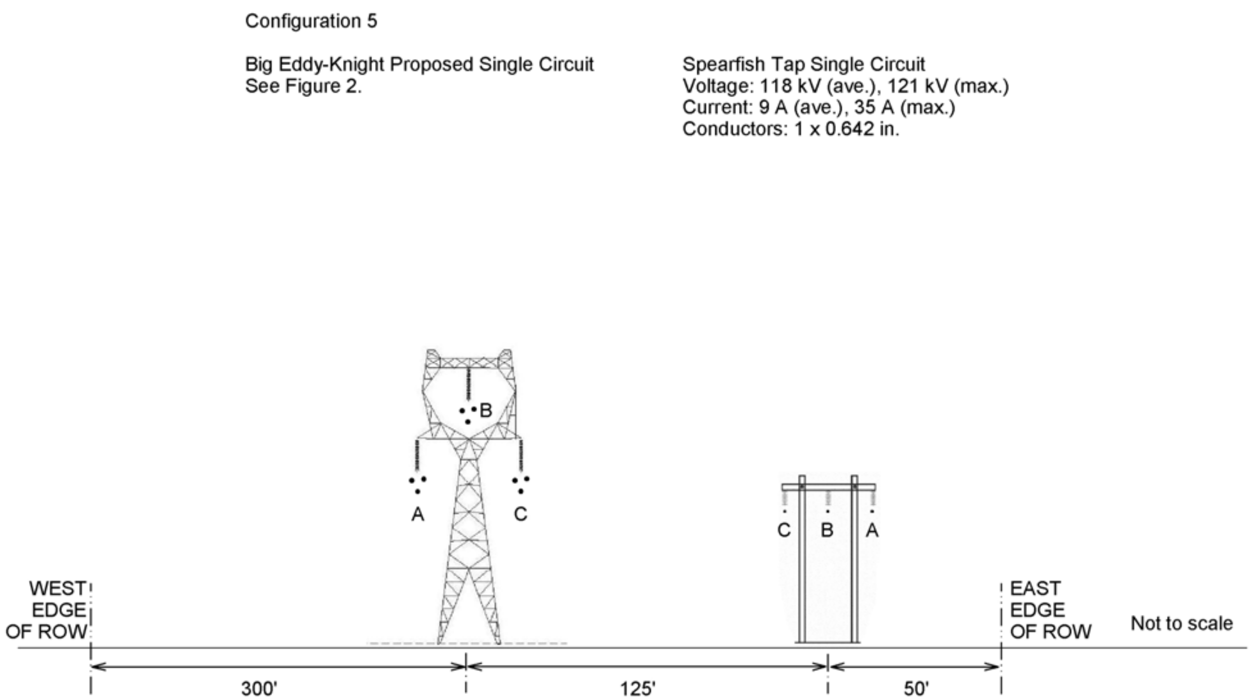


Figure 7: Single-circuit Configuration 6 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

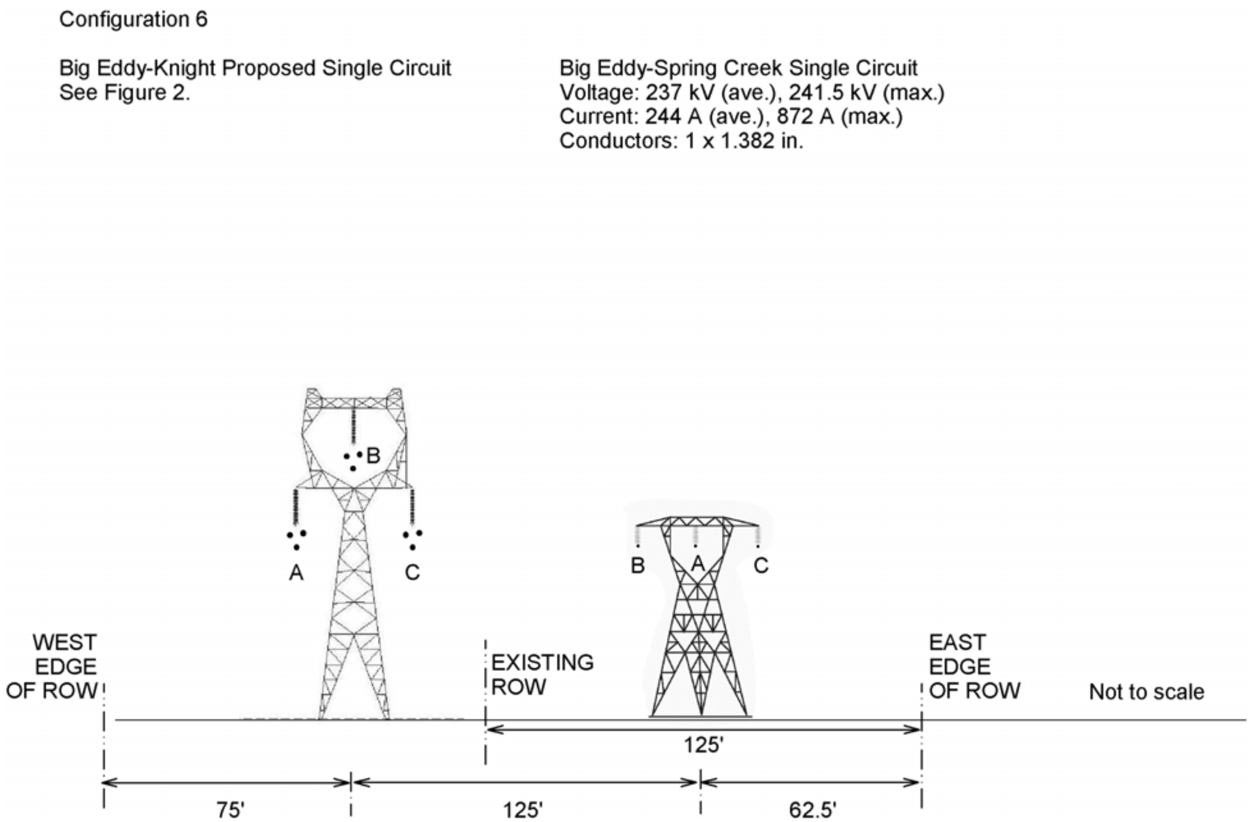


Figure 8: Double-circuit Configurations 7 and 7A for the proposed Big Eddy – Knight 500-kV line. The current is split between the two circuits in Configuration 7. The current is only on the west circuit in Configuration 7A and the east circuit conductors carry zero current and are not grounded. Configurations are described in Tables 1 and 2.

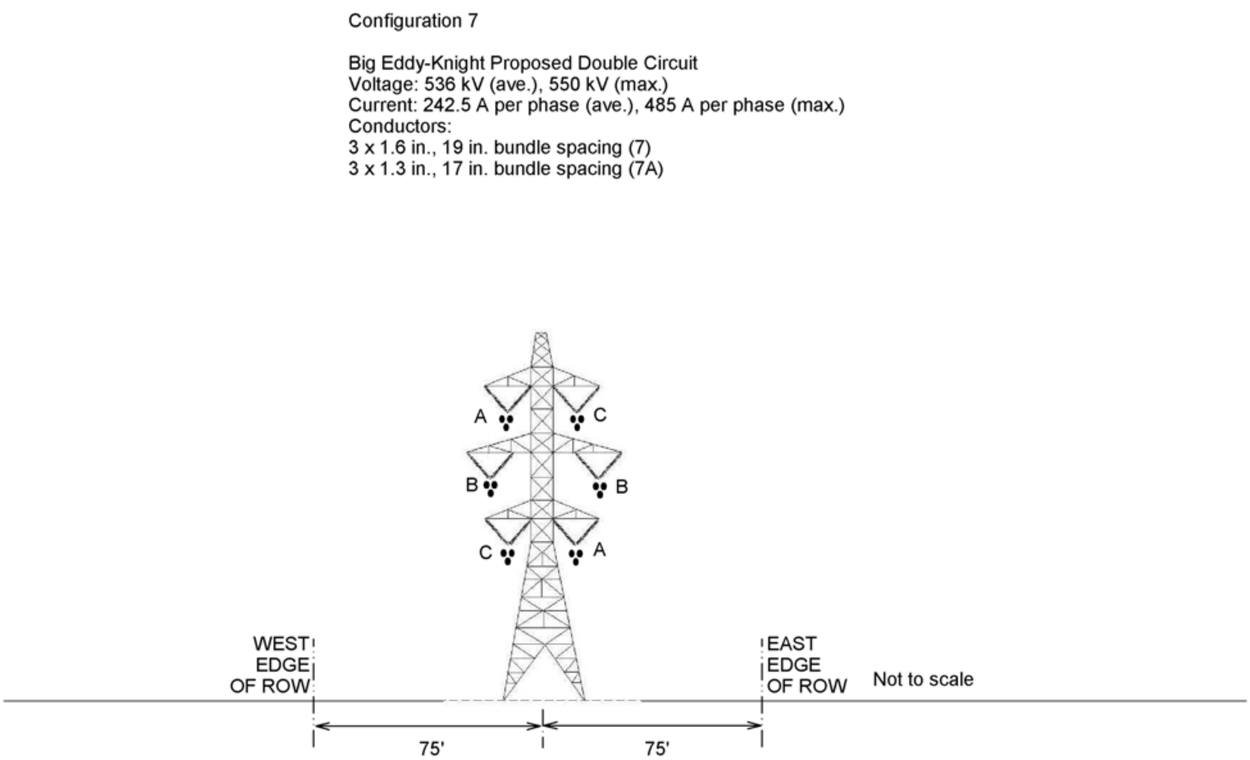


Figure 9: Double-circuit Configuration 8 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

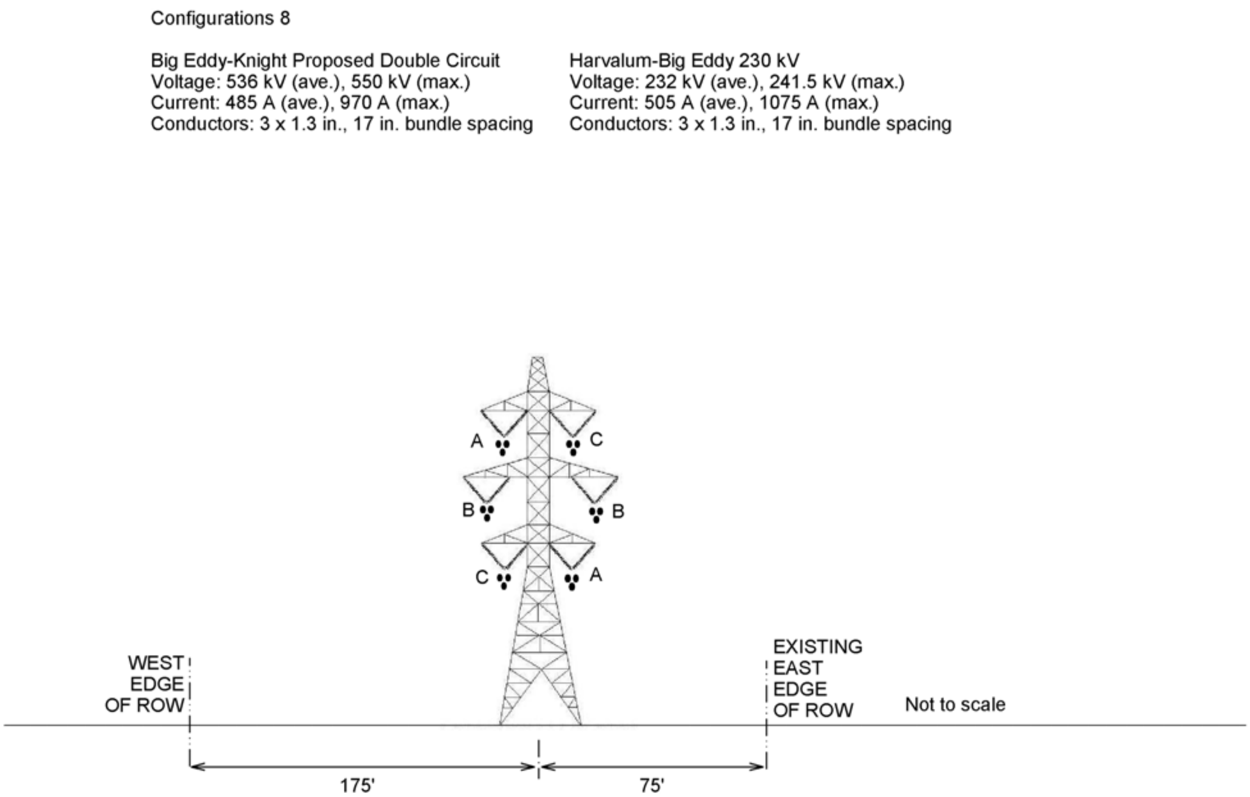


Figure 10: Double-circuit Configuration 9 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

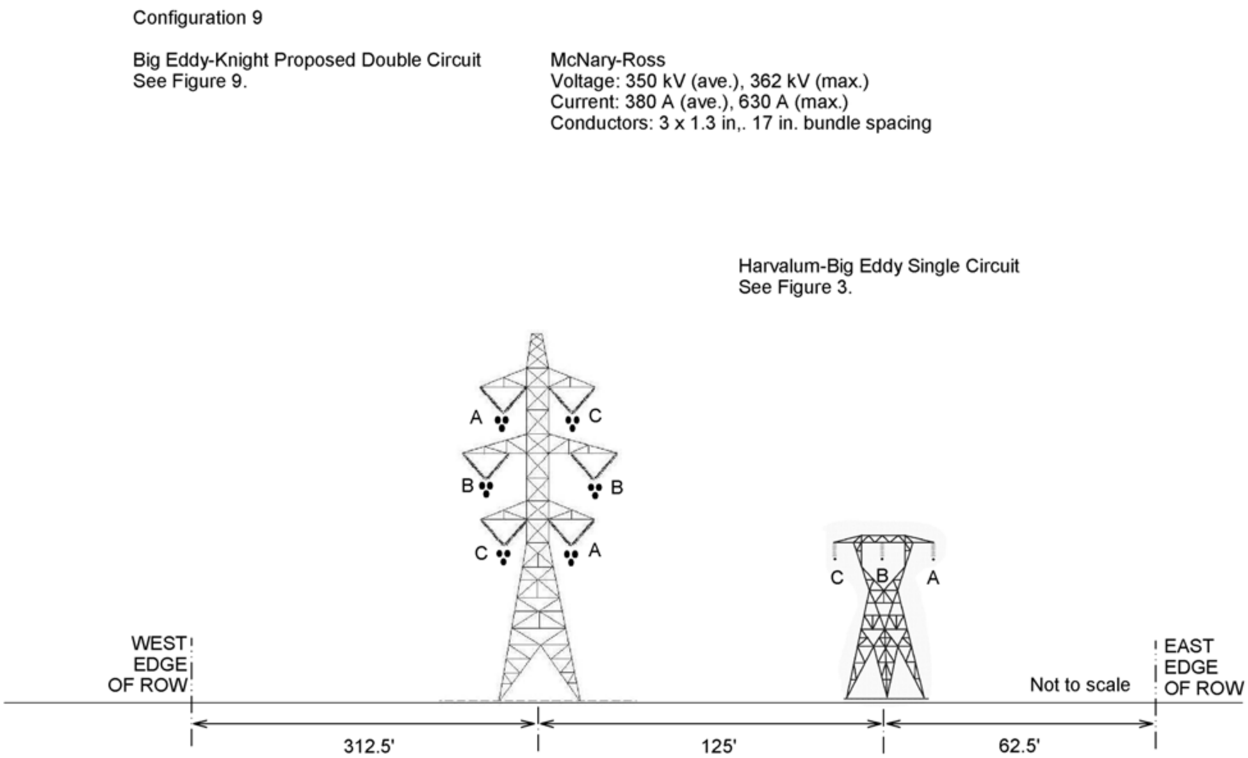


Figure 11: Double-circuit Configurations 10 and 11 for the proposed Big Eddy – Knight 500-kV line. The west circuit will be the proposed Big Eddy – Knight line and the east circuit will be the existing Chenoweth – Goldendale line (Configuration 10) or the existing Spearfish Tap line (Configuration 11). Configurations are described in Tables 1 and 2.

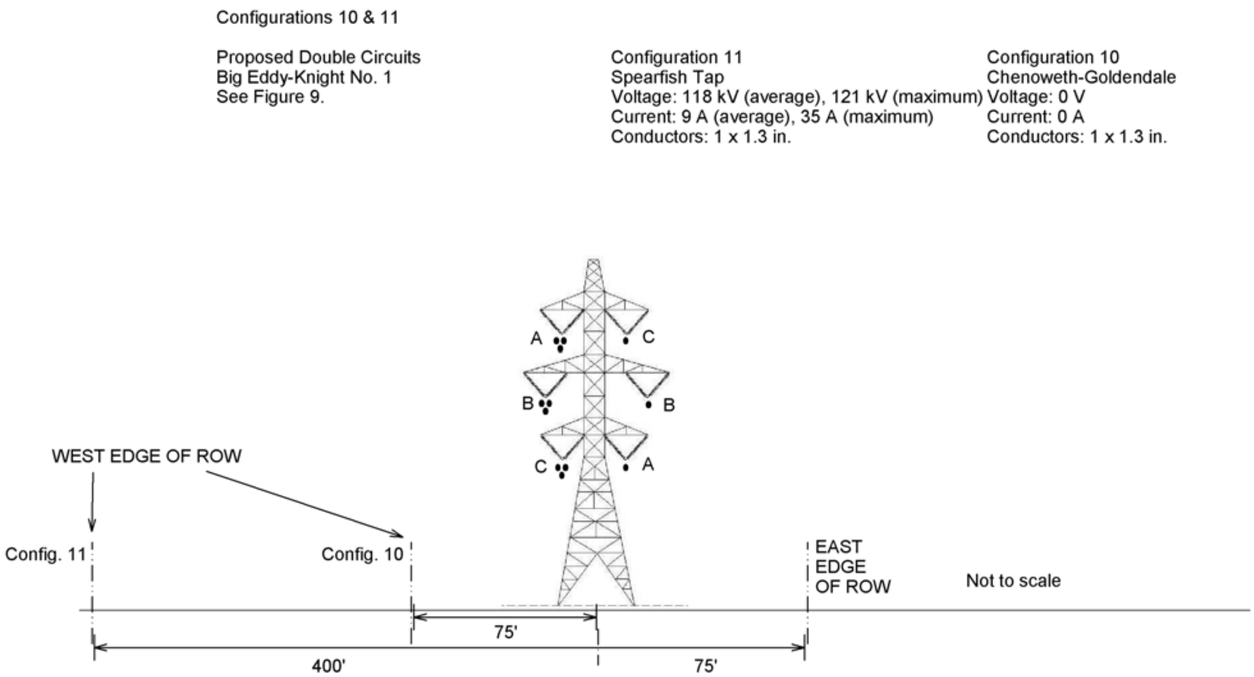


Figure 12: Double-circuit Configuration 12 for the proposed Big Eddy – Knight 500-kV line. Configurations are described in Tables 1 and 2.

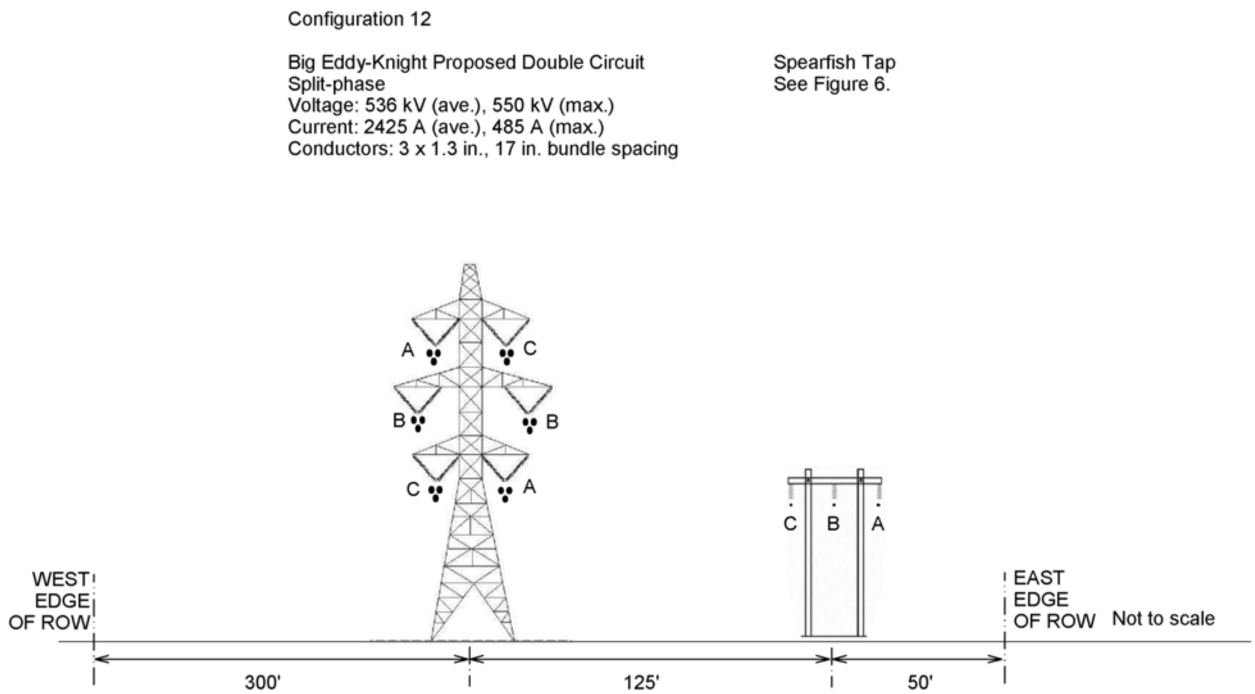


Figure 13: Electric-field profiles for single-circuit Configuration 1 of the proposed Big Eddy – Knight 500-kV line. Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

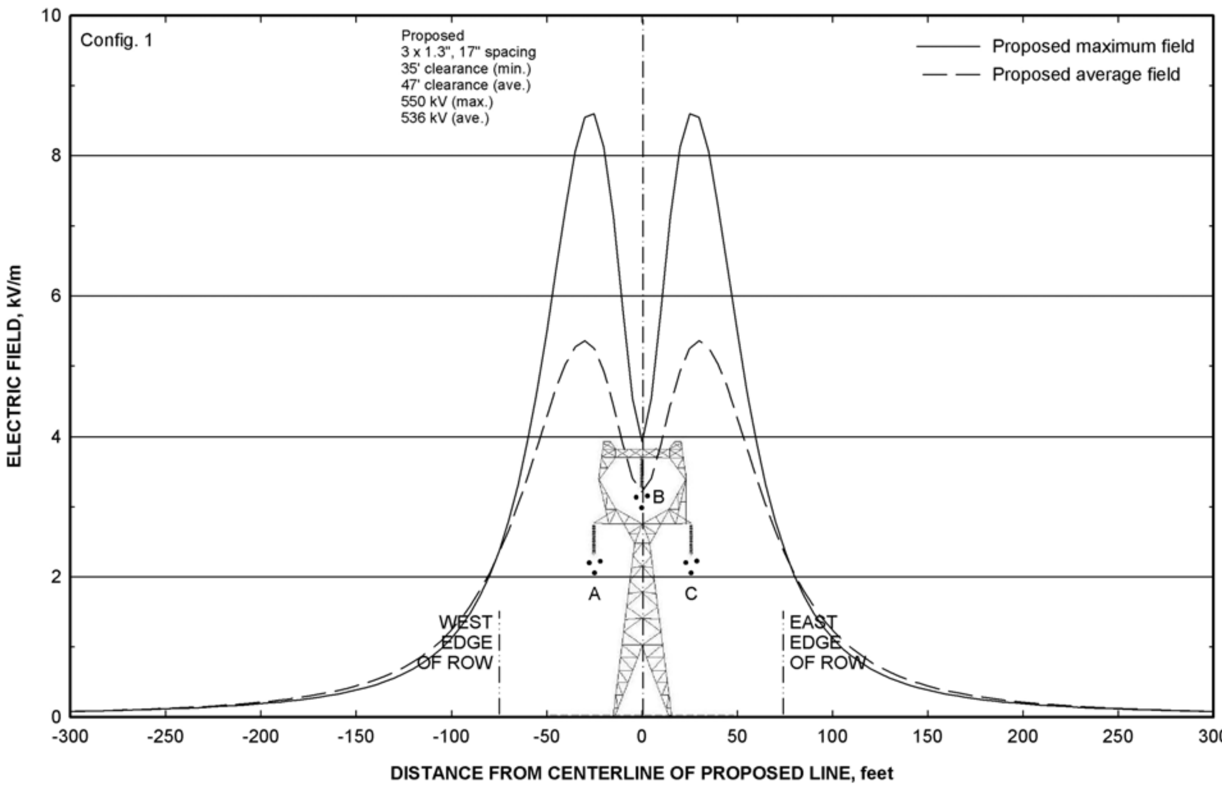


Figure 14: Electric-field profiles for single-circuit Configuration 2 of the proposed Big Eddy – Knight 500-kV line. Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

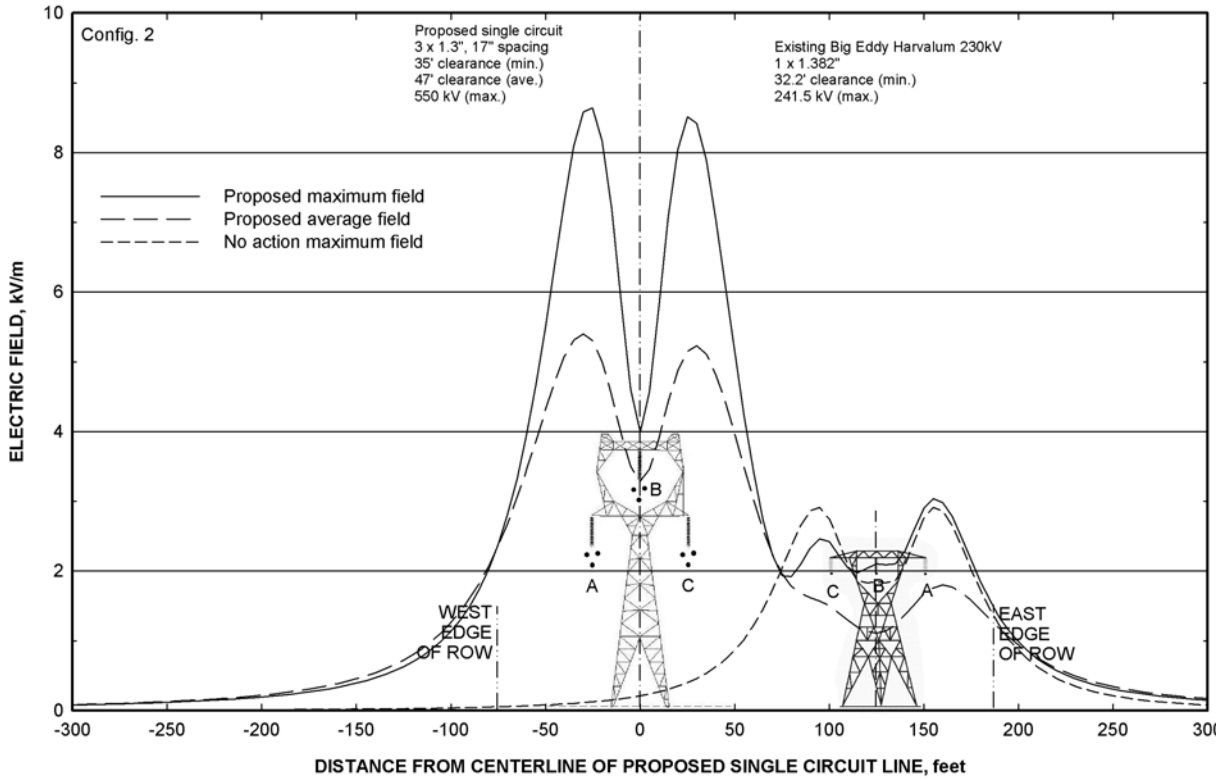


Figure 15: Electric-field profiles for single-circuit Configuration 3 of the proposed Big Eddy – Knight 500-kV line. Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

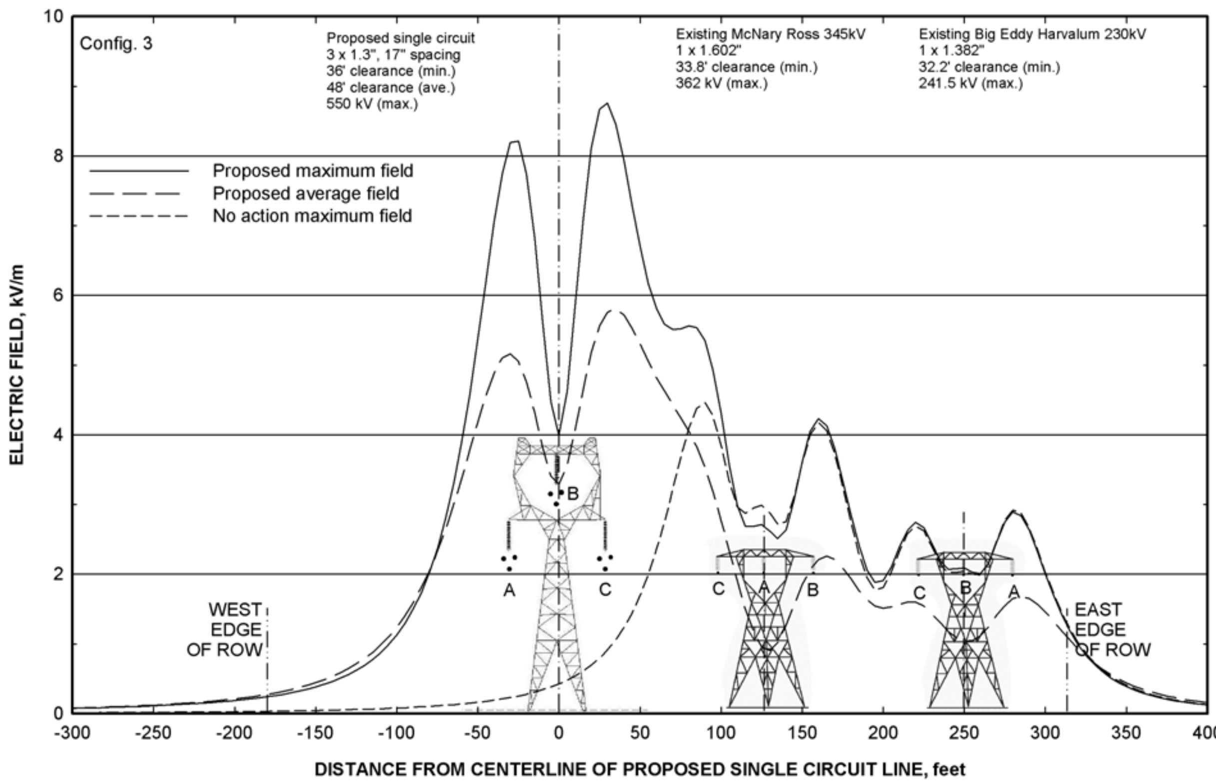


Figure 16: Electric-field profiles for single-circuit Configuration 4 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

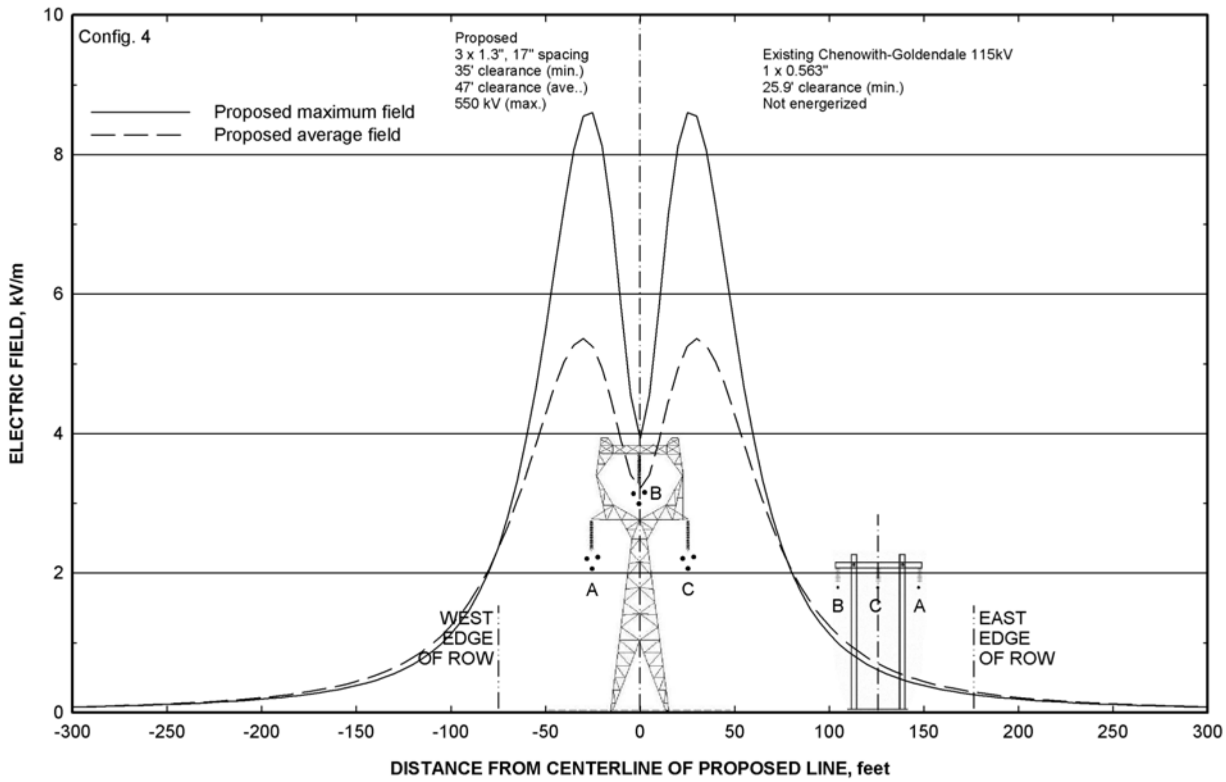


Figure 17: Electric-field profiles for single-circuit Configuration 5 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

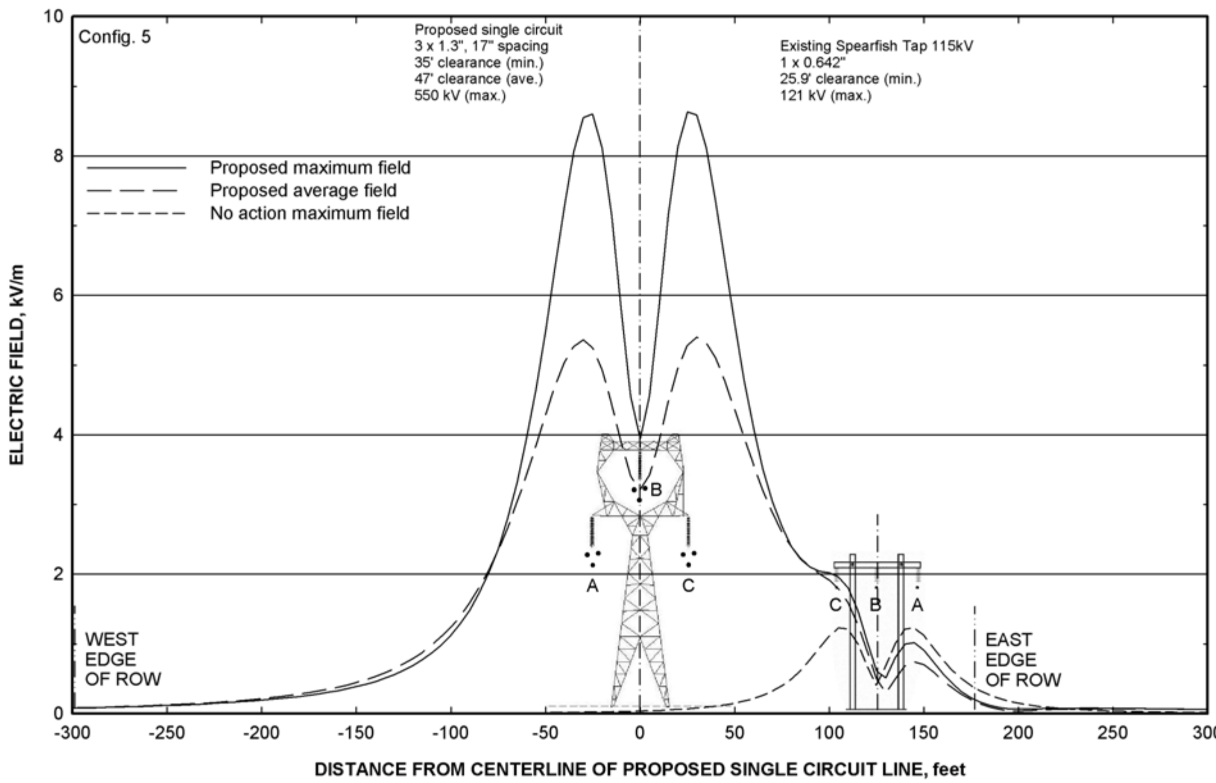


Figure 18: Electric-field profiles for single-circuit Configuration 6 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

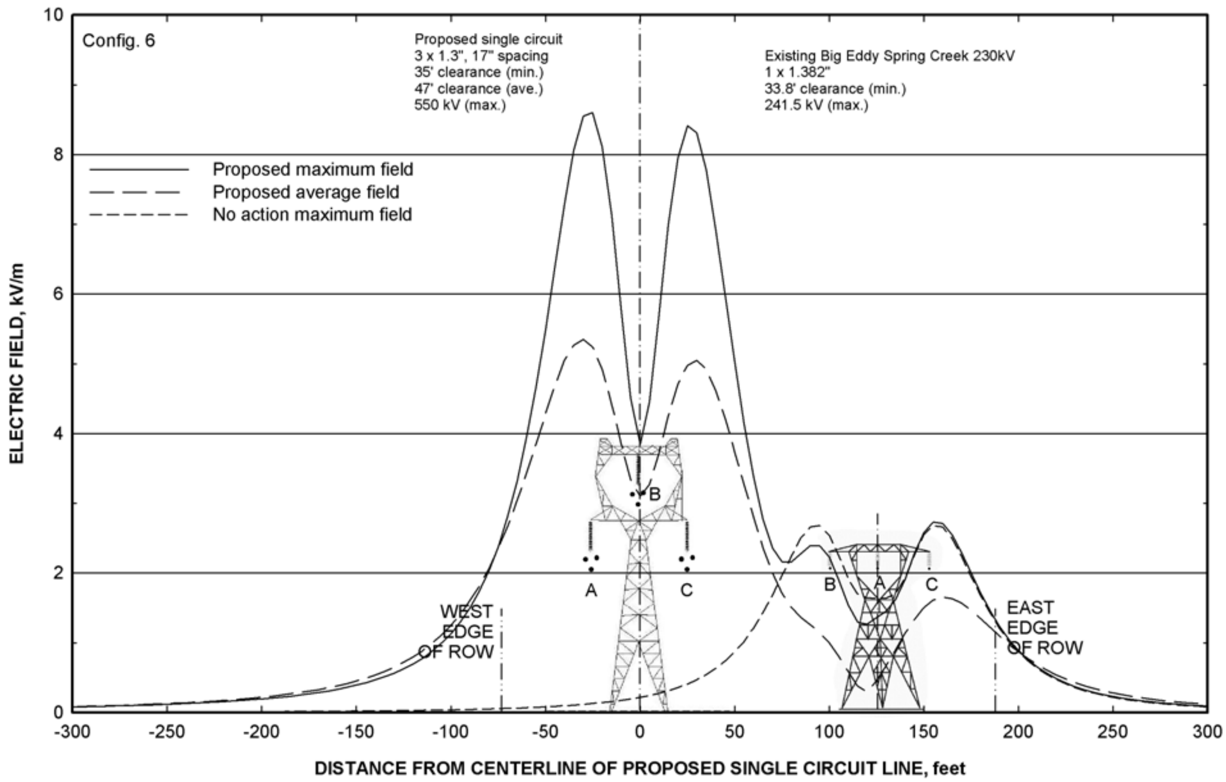


Figure 19: Electric-field profiles for double-circuit Configurations 7 and 7A of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

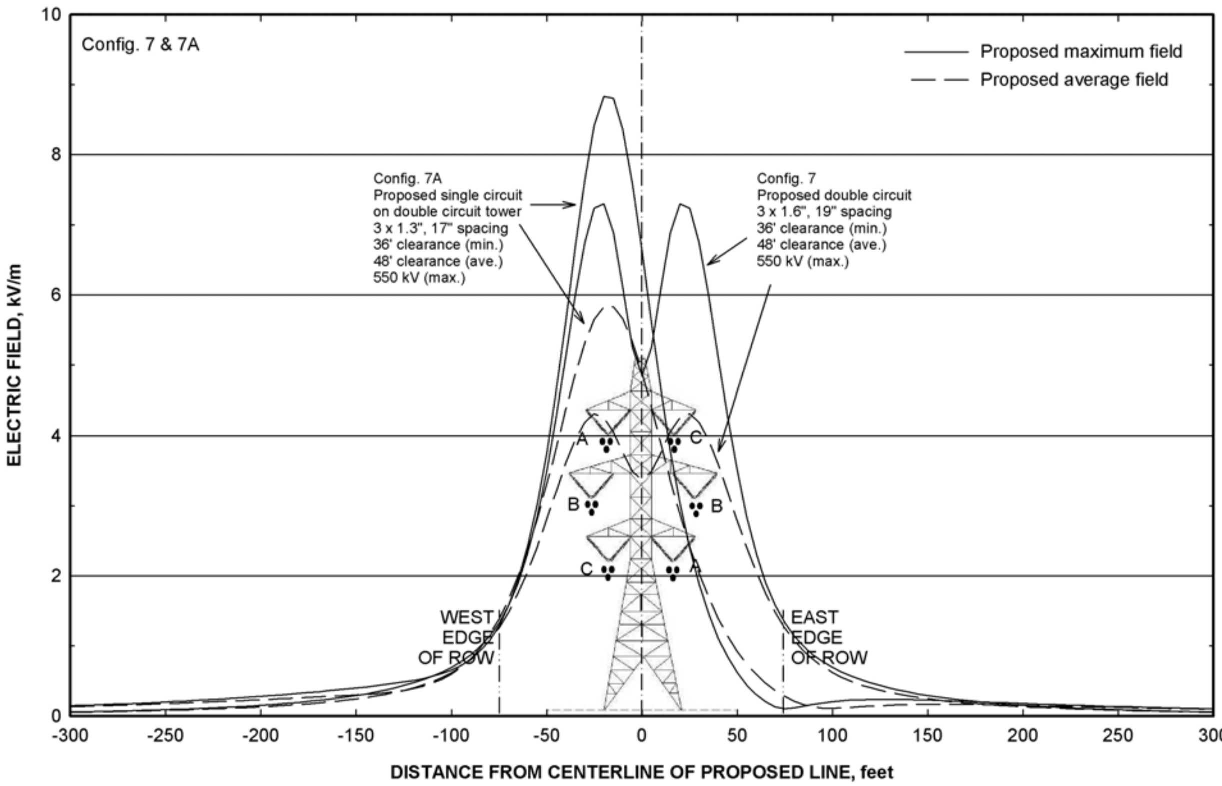


Figure 20: **Electric-field profiles for double-circuit Configuration 8 of the proposed Big Eddy – Knight 500-kV line.** Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

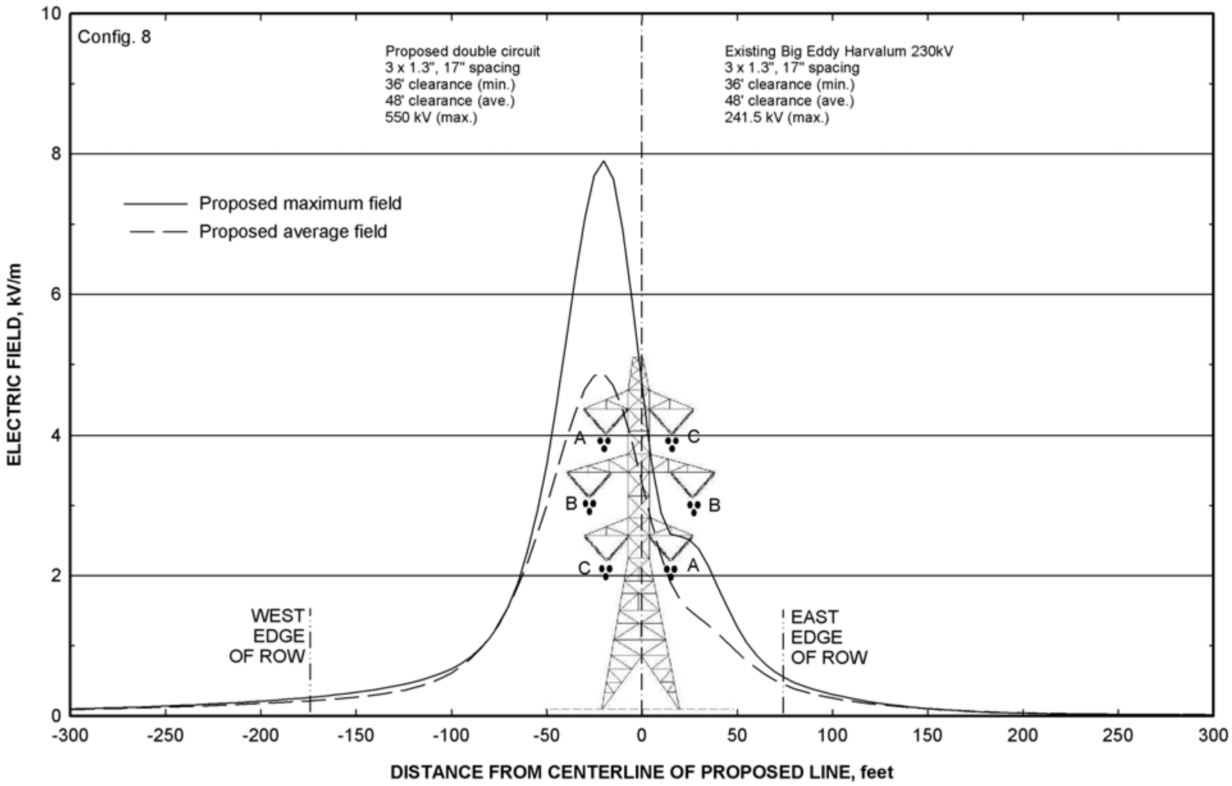


Figure 21: Electric-field profiles for double-circuit Configuration 9 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

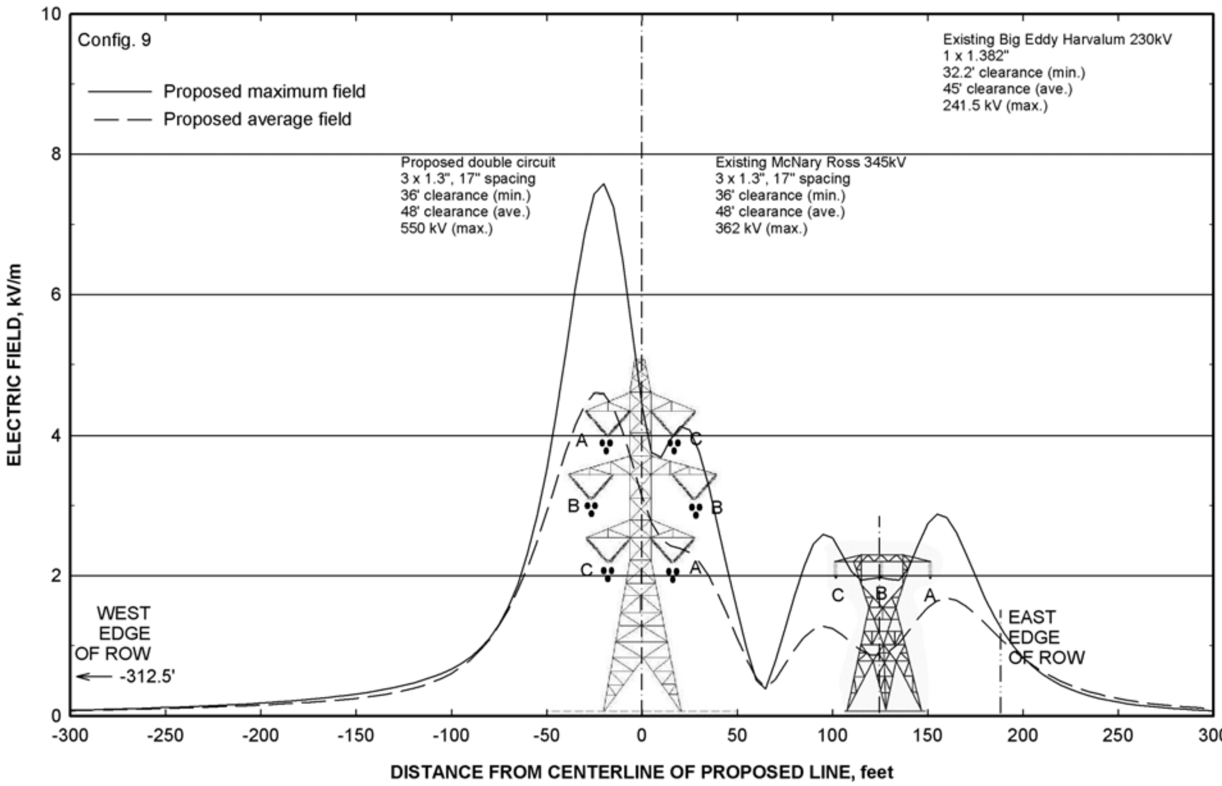


Figure 22: Electric-field profiles for double-circuit Configuration 10 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

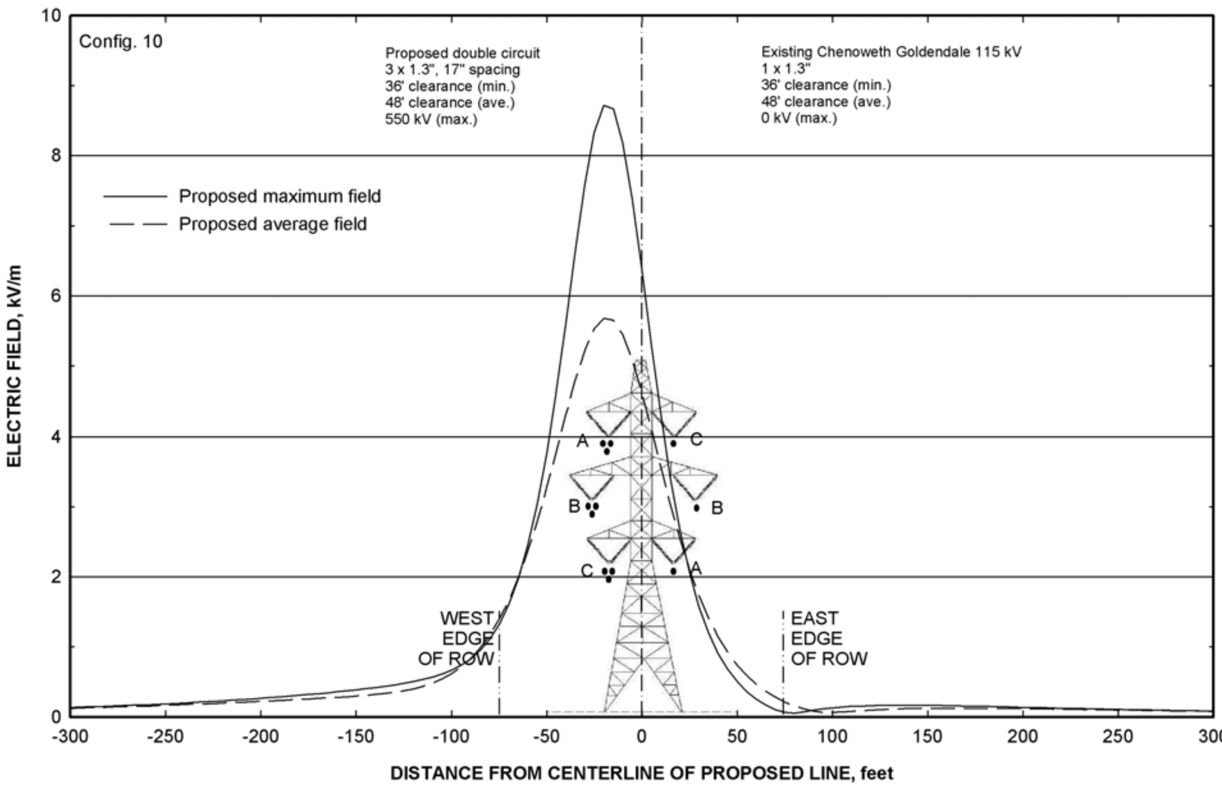


Figure 23: Electric-field profiles for double-circuit Configuration 11 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

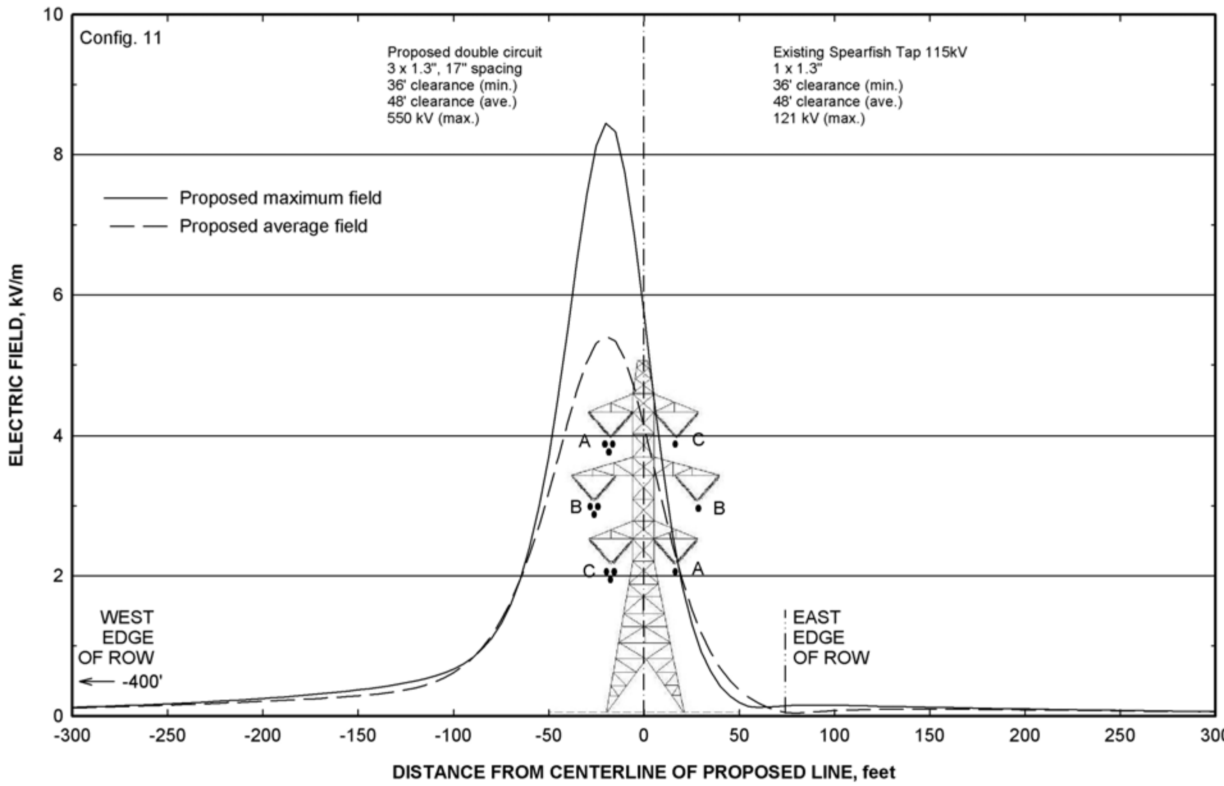


Figure 24: Electric-field profiles for double-circuit Configuration 12 of the proposed Big Eddy – Knight 500-kV line: Fields for maximum voltage with minimum and average clearances are shown. Configurations are described in Tables 1 and 2.

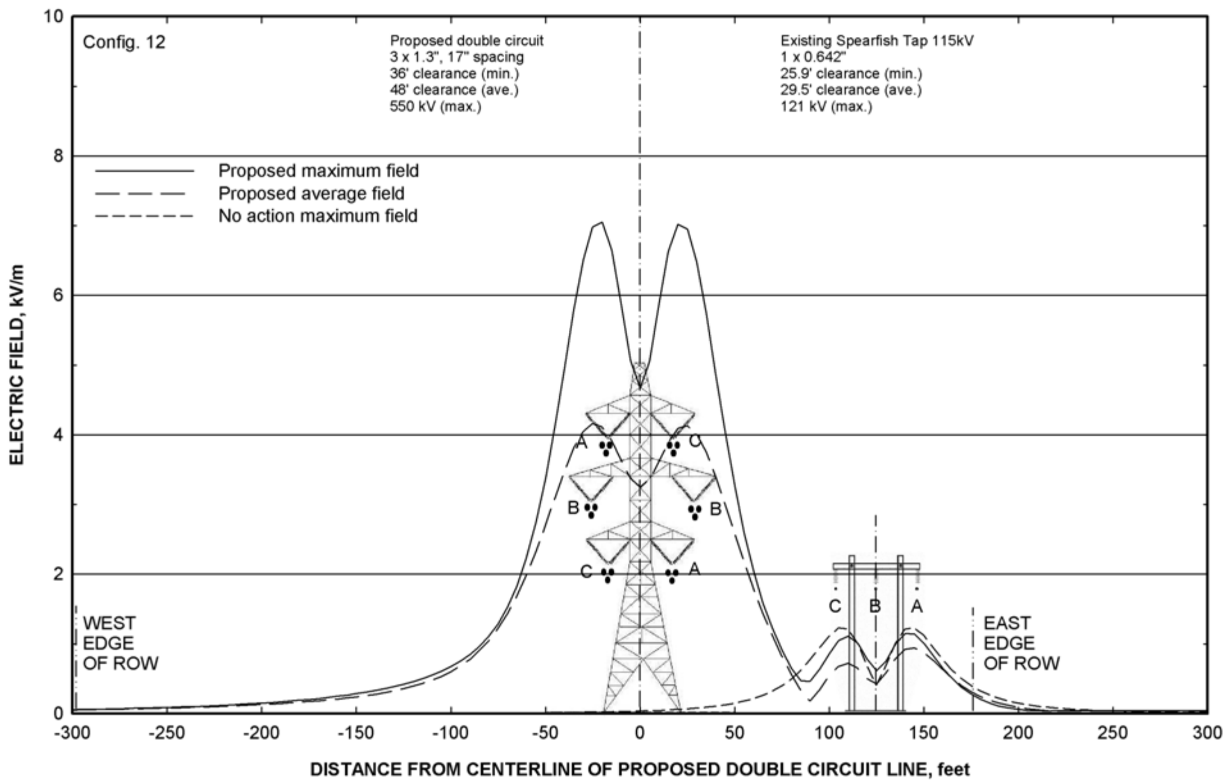


Figure 25: Magnetic-field profiles for single-circuit Configuration 1 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

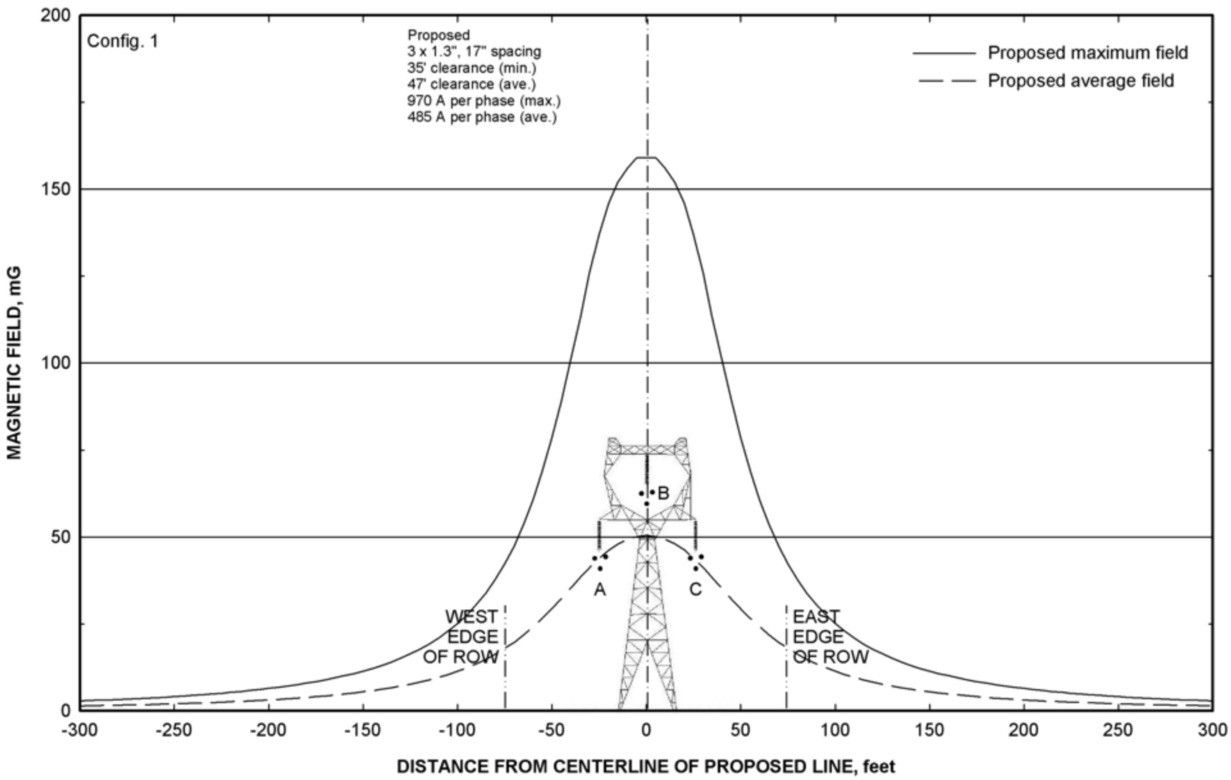


Figure 26: Magnetic-field profiles for single-circuit Configuration 2 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

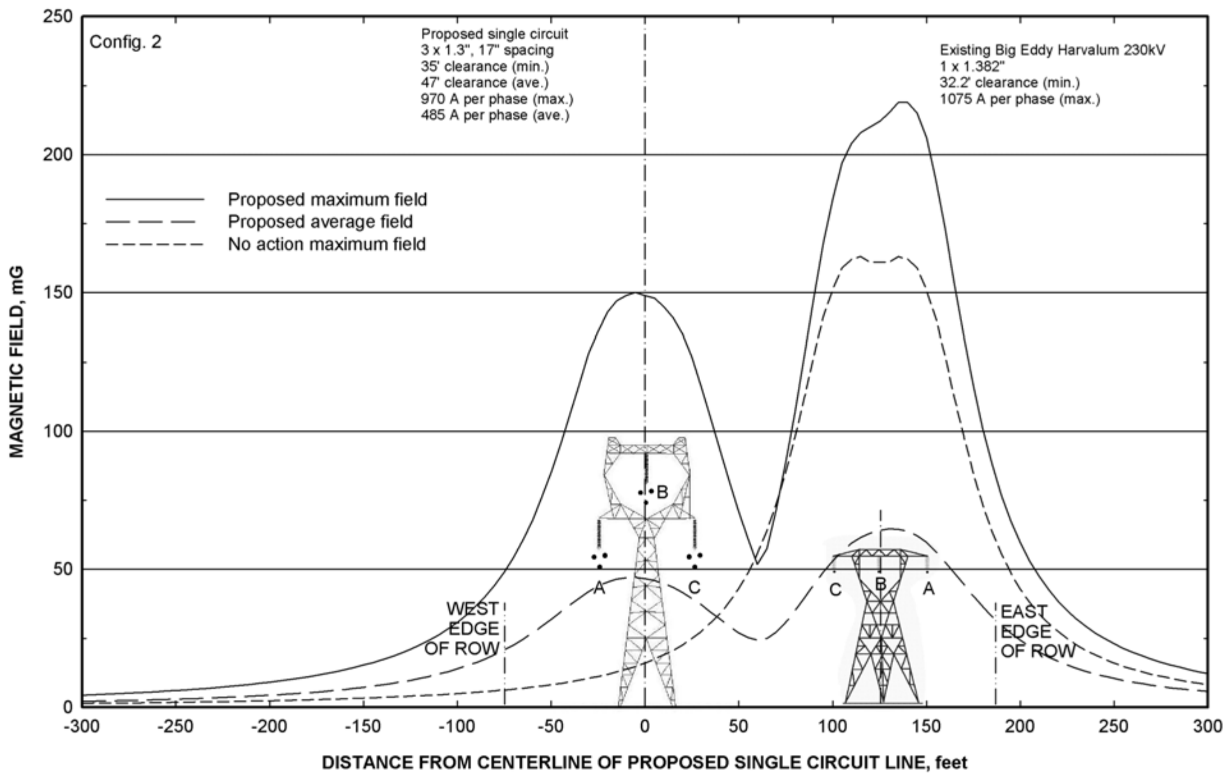


Figure 27: Magnetic-field profiles for single-circuit Configuration 3 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

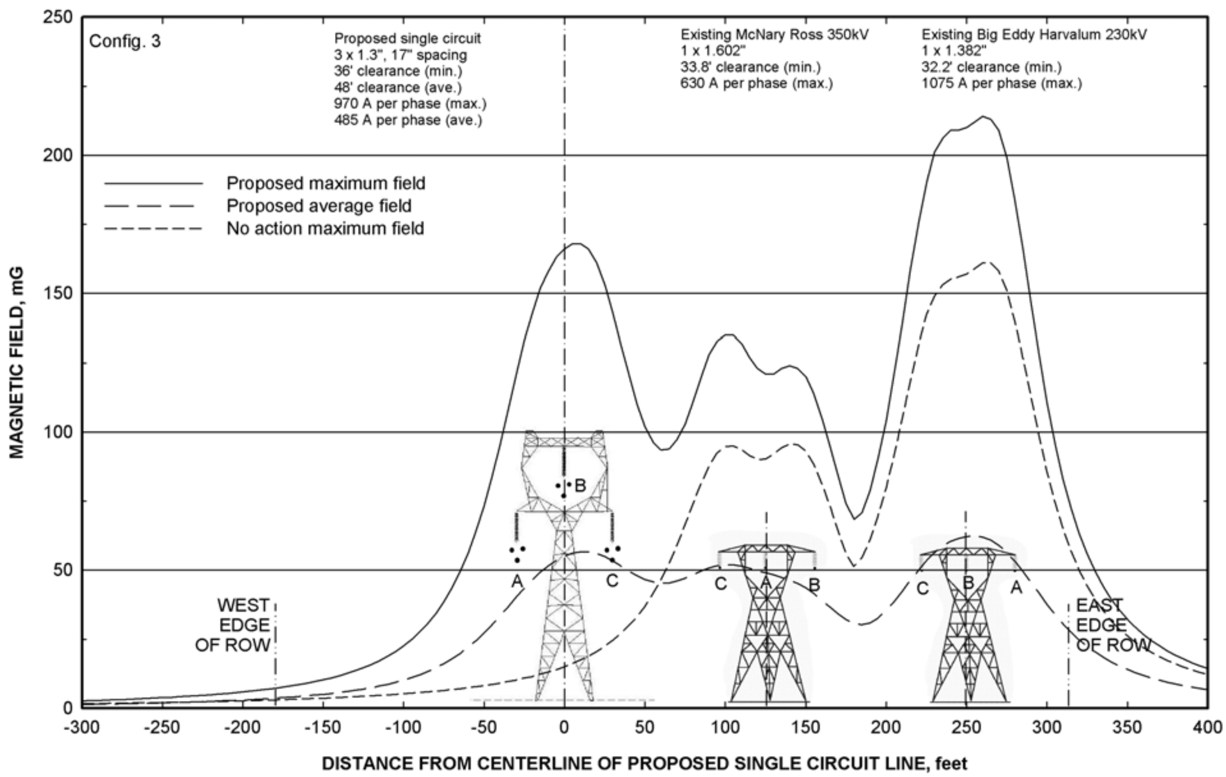


Figure 28: Magnetic-field profiles for single-circuit Configuration 4 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

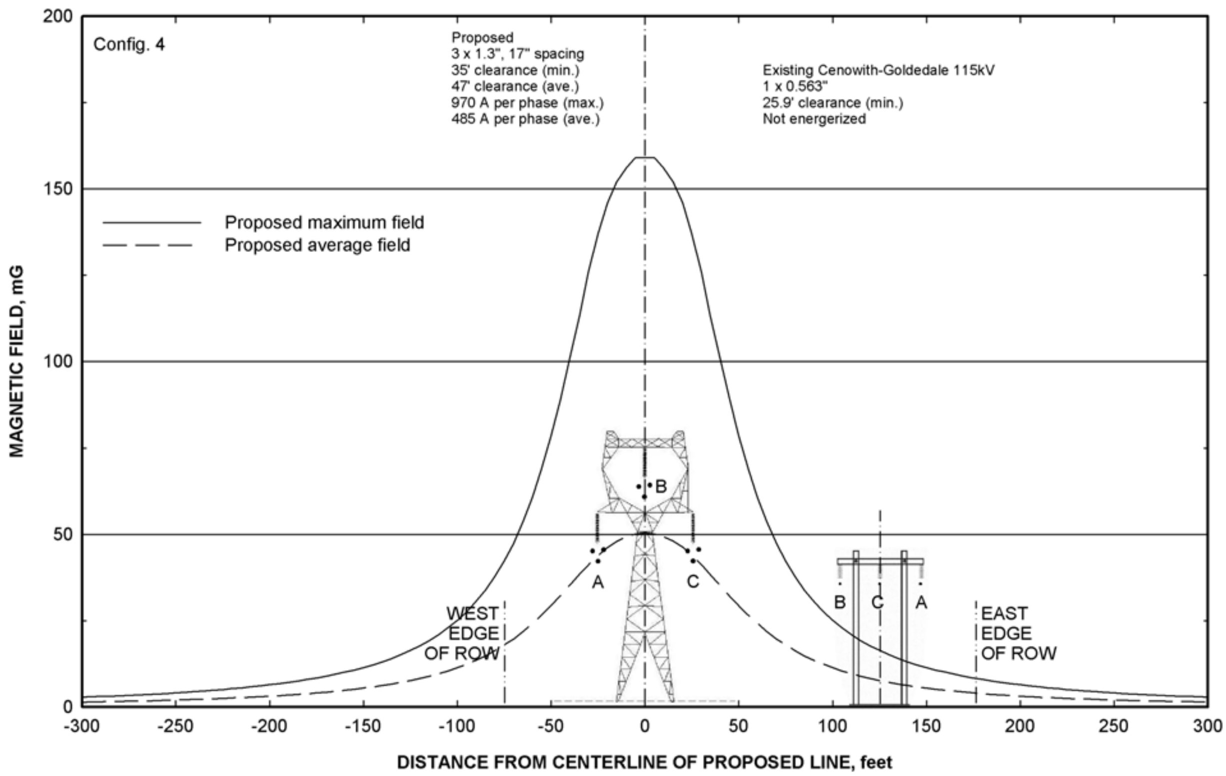


Figure 29: Magnetic-field profiles for single-circuit Configuration 5 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

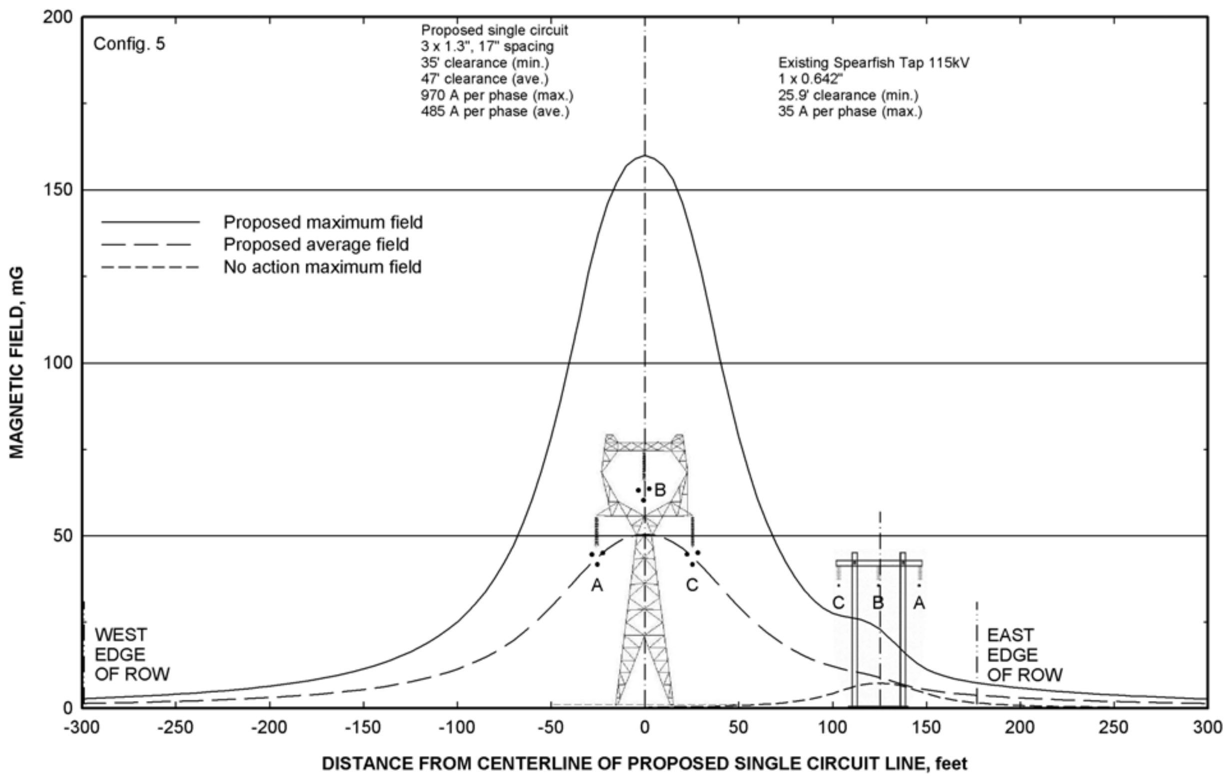


Figure 30: Magnetic-field profiles for single-circuit Configuration 6 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

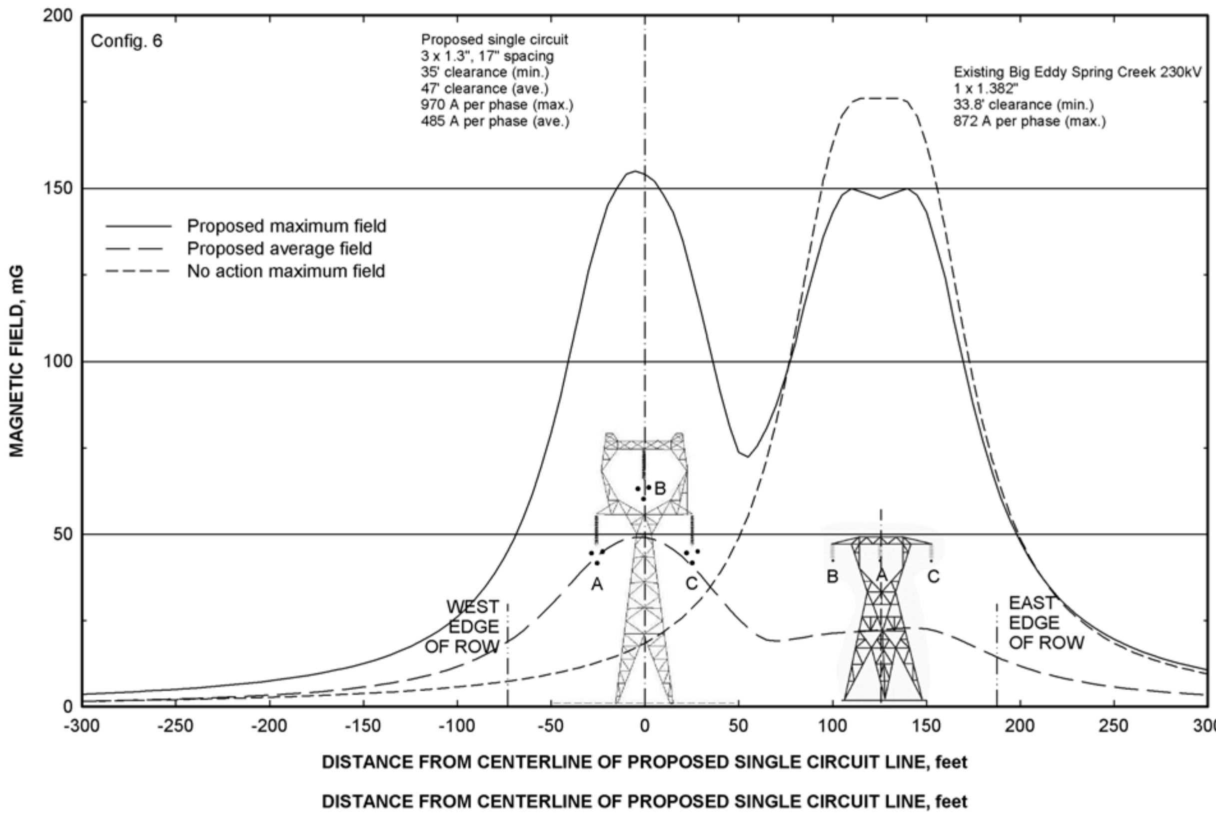


Figure 31: Magnetic-field profiles for double-circuit Configurations 7 and 7A of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

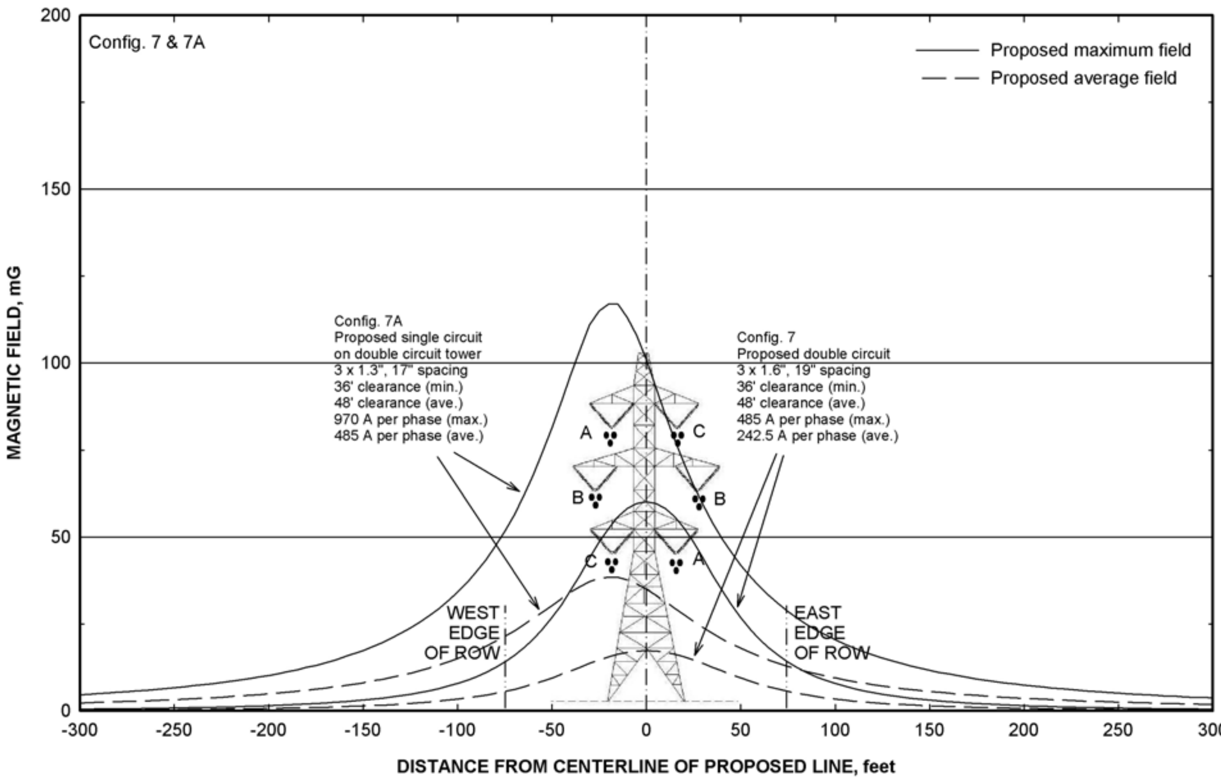


Figure 32: Magnetic-field profiles for double-circuit Configuration 8 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

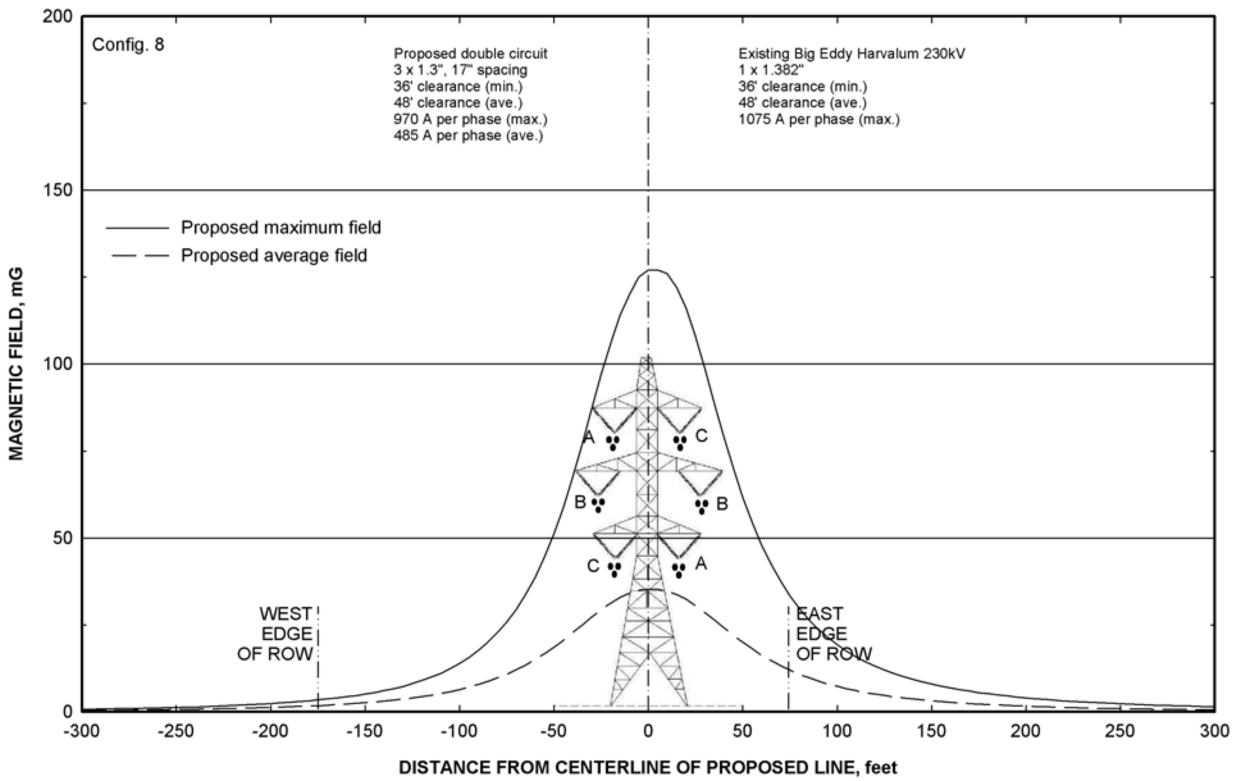


Figure 33: Magnetic-field profiles for double-circuit Configuration 9 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

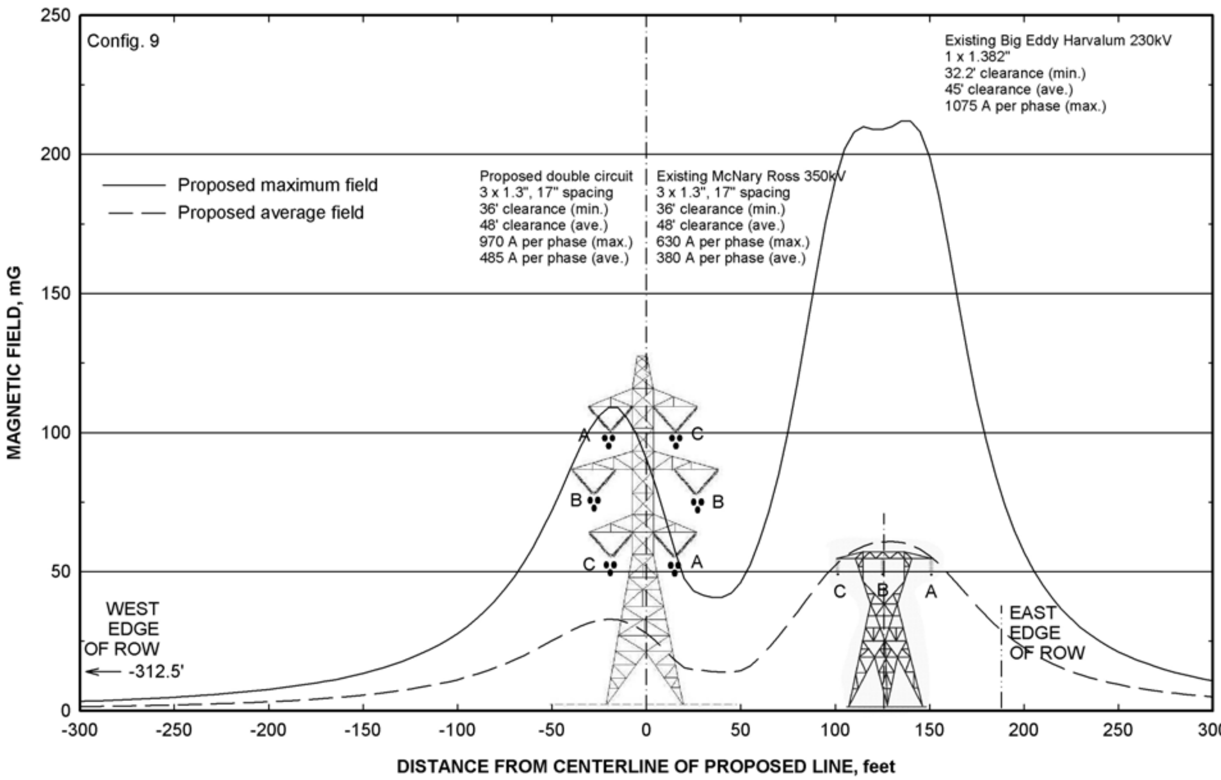


Figure 34: Magnetic-field profiles for double-circuit Configuration 10 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

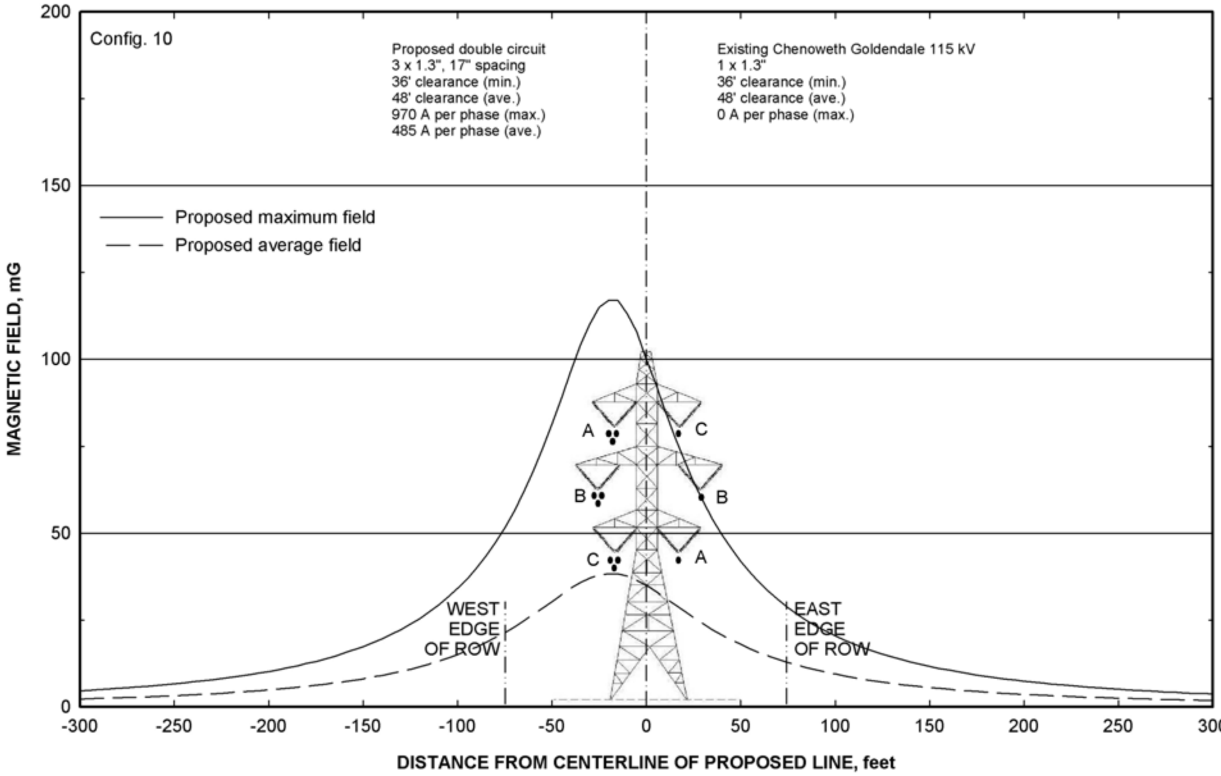


Figure 35: Magnetic-field profiles for double-circuit Configuration 11 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

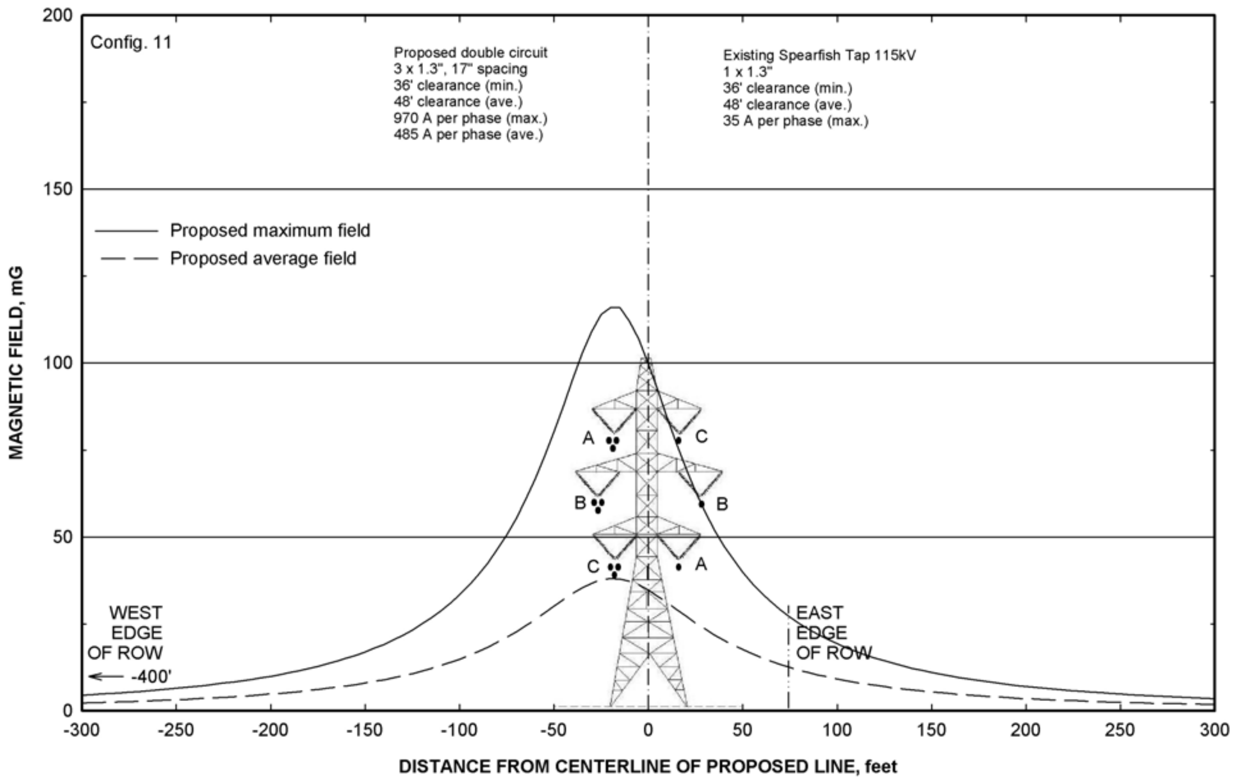


Figure 36: Magnetic-field profiles for double-circuit Configuration 12 of the proposed Big Eddy – Knight 500-kV line. Fields computed for maximum current with minimum clearance and for average current with average clearance are shown. Configurations are described in Tables 1 and 2.

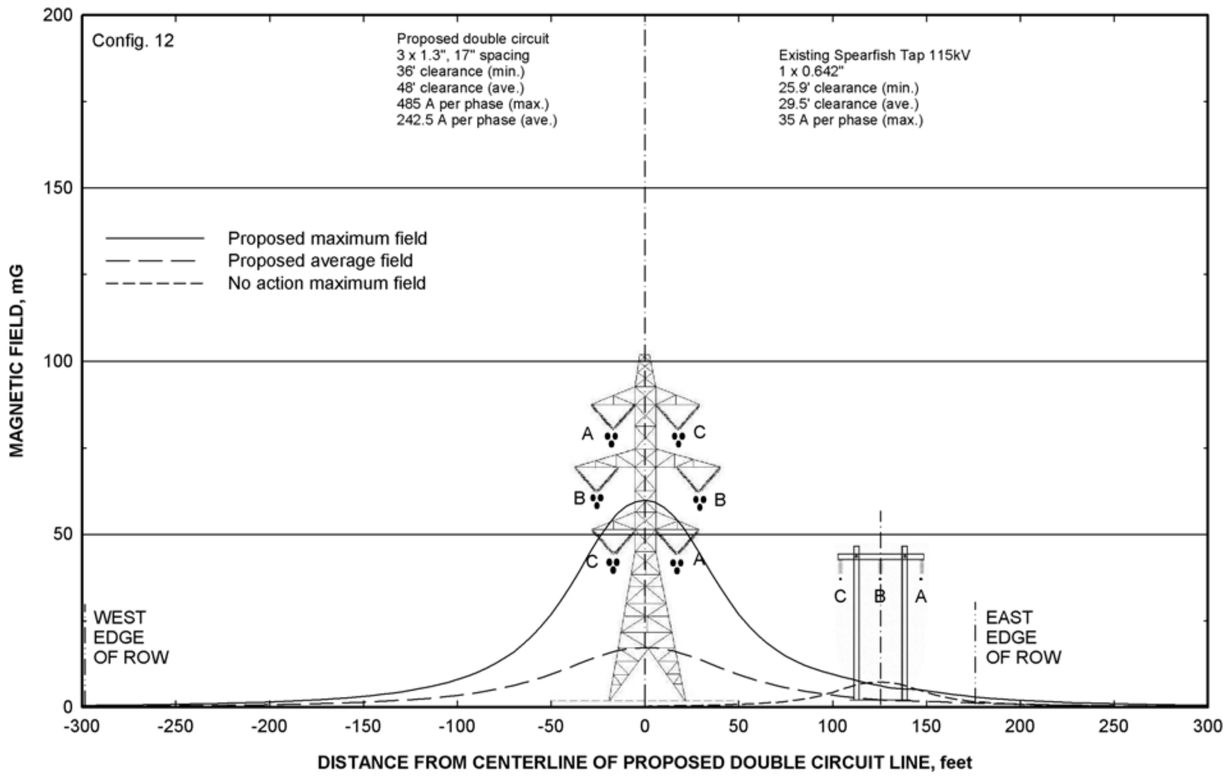
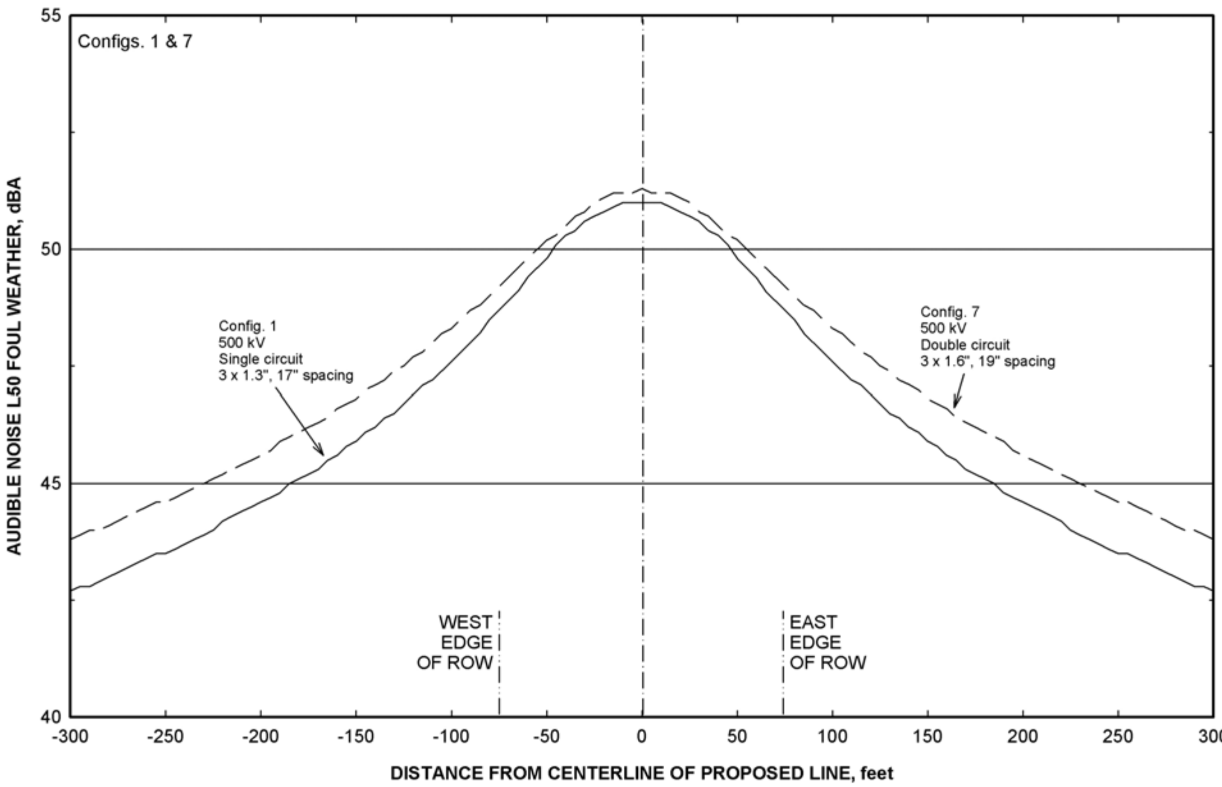


Figure 37: Audible Noise Profile for Proposed Big Eddy – Knight 500-kV Transmission Line Configurations 1 and 7 with No Adjacent Transmission Lines. Calculations performed for average voltage and average height. Configurations are described in Tables 1 and 2.



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Appendix F

Electric and Magnetic Fields Research on Health Effects

Health Sciences

Update of EMF Research - 2009

Update of EMF Research - 2009

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April 15, 2009

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Introduction

Electrical objects produce two field types – electric fields and magnetic fields. The term "field" is used to describe the way an object influences its surrounding area. A temperature field, for example, surrounds a warm object, such as a space heater. Electric and magnetic fields (EMF) surround any object that is generating, transmitting or using electricity, including appliances, wiring, office equipment, generators, batteries and any other electrical devices. EMFs are invisible and they cannot be felt or heard.

Electric fields occur as a result of the electric potential (or voltage) on these objects, and **magnetic fields** occur as a result of current flow through these objects.[1] Just like a temperature field, electric and magnetic fields can be measured and their levels depend on, among other things:

- Properties of the source of the field (voltage, current, configuration, etc.)
- Distance from the source of the field

Both electric and magnetic fields decrease rapidly with distance from the source, such that a magnetic field of 300 milligauss (mG) within 6 inches of a vacuum cleaner diminishes to 1 mG at 4 feet (NIEHS, 2002). This is similar to the way that the heat from a candle or campfire lessens as you move farther away. Although ordinary objects do not block magnetic fields, objects such as trees and buildings easily block electric fields.

The electrical power system in the United States (US) produces alternating current (AC) EMF that changes direction and intensity 60 times per second – i.e., a frequency of 60 Hertz (Hz).[2] This frequency is in the extremely low frequency (ELF) range of the electromagnetic spectrum. Electricity produced by generating stations flows as 60 Hz current through transmission and distribution lines and provides power to the many appliances and electrical devices that we use

---

1 The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter (kV/m); one kilovolt per meter is equal to 1,000 V/m. The strength of magnetic fields is expressed as magnetic flux density in units called gauss (G), or in milligauss (mG), where 1 G is equal to 1,000 mG.

2 Europe's electrical system produces 50 Hz EMF. Since 50 Hz EMF is also in the ELF range, research on 50 Hz EMF is relevant to questions on 60 Hz EMF.

in our homes, schools, and workplaces. Because electricity powers so many things in our daily lives, from lighting, heating and cooling our homes to powering our refrigerators and computers, magnetic fields are found throughout our daily environments.

Questions about whether these ubiquitous exposures could affect our health were raised in the 1970s. Since then, researchers from many different scientific disciplines have investigated this question and hundreds of studies have been conducted. The public frequently expresses concern about EMF, particularly in the context of new transmission lines. The intent of this report is to describe what this large body of research has told us about EMF and the precautions, if any, we should take to reduce or avoid exposures.

The Bonneville Power Administration (BPA) requested that Exponent update a report from July 2007 to provide a current summary of the status of the research on EMF.[3] The focus of the July 2007 report was on the conclusions of a comprehensive, weight-of-evidence review published by the World Health Organization (WHO) in June 2007, since that report represented the most recent review of the literature by a multidisciplinary scientific panel. The WHO organized a multidisciplinary Task Group of 21 scientists from around the world to draft a Monograph that summarized the research and provided conclusions as to whether there are risks associated with ELF-EMF and, if so, at what exposure levels (WHO, 2007a). The report concluded that the only established effects of ELF-EMF exposure are acute neurostimulatory effects that occur at very high levels of exposure; these exposure levels are not encountered in ordinary residential or occupational environments. The factsheet from this report is attached as Appendix 1 (WHO, 2007b) and can be found at http://www.who.int/mediacentre/factsheets/fs322/en/print.html.

Research is a constantly evolving process. Despite the volume of research available on EMF and the large reduction in uncertainty that research has achieved over the years, research continues with the goal of clarifying and replicating old findings and testing new hypotheses. New studies on ELF-EMF are published each year. To update its perspective on EMF research, this supplemental report identifies newly published studies and provides the reader with

[3] Exponent. Assessment of Research Regarding EMF and Health and Environmental Effects. Olympic Peninsula Reinforcement Transmission Line Project. July 2007.

perspective on if, and how, these recent studies have strengthened or changed the WHO conclusions.

A short section on the methods that scientists use to conduct studies and make decisions about health risks is also included as a framework for understanding later discussions (Section 1). The discussion of new research is broadly grouped by disease – cancer, reproductive/developmental effects, and neurodegenerative diseases – in Section 2. Both epidemiologic and *in vivo* research is summarized within the disease category and *in vitro* research is discussed separately. The possible effects of EMF on the functioning of pacemakers (Section 3) and on flora and fauna (Section 4) are also discussed.[4] Finally, guidelines for ELF-EMF exposure developed by scientific organizations to prevent against established health effects are summarized in Section 5.

4 Neither of these topics was covered in the WHO report, but a discussion is provided to determine whether recent studies alter statements from Exponent's 2007 BPA report.

1 Scientific Methods

Weight-of-evidence review

Most things that we encounter in our environment have no effect on our health. But, there are some things that may affect our health in a harmful or beneficial way. These include things that we encounter in the environment, such as sunlight, or things we eat, such as certain foods. Much time and money is spent by scientists around the world designing, conducting and publishing research to determine what factors may affect our health, including environmental exposures (like EMF), infectious agents and our genetics. The process for arriving at a conclusion about whether there is a health risk associated with any of these factors is usually not as straightforward or definitive as reporting by the lay media may suggest. Rather, it is a long process that requires repeated hypothesis generation and testing.

The process begins when a scientist forms a hypothesis and conducts a study to test that hypothesis. Studies are conducted by scientists at academic universities and scientific institutions around the world. Once the study is complete, the authors submit it to a scientific journal for publication, where it undergoes peer review prior to publication. The evidence to evaluate any health risk, therefore, is all of the relevant studies published in the peer-reviewed literature.

These individual research studies can be thought of as puzzle pieces. When all of the research is placed together, we have some understanding of possible health effects; however, no conclusions can be reached by looking at only one study, just as no picture can be formed with just one puzzle piece. Each study provides a different piece of information to the puzzle because of its unique strengths and weaknesses – if the study used valid methods and had no obvious sources of bias, it may provide a wealth of information or, if the study was not well done, it may provide little (if any) information.

This process of evaluating all of the research together to determine whether something poses a health risk (or benefit) is referred to as a weight-of-evidence review. There are three types of research that are considered in a weight-of-evidence review: epidemiologic observations in people, experimental studies in animals (*in vivo* research), and experimental studies in cells and tissues (*in vitro* research). It is important to consider all three types of research together because they provide complementary information:

- For epidemiology studies, scientists collect observational data about human populations in their day-to-day environments to determine whether there are patterns between exposures and diseases. These studies measure statistical associations to evaluate whether a disease and exposure occur together more often than expected. An important limitation of these studies is that, if an association is measured, they do not tell scientists how the exposure is truly related to the disease. That conclusion can only be reached by considering the entire body of research. Most of the studies evaluating EMF look at whether people with disease have higher estimates of EMF exposure in the past compared to people without disease.

- Experimental studies in which scientists expose animals (*in vivo*) to varying levels of electric or magnetic fields (some as high as 50,000 mG) are an important source of information. These studies compare the amount of disease they observe in exposed animals to the amount of disease they observe in animals that have not been exposed. The strength of animal studies is that scientists are able to control all aspects of the animals' lives to minimize the potential confounding effects of factors other than the exposure of interest. Of these studies, the most valuable for understanding disease are those in which the animals receive life-long exposures.

- A second type of experimental EMF study involves the exposure of isolated cells and tissues *in vitro* to EMF, and compares the characteristics of exposed and unexposed samples to look for differences that are indicative of a disease process. These studies are limited because what happens in cells or tissue outside a human body may not be the same as what happens inside a body.

Scientists, scientific organizations, and regulatory agencies use the weight-of-evidence approach worldwide to assess the possible health risks associated with exposures. A weight-of-evidence review begins with a systematic review of published, peer-reviewed scientific research in the fields of epidemiology, *in vivo* research, and *in vitro* research. The weight that individual studies provide to the overall conclusions is not equal – studies vary widely in terms of the sophistication and validity of their methods. Therefore, each study from each discipline must be critically evaluated and assigned a weight. A final conclusion is then reached by considering the cumulative body of research, giving more weight to studies of higher quality (see Figure 1).

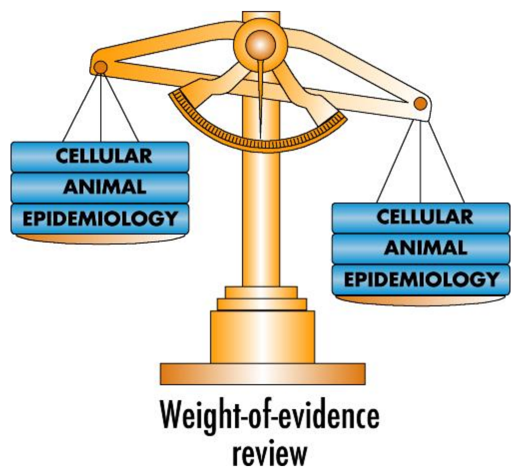

Figure 1. Weight-of-evidence reviews consider three types of research

Continuing with the puzzle example from above, the picture that is formed when the individual studies (or puzzle pieces) are assembled can take on many different shapes. In some cases (e.g., smoking and lung cancer), a clear picture of an adverse health effect was presented by the research within a relatively short time. In most cases, however, the picture is unclear and more questions are raised. It is impossible to prove the negative in science – i.e., to say that any exposure is completely safe – therefore, when it appears that there is little risk, research studies endeavor to reduce the uncertainty that there is a health effect through continued research. The only way to reduce this uncertainty is to conduct high quality studies with meaningful results that are replicated across study populations. Thus, in most areas of research, unless the data clearly indicates an increased risk at defined exposure levels, scientific panels will conclude that the research is inadequate and requires future research, until the uncertainty has been reduced below an acceptable level. While the public may interpret this conclusion as indicating concern, it is natural for scientists to recommend future research to either reduce uncertainty around a largely "negative" body of research or replicate findings that appear "positive" in nature.

Established scientific and health agencies organize panels to conduct weight-of-evidence reviews. These panels consist of experts from around the world in the areas of interest (e.g., epidemiology, neurophysiology, toxicology), and they follow standard scientific methods for arriving at conclusions about possible health risks. The conclusions of these reviews are looked to for the current scientific consensus on a particular topic and form the basis of recommendations made by organizations and governments on exposure standards and precautionary measures.

Numerous national and international organizations responsible for public health have convened multidisciplinary panels of scientists to conduct weight-of-evidence reviews and arrive at conclusions about the possible risks associated with ELF-EMF. These organizations include the following (in ascending, chronological order of their most recent publication):

- The **National Institute for Environmental Health Sciences** (**NIEHS**) assembled a 30-person Working Group to review the cumulative body of epidemiologic and experimental data and provide conclusions and recommendations to the United States government (NIEHS, 1998, 1999).

- The **International Agency for Research on Cancer** (**IARC**) completed a full carcinogenic evaluation of electric and magnetic fields in 2002.

- The **International Commission on Non-Ionizing Radiation Protection** (**ICNIRP**), the formally recognized organization for providing guidance on standards for non-ionizing radiation exposure for the WHO**,** published a review of the cumulative body of epidemiologic and experimental data on ELF-EMF in 2003.

- The **National Radiological Protection Board** (**NRPB**)[5] of the United Kingdom (UK) issued full evaluations of the research in 1992, 2001 and 2004, with supplemental updates (1993, 1994a) and topic-specific reports (1994b; 2001b; HPA, 2006) published in the interim.

- The **World Health Organization (WHO)** released a review in June 2007 as part of its International EMF Program to assess the scientific evidence of possible health effects of EMF in the frequency range from 0 to 300 GHz.

- The SSI of the **Swedish Radiation Protection Authority**, using other major scientific reviews as a starting point, evaluated recent studies in consecutive annual reports (SSI, 2007; SSI, 2008).

- The **Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)** issued a report in March 2007 and March 2009 updating previous conclusions (SSC, 1998; CSTEE, 2001) to the Health Directorate of the European Commission.

In August 2007, an *ad hoc* group of 14 scientists and public health and policy "experts" published a report, referred to as the BioInitiative Report, online to "assess scientific evidence on health impacts from electromagnetic radiation below current public exposure limits and evaluate what changes in these limits are warranted now to reduce possible public health risks in the future" (p. 4). The report was followed by two publications that summarized some of the online report's conclusions (Hardell and Sage, 2008; Davanipour and Sobel, 2009). The individuals who comprised this group did not represent any well-established regulatory agency, nor were they convened by a recognized scientific authority. The report has been criticized by scientific agencies because it did not follow the methods of a standard weight-of-evidence review and, for this reason, its conclusions and recommendations are not considered further in this report (HCN, 2008).[6] Appendix 2 provides a full criticism of the report.

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[5] The NRPB merged with the Health Protection Agency (HPA) in April 2005 to form its new Radiation Protection Division.

[6] http://www.gr.nl/pdf.php?ID=1743&p=1

Epidemiology basics

For reference, this section briefly describes the main types of epidemiology studies and the major issues that are relevant to evaluating their results. The two, main types of epidemiology studies are cohort studies and case-control studies (see Figure 2).

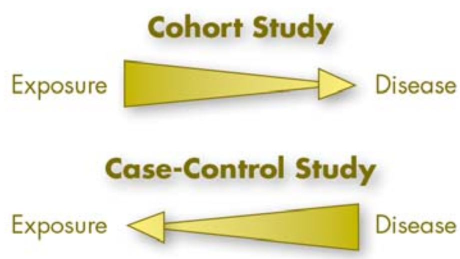

Figure 2. Basic design of cohort and case-control studies

A case-control study is a type of epidemiology study that compares the characteristics of people that have been diagnosed with a disease (i.e., cases) to a similar group of people who do not have the disease (i.e., controls). The prevalence and extent of past exposure to a particular agent is estimated in both groups to assess whether the cases have a higher exposure level than the controls, or vice versa.

In a case-control study, this comparison (or statistical association) is estimated quantitatively with an odds ratio (OR). An odds ratio is the ratio of the odds of exposure among persons with a disease to the odds of exposure among persons without a disease. The general interpretation of an odds ratio equal to 1.0 is that the odds of exposure are the same in the case and control groups (i.e., there is no statistical association between the exposure and disease). If the odds ratio is greater than 1.0, the inference is that the odds of exposure are greater in the case group or, in other words, the exposure may increase the risk of the disease (see Figure 3 below).

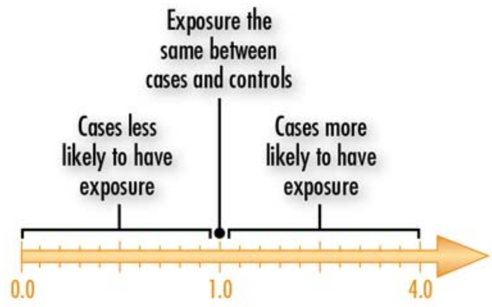

Figure 3. Interpretation of an odds ratio in a case-control study

Each OR is reported with a confidence interval (CI), which is a range of OR values that have a specified probability of occurring if the study is assumed to be repeated a large number of times. A 95% CI, for example, provides the range of values that are likely to occur in 95% of repeated experiments. In short, a CI tells you how certain (or confident) you are about the OR you calculated from your data; if the CI includes 1.0, for example, you cannot statistically exclude the possibility that the OR is 1.0, meaning the odds of exposure are the same in the case and control groups.

A cohort study is the reverse of a case-control study – researchers study a population without disease and follow them over time to see if persons with a certain exposure develop disease at a higher rate than unexposed persons. The mathematics of cohort studies are similar to a case-control studies, although the risk estimate is referred to as a relative risk (RR). The RR is equal to rate of disease in the exposed group divided by the rate of disease in the unexposed group, with values greater than 1.0 suggesting that the exposed group has a higher rate of disease.

A RR or OR value is simply a measure of how often a disease and exposure occur together in a particular study population – it does not mean that there is a known or causal relationship. Before any conclusions can be drawn, all studies must be identified and each study must be evaluated to determine the possible role that factors such as chance, bias and/or confounding may have played in the study's results.

- *Chance* refers to a random event, like a coincidence. An association can be observed between an exposure and disease that is simply the result of a chance occurrence. Statistics, such as the CI, are calculated to determine whether chance is a likely explanation for the findings.
- *Bias* refers to any error in the design, conduct, or analysis of a study that results in a distorted estimate of an exposure's effect on the risk of disease. There are many different types of bias; for example, selection bias may occur if the characteristics of cases that participate in a study differ in a meaningful way from the characteristics of those subjects that do not participate (e.g., if cases that live near a power line are more likely to participate because they are concerned about this possible exposure).
- *Confounding* is a situation in which an association is distorted because the exposure being studied is associated with other risk factors for the disease. For example, a link between coffee drinking in mothers and low birth weight babies may be observed in a study. However, some women who drink coffee also smoke cigarettes. When the smoking habits of mothers are taken into account, coffee drinking may not be associated with low birth weight babies because the confounding effect of smoking has been removed.

As part of the weight-of-evidence review process, each study's design and methods are critically evaluated to determine if and how chance, bias, and confounding may have affected the results, and, as a result, the weight that should be placed on the study's findings.

IARC classifications

This section briefly describes the method that the IARC uses following a weight-of-evidence review to classify exposures based on the evidence in support of carcinogenicity. The WHO adopted this method in their 2007 report on ELF-EMF, and other scientific agencies refer to it as well.

First, each research type (epidemiology, *in vivo* and *in vitro*) is evaluated to determine the strength of evidence in support of carcinogenicity (as defined in Figure 4). With regard to epidemiologic studies, *sufficient evidence* is used to describe a body of research where an association is found and chance, bias and confounding can be ruled out with "reasonable confidence." *Limited evidence* is used to describe a body of research where the findings are inconsistent, or where an association is observed but there are outstanding questions about study design or other methodological issues that preclude making strong conclusions. *Inadequate evidence* describes a body of research where it is unclear whether the data is supportive or unsupportive of causation because there is a lack of data or there are major quantitative or qualitative issues. The same overall categories apply for *in vivo* research (see Figure 4). *In vitro* research, although not described in Figure 4, is used to a lesser degree in evaluating carcinogenicity and is classified as strong, moderate or weak.

Agents are then classified into the following categories using the combined categories from epidemiology, *in vivo* and *in vitro* research: carcinogenic to humans, probably carcinogenic to humans, possibly carcinogenic to humans, unclassifiable, and probably not carcinogenic to humans (from highest to lowest risk). For example, the category "possibly carcinogenic to humans" typically denotes exposures for which there is limited evidence of carcinogenicity in epidemiology studies and less than sufficient evidence of carcinogenicity in *in vivo* studies.

The IARC has reviewed over 900 substances and exposure circumstances to evaluate their potential carcinogenicity. For context, Figure 5 provides examples of some of the more common exposures that have been classified in each category. As Figure 5 shows, over 80% of exposures fall in the categories "possible carcinogen" (27%) or "non-classifiable" (55%). This occurs because, as described above, it is nearly impossible to prove that something is completely safe and few exposures show a clear-cut or probable risk, so most agents will end up in either of these two categories. Note that throughout the entire history of the IARC only one agent has been classified in the category "probably not carcinogenic," which illustrates the conservatism of the evaluations and the difficulty in proving the absence of an effect beyond all doubt.

Over half of the agents are *not classifiable* in terms of carcinogenicity, i.e., it is unclear whether they can cause cancer, and hair coloring products, jet fuel and tea are included in this category. *Possible carcinogens* include occupation as a firefighter, coffee, and pickled vegetables, in addition to magnetic fields. Exposures identified as *probable carcinogens* include high temperature frying of food, occupation as a hairdresser, and use of sun beds. Finally, *known carcinogens* include benzene, asbestos, solar radiation and tobacco smoke. As Figure 5 shows, there is much uncertainty about whether certain agents will lead to cancer, and possible and probable carcinogens include substances to which we are commonly exposed or are common exposure circumstances.

	Epidemiology Studies				Animal Studies			
	Sufficient evidence	Limited evidence	Inadequate evidence	Evidence suggesting lack of carcinogenicity	Sufficient evidence	Limited evidence	Inadequate evidence	Evidence suggesting lack of carcinogenicity
Known Carcinogen	✓							
Probable Carcinogen		✓			✓			
Possible Carcinogen		✓				✓	✓	
Not Classifiable			✓			✓	✓	
Probably not a Carcinogen				✓				✓

Sufficient evidence in epidemiology studies—A positive association is observed between the exposure and cancer in studies, in which chance, bias and confounding were ruled out with "reasonable confidence."

Limited evidence in epidemiology studies—A positive association has been observed between the exposure and cancer for which a causal interpretation is considered to be credible, but chance, bias or confounding could not be ruled out with "reasonable confidence."

Inadequate evidence in epidemiology studies—The available studies are of insufficient quality, consistency or statistical power to permit a conclusion regarding the presence or absence of a causal association between exposure and cancer, or no data on cancer in humans are available.

Evidence suggesting a lack of carcinogenicity in epidemiology studies—There are several adequate studies covering the full range of levels of exposure that humans are known to encounter, which are mutually consistent in not showing a positive association between exposure to the agent and any studied cancer at any observed level of exposure. The results from these studies alone or combined should have narrow confidence intervals with an upper limit close to the null value (e.g. a relative risk of 1.0). Bias and confounding should be ruled out with reasonable confidence, and the studies should have an adequate length of follow-up.

Sufficient evidence in animal studies—An increased incidence of malignant neoplasms is observed in (a) two or more species of animals or (b) two or more independent studies in one species carried out at different times or indifferent laboratories or under different protocols. An increased incidence of tumors in both sexes of a single species in a well-conducted study, ideally conducted under Good Laboratory Practices, can also provide sufficient evidence.

Limited evidence in animal studies—The data suggest a carcinogenic effect but are limited for making a definitive evaluation, e.g. (a) the evidence of carcinogenicity is restricted to a single experiment; (b) there are unresolved questions regarding the adequacy of the design, conduct or interpretation of the studies; etc.

Inadequate evidence in animal studies—The studies cannot be interpreted as showing either the presence or absence of a carcinogenic effect because of major qualitative or quantitative limitations, or no data on cancer in experimental animals are available

Evidence suggesting a lack of carcinogenicity in animal studies—Adequate studies involving at least two species are available which show that, within the limits of the tests used, the agent is not carcinogenic.

Figure 4. Basic IARC method for classifying exposures based on potential carcinogenicity

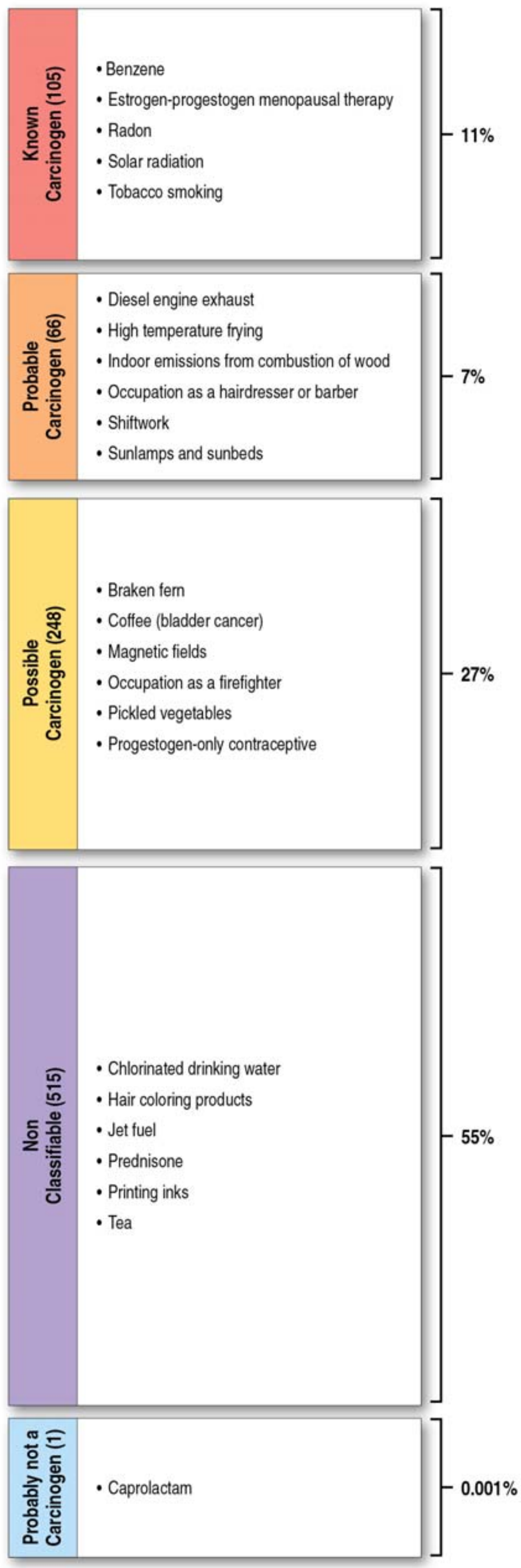

Figure 5. Percentage of substances classified in each IARC category with examples

2 Human Health Research

The following sections describe peer-reviewed research published between January 1, 2006 and March 20, 2009. A literature review was conducted to identify new epidemiologic, *in vivo* and *in vitro* research published on 50 or 60 Hz ELF-EMF. A large number of search strings referencing the exposure and diseases of interest, as well as authors that regularly publish in this area, were included as search terms in a database known as PubMed (http://www.ncbi.nlm.nih.gov/PubMed/).[7] A scientist with experience in this area reviewed the search results to identify relevant studies. This report focuses on the diseases that have received the most attention – cancer, reproductive or developmental effects, and neurodegenerative diseases. Many other health effects have been studied (suicide, depression, electrical hypersensitivity, cardiovascular effects, etc.), but for brevity and because research on these topics evolves slowly, these topics are not summarized here. The WHO report provides a good resource for the status of research on these additional health effects.

This update focuses on identifying and summarizing new epidemiologic and *in vivo* research, since this research is the most informative for risk assessment in this field; for the status of *in vitro* research, we include our discussion from the July 2007 report.

Cancer

Childhood leukemia

What was previously known about childhood leukemia and what did the WHO report conclude?

Scientific panels have concluded consistently that magnetic fields are a "possible carcinogen" largely because of findings from case-control studies of childhood leukemia. Since 1979, approximately 35 studies from the US, Canada, Europe, New Zealand and Asia have evaluated the relationship between childhood leukemia and some proxy of magnetic field exposure,

[7] PubMed is a service of the U.S. National Library of Medicine that includes over 17 million citations from MEDLINE and other life science journals for biomedical articles back to the 1950s. PubMed includes links to full text articles and other related resources.

including: long-term (48 hour) personal monitoring; spot or long-term (24 or 48 hours) measurements in structures and outdoors; calculations using loading, line configuration, and distance of nearby power installations to estimate historical, residential exposure; and wire code categories.[8] As a group of independent studies, they did not show a clear or consistent association between magnetic fields and childhood leukemia. The largest and most methodologically sound case-control studies to directly estimate magnetic field exposure did not report a consistent relationship, for example (Linet et al., 1997; McBride et al., 1999; UKCCS, 2000). When two independent pooled analyses combined the data from these case-control studies, however, an approximate 2-fold statistically significant association was observed between rare average magnetic field exposure above 3-4 mG and childhood leukemia (Ahlbom et al., 2000; Greenland et al., 2000); in other words, children with leukemia were about 2 times more likely to have had estimated magnetic field exposures above 3-4 mG. Average exposures at this level are rare; according to the WHO, results from several extensive surveys showed that approximately 0.5–7% of children had time-averaged exposures in excess of 3 mG and 0.4–3.3% had time-averaged exposures in excess of 4 mG (WHO, 2007a).

The most significant limitation of these studies is their methods for estimating exposure, in that (at best) spot or long-term measurements and calculations post-diagnosis are used to approximate cumulative exposure pre-diagnosis in the absence of any information on the etiologically relevant exposure metric or window. Most studies have used the time-weighted average (TWA) exposure metric, meaning the average of all exposures encountered over the day, but it is possible that other metrics may be more biologically relevant to disease causation, such as the percentage of time above a certain threshold or exposure to peak magnetic fields. Pooled analyses are limited because they combine data that was collected in very different ways. Since the individual epidemiology studies and the pooled analyses are limited in many ways (including the way that they estimate exposure), it is unclear whether this association is causal in nature – i.e., whether exposure to magnetic fields in the range of 3-4 mG has any relationship with the development of childhood leukemia or whether the association is simply a consequence of an error in the study's design. Furthermore, *in vivo* studies do not provide any evidence to suggest that the association is causal in nature: these studies have not indicated any consistent

[8] Wire code categories are categories used to classify the potential magnetic field exposures at residences based on the characteristics of nearby power installations.

increase in cancer in animals when they are exposed to high levels of magnetic fields over the course of their lifetime (see section "*In vivo* studies of carcinogenesis"), and there is no known mechanism by which magnetic fields cause cancer (see section "*In vitro* studies of carcinogenesis").

Since chance, bias and confounding could not be ruled out as an explanation for the association, the IARC concluded in 2002 that the data on childhood leukemia provided limited evidence of carcinogenicity. In 2007, the WHO reviewed studies published since the 2002 IARC review and concluded that the new epidemiologic studies were consistent with the classification of limited epidemiologic evidence in support of carcinogenicity and, together with the largely negative *in vivo* and *in vitro* research, consistent with the classification of magnetic fields as a possible carcinogen (see Figure 4).[9]

Since it is unclear whether the association is real, the WHO report evaluated other factors that might be partially, or fully, responsible for the association, including: chance, control selection bias, confounding from hypothesized or unknown risk factors, and misclassification of magnetic field exposure, as noted below and exemplified in Figure 6. See page 8 for a description of these technical terms.

- ✓ The WHO report concluded that **chance** is an unlikely explanation since the pooled analyses had a larger sample size and decreased variability.

- ✓ **Control selection bias** occurs when the controls that decide to participate in the study do not represent the true exposure experience of the non-diseased population. In the case of magnetic fields, the WHO speculates that controls with a higher socioeconomic status (SES) may participate in studies more than lower SES controls and, since higher SES persons may have lower magnetic field exposures or tend to live farther from transmission lines, the control group's magnetic field exposure may be artificially low. Thus, when the exposure experience of the control group is compared to the case group, it appears that there is a difference between the case and control group. The WHO

[9] The WHO concluded the following: "Consistent epidemiological evidence suggests that chronic low intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted" (p. 355-6, WHO, 2007a).

concluded that **control selection bias** is probably occurring in these studies and would result in an overestimate of the true association, but would not explain the entire observed statistical association

- ✓ The WHO panel concluded that it is less likely that **confounding** is causing the observed association, although the possibility that some yet-to-be identified confounder is responsible for the association cannot be fully excluded. Suggested risk factors that may be confounding the relationship include SES, residential mobility, contact currents, and traffic density.[10]

- ✓ The WHO stated that the possible effects of **exposure misclassification** are the most difficult to predict. EMF presents unique challenges in exposure assessment because it is ubiquitous, imperceptible, and has many sources (Kheifets and Oksuzyan, 2008). No target exposure or exposure window has been identified, and the numerous methods of estimating exposure likely result in a different degree of error within and between studies. Most reviews have concluded that exposure misclassification would likely result in an underestimate of the true association, meaning the association we observe is lower than the true value; however, the extent to which this might occur varies widely and is difficult to assess (Greenland et al., 2000). The WHO concluded that exposure misclassification is likely present in these studies, but is unlikely to provide an entire explanation for the association.

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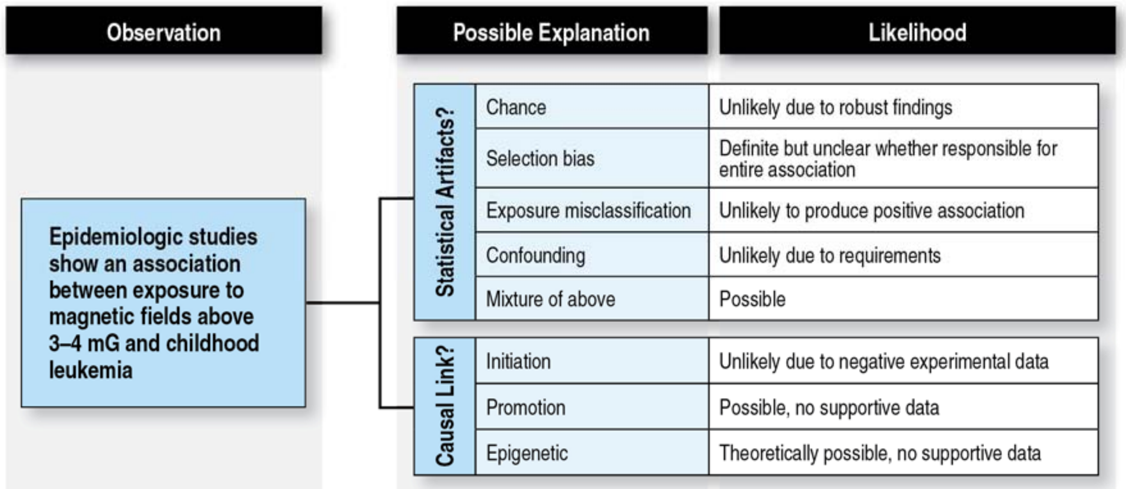
[10] For example, if dwellings near power lines encounter higher traffic density and pollution from traffic density causes childhood leukemia, traffic density may cause an observed association between magnetic field exposure and childhood leukemia.



Source: Adapted from Schüz and Ahlbom (2008)

Figure 6. Possible explanations for the observed association between magnetic fields and childhood leukemia

The WHO stated that reconciling the epidemiologic data on childhood leukemia and the negative (i.e., no hazard or risk observed) experimental findings through innovative research is currently the highest priority in the field of ELF-EMF research. Given that few children are expected to have average magnetic field exposures greater than 3-4 mG, however, the WHO stated that the public health impact of magnetic fields on childhood leukemia would be low if the association was determined to be causal.

What relevant studies have been published since the WHO report?

Several relevant studies published after the WHO review (see Table 1) report statistically significant associations between estimates of magnetic field exposure and childhood leukemia, including reports of an association between childhood leukemia and magnetic field levels greater than approximately 6 mG in children genetically susceptible to leukemia (Mejia-Arangure et al., 2007) and greater than approximately 4 mG in children with poor outcomes following a leukemia diagnosis (Foliart et al., 2006, 2007; Svendsen et al., 2007). There was no consistent exposure-response relationship in these studies, however, and small numbers in the upper exposure categories limit the overall conclusions we can make about these studies.

In a pooled analysis of previously published studies, Schüz et al. (2007) evaluated the hypothesis that nighttime residential magnetic-field exposure may be a more biologically relevant exposure for leukemia risk. The authors observed associations between leukemia and nighttime exposures that were similar to those observed in the original pooled analyses of 24- and 48-hour exposures (Ahlbom et al., 2000), suggesting that nighttime exposure does not reduce exposure misclassification and result in a stronger association.

A relationship between residential distance within 500 meters of a power line and childhood leukemia was reported in a recent study in Iran (Feizi and Arabi, 2007). The validity of this study is limited significantly by its small size, possible selection bias, lack of assessment of possible confounding variables (such as SES and mobility), and reliance upon distance as a proxy for exposure. The WHO noted that distance is a poor proxy of magnetic field exposure[11] and a recent re-analysis of data from two case-control studies in the UK and Germany confirmed this statement. Maslanyj et al. (2009) reported that only 23% of homes in a 200-meter corridor of 220-440 kV lines had a magnetic field level above 2 mG. This finding calls into question the relevance of the associations reported in the large case-control study by Draper et al. in 2005 and in the later study by Feizi and Arabia. The fact that the association is observed at distances greater than where magnetic or electric fields from a transmission line could be measured and there is very little correlation between distance and magnetic field levels argues against magnetic fields as the explanation for the statistical association.

Most childhood leukemias are characterized by a genetic anomaly that can be identified prenatally, but not all children with these anomalies go on to develop childhood leukemia (Buffler et al., 2005). It has been suggested that other postnatal events (e.g., environmental or viral exposures) are necessary for childhood leukemia to occur, although little research has been done in this area. This hypothesis suggests that the association may be concentrated in subgroups of the population that have both the genetic anomaly and some other exposure.

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[11] The WHO concluded the following, with respect to the Draper et al. (2005) findings: “[the] observation of the excess risk so far from the power lines, both noted by the authors and others, is surprising. Furthermore, distance is known to be a very poor predictor of magnetic field exposure, and therefore, results of this material based on calculated magnetic fields, when completed, should be much more informative” (p. 270, WHO 2007a).

The first study to examine a magnetic field-gene interaction in relation to childhood leukemia was published recently in China (Yang et al., 2008). They evaluated residential distance from power lines and the genetic variation of five genes associated with DNA repair in a group of children with childhood leukemia. The authors illustrated that a variation of one gene involved in DNA repair (but not four other genes) was more likely to be measured in children with leukemia living within 100 meters from a power line or transformer, compared to children with leukemia living at a farther distance. The significance of this finding is unknown and, as with all genetic epidemiology studies, the results cannot be deemed reliable until they are replicated. Several major limitations of the study are important to consider: (1) since this study enrolled only cases of childhood leukemia and no control group, the authors do not provide any information about the distribution of this DNA repair variation in children without leukemia and, as a result, no conclusions can be drawn about the relationship of this gene to childhood leukemia risk or etiology, (2) it is unknown what role (if any) DNA repair genes play in the development of childhood leukemia, and (3) distance is a poor proxy for magnetic field exposure. Although a positive association between distance and one specific gene was observed in this study, the results do not provide information to draw any conclusions about gene-magnetic field interactions in the etiology of childhood leukemia at this time. A study that could truly elucidate magnetic field-gene interactions has been proposed in the Danish National Birth Cohort (Greenland and Kheifets, 2009).

Mezei et al. (2008b) assessed the likelihood that control selection bias could be causing the observed association in a previously published study of childhood leukemia in Canada (McBride et al., 1999). This study evaluated whether there were differences between the controls that participated and the controls that did not participate in the 1999 study. The goal of the study was to assess whether the non-participating controls had a higher prevalence of some factor that made them more likely to have a higher magnetic field exposure than the participating controls and, thus, resulted in an under-representation of exposure prevalence in the control group and an overestimation of the risk estimate. The study suggested that control selection bias was operating to some extent, although the authors noted the inherent problems associated with estimating magnetic field exposure and, therefore, concluded, “the role of selection bias cannot entirely be dismissed on the basis of these results alone” (p. 1).

In response to the WHO recommendations to "focus on new aspects of exposure, potential interaction with other factors or on high exposure groups" (p. 17), some recent research has been innovative in the area of childhood leukemia and magnetic field exposure. These recent studies, like some early studies, have observed associations between estimates of high average magnetic field exposure/distance and childhood leukemia, although recent data suggests that control selection bias may play some role in this observed association. None of these recent studies are sufficiently strong methodologically, nor do the findings display causal patterns (exposure-response, consistency and strength) to alter previous conclusions that the epidemiologic evidence on magnetic fields and childhood leukemia is limited. Chance, confounding, and several sources of bias cannot be ruled out. The lack of evidence from recent *in vivo* research supports this conclusion (see section "*In vivo* studies of carcinogenicity" below).

This conclusion is supported by recent reviews (Kheifets and Oksuzyan, 2008; Schüz and Ahlbom, 2008) and the recent conclusions of scientific organizations (SSI, 2007; SSI, 2008; HCN, 2009; SCENIHR, 2009).

Do researchers investigating childhood leukemia consider magnetic fields a very important area of research?

Researchers will continue to investigate the magnetic field-childhood leukemia association. Magnetic fields, however, are just one area of study in the large body of research on the possible causes of childhood leukemia. There are many other hypotheses that are under investigation that point to possible genetic, environmental, and infectious explanations for childhood leukemia. There are other hypotheses with similar or stronger support in epidemiology studies; magnetic fields are one among many research priorities in the field of childhood leukemia (Ries et al., 1999; McNally and Parker, 2006; Belson et al., 2007; Rossig and Juergens, 2008).

Table 1. Relevant studies of childhood leukemia published after WHO report

Authors	Year	Study
Feizi and Arabi	2007	Acute childhood leukemias and exposure to magnetic fields generated by high voltage overhead power lines – a risk factor in Iran
Foliart, et al.	2006	Magnetic field exposure and long-term survival among children with leukaemia.
Foliart, et al.	2007	Magnetic field exposure and prognostic factors in childhood leukemia.
Maslanyj, et al.	2009	Power frequency magnetic fields and risk of childhood leukaemia: Misclassification of exposure from the use of the distance from power line' exposure surrogate.
Mejia-Arangure, et al.	2007	Magnetic fields and acute leukemia in children with Down Syndrome.
Mezei, et al.	2008b	Assessment of selection bias in the Canadian case-control study of residential magnetic field exposure and childhood leukemia.
Svendsen, et al.	2007	Exposure to magnetic fields and survival after diagnosis of childhood leukemia: a German cohort study.
Schüz, et al.	2007	Nighttime exposure to electromagnetic fields and childhood leukemia: an extended pooled analysis.
Yang, et al.	2008	Case-only of interactions between DNA repair genes (hMLH1, APEX1, MGMT, XRCC1 and XPD) and low-frequency electromagnetic fields in childhood acute leukemia

Childhood brain cancer

What was previously known about childhood brain cancer and what did the WHO report conclude?

The research related to magnetic fields and childhood brain cancer has been less consistent than that observed for childhood leukemia. The WHO report recommended the following:

> As with childhood leukaemia, a pooled analysis of childhood brain cancer studies should be very informative and is therefore recommended. A pooled analysis of this kind can inexpensively provide a greater and improved insight into the existing data, including the possibility of selection bias and, if the studies are sufficiently homogeneous, can offer the best estimate of risk (p. 18, WHO 2007a).

What relevant studies have been published since the WHO report?

The two relevant studies of childhood brain cancer and magnetic field exposure are listed in Table 2 below. In response to the WHO recommendation, Mezei et al. (2008a) performed a meta-analysis of studies on childhood brain tumors and residential magnetic field exposure. Thirteen epidemiologic studies were identified that used various proxies of magnetic field exposure (distance, wire codes, calculated magnetic fields, and measured magnetic fields). For all of the exposure proxies considered, the combined effect estimate was close to 1.0 and not statistically significant, indicating no association between magnetic field exposure and childhood brain tumors. A sub-group of five studies, however, with information on childhood brain tumors and calculated or measured magnetic fields greater than 3-4 mG reported a combined OR that was elevated but not statistically significant (OR=1.68, 95% CI=0.83-3.43). The authors suggested two explanations for this elevated OR. First, they stated that an increased risk of childhood brain tumors could not be excluded at high exposure levels (i.e., >3-4 mG). Second, they stated that the similarity of this result to the findings of the pooled analyses of childhood leukemia suggests that control selection bias is operating in both analyses. Overall, the authors concluded that the analysis did not find a significant increase in childhood brain cancer risk using various proxies of residential exposure to magnetic fields.

Studies of parental occupational magnetic field exposure and childhood brain tumors have been inconsistent. In a pooled analysis of two Canadian case-control studies, Li et al. (2009) calculated individual maternal occupational magnetic field exposure pre- and post-conception and analyzed these estimates in relation to brain cancer in their offspring. The study provided some indication of an association with all brain cancer and average maternal occupational magnetic field exposure and confirmed a previously observed association with the occupation of seamstress. More research is required to understand if magnetic fields during or before pregnancy are related to the development of childhood brain cancer.

These two studies do not change the classification of the epidemiologic evidence as inadequate in relation to childhood brain cancer. Although the meta-analysis of brain cancer observed an association, it could not be distinguished from a chance finding.

Table 2. Relevant studies of childhood brain cancer published after WHO report

Authors	Year	Study
Li, et al.	2009	Maternal occupational exposure to extremely low frequency magnetic fields and the risk of brain cancer in the offspring.
Mezei et al.	2008a	Residential magnetic field exposure and childhood brain cancer: a meta-analysis.

Breast cancer

What was previously known about breast cancer and what did the WHO report conclude?

The WHO reviewed studies of breast cancer and residential magnetic field exposure, electric blanket usage, and occupational magnetic field exposure. These studies did not report consistent associations between magnetic field exposure and breast cancer, and the WHO concluded that, since the recent body of research was higher in quality compared with previous studies, it provided strong support to previous consensus statements that magnetic field exposure does not influence the risk of breast cancer.[12]

Breast cancer received particular attention because researchers hypothesized that it could be related to magnetic field exposure through a pathway involving the hormone melatonin. While this hypothesis was novel, it did not receive consistent or strong support from epidemiology or experimental studies. While research will continue in this area, scientific reviews have been strong in their conclusion that the part of this hypothesis linking magnetic fields to breast cancer is unlikely (NRPB, 2006; WHO, 2007a).

The WHO recommended no further research with respect to breast cancer and magnetic field exposure.

What relevant studies have been published since the WHO report?

Two case-control studies have recently been published, both of which qualitatively estimated occupational magnetic field exposure among breast cancer cases and compared it to controls.[13] Ray et al. (2007) was a nested case-control study in a cohort of approximately 250,000 textile workers in China followed for breast cancer incidence, and McElroy et al. (2007) evaluated occupational exposures to high, low, medium, or background EMF levels in a large number of breast cancer cases and controls. Neither study observed a significant association between breast cancer and higher estimated magnetic field exposure. A large cohort study of utility workers in Denmark also recently reported that women exposed to higher occupational magnetic field levels did not have higher rates of breast cancer (Johansen et al., 2007).

[12] The WHO concluded, "Subsequent to the IARC monograph a number of reports have been published concerning the risk of female breast cancer in adults associated with ELF magnetic field exposure. These studies are larger than the previous ones and less susceptible to bias, and overall are negative. With these studies, the evidence for an association between ELF exposure and the risk of breast cancer is weakened considerably and does not support an association of this kind" (p. 307, WHO 2007a).

[13] Peplonska et al. (2007) is a case-control study of female breast cancer reporting associations for a wide range of occupations and industries. It is not considered in depth in this report because no qualitative or quantitative estimates of magnetic field exposure were made, beyond occupation and industry titles.

These studies, particularly the large cohort of utility workers, add to growing support against a role for magnetic fields in breast cancer. This is consistent with the recent conclusion by the SCENIHR, which stated that the association is "unlikely" (p. 7, SCENIHR 2007).

Table 3. Relevant studies of breast cancer published after WHO report

Authors	Year	Study
Johansen, et al.	2007	Risk for leukaemia and brain and breast cancer among Danish utility workers: A second follow-up.
McElroy, et al.	2007	Occupational exposure to electromagnetic field and breast cancer risk in a large, population-based, case-control study in the United States.
Ray, et al.	2007	Occupational exposures and breast cancer among women textile workers in Shanghai.

Other adult cancers

What was previously known about other adult cancers and what did the WHO report conclude?

In general, scientific panels have concluded that there is not a strong or consistent relationship between other adult cancers (leukemia, lymphoma, or brain cancers) and exposure to magnetic fields; however, the possibility cannot be entirely ruled out because the findings have been inconsistent (IARC, 2002; WHO 2007a). The fact that stronger findings have not been observed in studies with better exposure assessment methods has led the scientific panels to conclude that the evidence for an association is weak and the observed inconsistency is probably due to chance or bias. The IARC classified the epidemiologic data with regard to adult leukemia, lymphoma and brain cancer as "inadequate" in 2002, and the WHO confirmed this classification in 2007, with the remaining uncertainty attributed mainly to limitations in exposure assessment methods.

Much of the research on EMF and adult cancers is related to occupational exposures, given the higher range of exposures encountered in the occupational environment. The main limitation of these studies, however, has been the methods used to assess exposure, with early studies relying simply on a person's occupational title (often taken from a death certificate) and later studies linking a person's full or partial occupational history to representative average exposures for each occupation (i.e., a job exposure matrix). The latter method, while advanced, still has some important limitations, as highlighted recently in a review summarizing an expert panel's findings by Kheifets et al. (2009).[14] While a person's occupation may provide some indication of the overall magnitude of their occupational magnetic field exposure, it does not take into account the possible variation in exposure due to different job tasks within occupational titles, the frequency and intensity of contact to relevant exposure sources, or variation by calendar time. Furthermore, since scientists do not know any mechanism by which magnetic fields could lead to cancer, an appropriate exposure metric is unknown.

Therefore, in order to reduce the remaining uncertainty about whether there is an association between magnetic fields and these cancers, researchers have recommended (1) meta-analyses to clarify the inconsistency of the data and (2) better exposure assessment methods that incorporate a greater level of detail on tasks and exposure characteristics such as spark discharge, contact current, harmonics, etc. (WHO, 2007a; Kheifets et al., 2009).

Adult brain cancer

What was previously known about adult brain cancer and what did the WHO report conclude?

As described above, the WHO classified the epidemiologic data on adult brain cancer as inadequate[15] and recommended (1) updating the existing cohorts of occupationally-exposed individuals in Europe and (2) pooling the epidemiologic data on brain cancer and adult leukemia to confirm the absence of an association.

What relevant studies have been published since the WHO report?

Epidemiologic studies published after 2006 on adult brain cancer and EMF exposure are listed in Table 6 and include two case-control studies, two cohort studies, and a meta-analysis, all of which are related to occupational magnetic field exposure.

In response to the WHO recommendation, two cohorts of approximately 20,000 occupationally-exposed persons each were updated: a cohort of utility workers in Denmark and a cohort of

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[14] Kheifets et al. (2009) reports on the conclusions of an independent panel organized by the Energy Networks Association in the UK in 2006 to review the current status of the science on occupational EMF exposure and identify the highest priority research needs.

[15] The WHO concluded, "In the case of adult brain cancer and leukaemia, the new studies published after the IARC monograph do not change the conclusion that the overall evidence for an association between ELF [EMF] and the risk of these disease remains inadequate" (p. 307, WHO 2007a).

railway workers in Switzerland (Johansen et al., 2007; Röösli et al, 2007a). In both cohorts, brain cancer rates were similar between jobs with high magnetic field exposure and jobs with lower exposures. A case-control study of gliomas was conducted in Australia and reported no associations with higher estimated magnetic field exposure, using a standard job-exposure matrix (Karipidis et al., 2007a). Forssén et al. (2006) performed a large registry-based case-control study of acoustic neuroma and reported no association between higher occupational magnetic field exposures and this benign and rare brain cancer type. Another large case-control study was recently published of gliomas and meningiomas in the United States (Coble et al., 2009). For the first time, the exposure metric in this study incorporated the frequency of exposure to EMF sources, as well as the distance people worked from these sources, on an individual basis. The authors also evaluated exposure metrics aside from TWA exposure (maximum exposed job, total years of exposure above 1.5 mG, cumulative lifetime exposure, and average lifetime exposure). No association was reported between any of these exposure metrics and brain cancer.

As recommended in the WHO report, a meta-analysis of occupationally exposed cohorts was performed by Khefeits et al. (2008). All relevant publications of occupational EMF exposure and adult leukemia or brain cancer were collected and summary risk estimates were calculated using various schemes to weight and categorize the study data. The authors reported a small and statistically significant increase of leukemia and brain cancer in relation to the highest estimate of magnetic field exposure in the individual studies. Several findings, however, led the authors to conclude that magnetic field exposure is not responsible for the observed associations with leukemia and brain cancer, including the lack of a consistent pattern among leukemia subtypes when the past and new meta-analyses were compared. In addition, for brain cancer, the recent meta-analysis reported a weaker estimated association than the previous meta-analysis, whereas a stronger association would be expected since the quality of studies has increased over time. The authors concluded, "the lack of a clear pattern of EMF exposure and outcome risk does not support a hypothesis that these exposures are responsible for the observed excess risk" (p. 677).

Recent studies have reduced possible exposure misclassification by improving exposure assessment methods (i.e., the expanded job-exposure matrix in Coble et al., 2009) and attempted to clarify inconsistencies by updating studies and meta-analyzing data (Johansen et al., 2007; Röösli et al., 2007a; Kheifets et al., 2008); however, despite these advancements, no association has been observed. While an association still cannot be *entirely* ruled out because of the remaining deficiencies in exposure assessment methods, the current database of studies provides weak evidence of an association between magnetic fields and brain cancer.[16] The lack of evidence from *in vivo* research supports this conclusion (see section "*In vivo* studies of carcinogenicity" below). The recent report by the SCENIHR described the data on brain cancers as "uncertain" (p. 43, SCENIHR 2009).

Table 4. Relevant studies of adult brain cancer published after WHO report

Authors	Year	Study
Coble et al.	2009	Occupational exposure to magnetic fields and the risk of brain tumors.
Forssén et al.	2006	Occupational magnetic field exposure and the risk of acoustic neuroma.
Johansen et al.	2007	Risk for leukaemia and brain and breast cancer among Danish utility workers: A second follow-up.
Karipidis et al.	2007a	Occupational exposure to low frequency magnetic fields and the risk of low grade and high grade glioma.
Kheifets et al.	2008	Occupational electromagnetic fields and leukemia and brain cancer: An update to two meta-analyses.
Röösli et al.	2007a	Leukaemia, brain tumours and exposure to extremely low frequency magnetic fields: cohort study of Swiss railway employees.

Adult leukemia and lymphoma

What was previously known about adult leukemia/lymphoma and what did the WHO report conclude?

The same issues discussed above with regard to adult brain cancer are relevant to research on adult leukemia/lymphoma. The WHO classified the epidemiologic evidence as "inadequate" and recommended updating the existing occupationally exposed cohorts in Europe and the meta-analysis on occupational magnetic field exposure[17] (p. 307, WHO 2007a).

What relevant studies have been published since the WHO report?

Two cohorts of occupationally exposed workers and a meta-analysis of occupational magnetic field exposure (all of which were described above) reported on the possible association of

[16] A recent consensus statement by the National Cancer Institute's Brain Tumor Epidemiology Consortium confirms this statement. They classified residential power frequency EMF in the category "probably not risk factors" and described the epidemiologic data as "unresolved" (p. 1958, Bondy et al., 2008).

[17] No specific conclusions were provided by the WHO with regard to lymphoma.

occupational magnetic field exposure and adult leukemia. Also, a case-control study described patterns of estimated residential magnetic field exposure and combined lymphoma and leukemia diagnostic categories.

In the occupational cohort of Swiss railway workers, the authors noted a stronger association among occupations with higher estimates of magnetic field exposures, but the associations were not statistically significant (Röösli et al, 2007a). In the study of Danish utility workers, no increases in leukemia rates were observed in job titles that involved higher exposures to magnetic fields (Johansen et al., 2007). As described above, the updated meta-analysis by Kheifets et al. (2008) reported a weak association between estimated occupational magnetic field exposure and leukemia, but the authors felt that the data was not indicative of a true association.

Lowenthal et al. (2007) grouped cases in five diagnostic categories as lymphoproliferative disorders (LPD) (including acute lymphoblastic leukemia [ALL]) and cases in three diagnostic categories (including acute myeloid leukemia [AML] and other leukemias) as myeloproliferative disorders (MPD). These groups included both adults and children of all ages. The authors estimated exposure by obtaining a lifetime residential history and assessing distance of residences from 88-kV, 110-kV, and 220-kV power lines. They reported elevated, but not statistically significant, ORs for those who lived within 50 meters of any of these power lines, and an indication of decreasing ORs with increasing distance. This study adds very little to the existing database of information on adult leukemia and residential exposure, however, because of fundamental limitations. For example, different cancer types were combined and for different ages of diagnosis. It is well known that cancer etiology varies by cancer type, cancer subtype and diagnostic age.

Very little is known about the etiology of Non-Hodgkin lymphoma (NHL) in general and few studies have been conducted in relation to magnetic field exposure. In one of the first studies to estimate cumulative occupational magnetic field exposure among NHL cases, Karipidis et al. (2007b) reported a statistically significant association between NHL and the highest category of exposure (OR=1.59, 95% CI=1.07-2.36). Overall, the study was well conducted, with its most significant limitation being the possibility of uncontrolled confounding. Since this is one of the first studies on NHL and magnetic field exposure, further research is required. Of note, the cohort of railway workers in Switzerland did not report an increase in NHL deaths among the more highly exposed workers (Röösli et al, 2007a).

The recent literature also includes a novel study examining whether there are differences in the activity of the natural killer (NK) cell, which is known to control cancer development, among persons occupationally exposed to magnetic fields (Gobba et al., 2008). Higher measured magnetic field levels during three complete work shifts (i.e., > 10 mG) were associated with reduced NK activity. This is suggests a cancer-causing mechanism, but future studies are required to replicate this finding and understand the significance of NK activity in cancer causation.

Recent studies of adult leukemia have attempted to clarify inconsistencies by updating studies and meta-analyzing data (Johansen et al., 2007; Kheifets et al., 2008; Röösli et al, 2007a); however, despite these advancements, no clear or statistically significant association has been observed. While an association still cannot be *entirely* ruled out because of the remaining deficiencies in exposure assessment methods, the current database of studies provides weak evidence of an association between magnetic fields and leukemia. The lack of evidence from *in vivo* research (see section "*In vivo* studies of carcinogenicity" below) supports this conclusion. Preliminary results related to NHL have been published and require further investigation, although *in vivo* research does not suggest a relationship between lymphoma and magnetic fields.

Table 5. Relevant studies of adult leukemia/lymphoma published after WHO report

Authors	Year	Study
Gobba et al.	2008	Extremely low frequency-magnetic fields (ELF-EMF) occupational exposure and natural killer activity in peripheral blood lymphocytes.
Johansen et al.	2007	Risk for leukaemia and brain and breast cancer among Danish utility workers: A second follow-up.
Karipidis et al.	2007b	Occupational exposure to power frequency magnetic fields and risk of non-Hodgkin lymphoma
Lowenthal et al.	2007	Residential exposure to electric power transmission lines and risk of lymphoproliferative and myeloproliferative disorders: a case-control study.
Röösli et al.	2007a	Leukaemia, brain tumours and exposure to extremely low frequency magnetic fields: cohort study of Swiss railway employees.

In vivo studies of carcinogenesis

What was previously known about *in vivo* studies of carcinogenesis and what did the WHO report conclude?

It is standard procedure to conduct studies on laboratory animals to determine whether exposure to a specific agent leads to the development of cancer (USEPA, 2005). This approach is used because all known human carcinogens cause cancer in laboratory animals. In the field of ELF-EMF research, a number of research laboratories have exposed rodents, including those with a particular genetic susceptibility to cancer, to high levels of magnetic fields over the course of their lifetime and performed tissue evaluations to assess the incidence of cancer in many organs. In these studies, magnetic field exposure has been administered alone (to test for the ability of magnetic fields to act as a complete carcinogen), in combination with a known carcinogen (to test for a promotional or co-carcinogenetic effect), or in combination with a known carcinogen and a known promoter (to test for a co-promotional effect).

The WHO described four large-scale, long-term studies of rodents exposed to magnetic fields over the course of their lifetime that did not report increases in any type of cancer (Mandeville et al., 1997; Yasui et al., 1997; Boorman et al., 1999a, b; McCormick et al., 1999). No directly relevant animal model for childhood ALL existed at the time of the WHO report. Some animals, however, develop a type of lymphoma similar to childhood ALL and studies exposing transgenic mice predisposed to this lymphoma to ELF magnetic fields did not report an increased incidence of lymphoma (Harris et al., 1998; McCormick et al., 1998; Sommer and Lerchel, 2004).

Studies investigating whether exposure to magnetic fields can promote cancer or act as a co-carcinogen used known cancer-causing agents, such as ionizing radiation, UV radiation or other chemicals. No effects were observed for studies on chemically-induced preneoplastic liver lesions, leukemia/lymphoma, skin tumors, or brain tumors; however, the incidence of 7,12-dimethylbenz[a]anthracene (DMBA)-induced mammary tumors was increased with magnetic field exposure in a series of experiments in Germany (Löscher et al., 1993, 1994, 1997; Baum et al., 1995; Löscher and Mevissen, 1995; Mevissen et al., 1993a,b, 1996a,b, 1998), suggesting that magnetic field exposure increased the proliferation of mammary tumor cells. These results were not replicated in subsequent series of experiments in a US laboratory (Anderson et al., 1999; Boorman et al.1999a,b; NTP, 1999), possibly due to differences in experimental protocol and the species strain. In Fedrowitz et al. (2004), exposure enhanced mammary tumor development in one sub-strain (Fischer 344 rats), but not in another sub-strain that was obtained from the same breeder, which argues against a promotional effect of magnetic fields.[18]

Some studies have reported an increase in genotoxic effects among exposed animals (e.g., DNA strand breaks in the brains of mice [Lai and Singh, 2004]), although the results have not been replicated.

In summary, the WHO concluded the following with respect to *in vivo* research: "There is no evidence that ELF exposure alone causes tumours. The evidence that ELF field exposure can enhance tumour development in combination with carcinogens is inadequate" (p. 322, WHO 2007a). Recommendations for future research included the development of a rodent model for childhood ALL and the continued investigation of whether magnetic fields can act as a promoter or co-carcinogen.

What relevant studies have been published since the WHO report?

Pursuant to the WHO recommendation and in view of the available evidence that exposure to magnetic fields *alone* does not increase the occurrence of cancer, the literature published following the WHO report includes numerous *in vivo* studies testing different hypotheses of cancer promotion, including effects on brain cancer (Chung et al., 2008), breast cancer (Fedrowitz and Löscher, 2008), and lymphoma/leukemia (Bernard et al., 2008; Negishi et al., 2008), as referenced below. In each of these studies, the animals were treated first with chemicals known to initiate the cancer process in cells. Initiated animals are more likely to develop cancer, and a subsequent exposure, known as a promoter, is often needed for an initiated cell to reproduce into many cancer cells. Recent studies first treated the animals with the initiators ethylnitrosourea (ENU) (Chung et al., 2008), n-butylnitrosourea (BNU) (Bernard et al., 2008), or DMBA (Fedrowitz and Löscher, 2008; Negishi et al., 2008). An additional

[18] The WHO concluded with respect to the German studies of mammary carcinogenesis, "Inconsistent results were obtained that may be due in whole or in part to differences in experimental protocols, such as the use of specific substrains" (p. 321, WHO 2007a).

study by Sommer and Lerchel (2006) tested whether magnetic fields alone increased the incidence of lymphoma in mice virally predisposed to lymphoblastic lymphoma.

Chung et al. (2008) examined the possible role of 60 Hz magnetic fields in promoting brain tumors initiated by ENU injections *in utero*; the authors concluded that there was no evidence from this study that 60 Hz magnetic field exposures up to 5,000 mG promoted tumor development.

Fedrowitz and Löscher (2008) is the most recent study from the German laboratory that previously reported increases in DMBA-induced mammary tumors with high magnetic field exposure. In this recent study, the researchers exposed DMBA-treated Fischer 344 rats (the strain of inbred rats used in previous experiments) to either high levels of magnetic fields (1,000 mG) or no exposure for 26 weeks and reported that the incidence of mammary tumors was significantly elevated in the group exposed to magnetic fields (Fedrowitz and Löscher, 2008). No independent replication of this experiment has yet occurred and questions still remain about the effect of experimental protocol and species strain.

Sommer and Lerchl (2006) is a follow-up to an earlier study (Sommer and Lerchl, 2004) that reported no increases in lymphoma among predisposed animals chronically exposed to magnetic fields (up to 1,000 mG for 24 hours per day for 32 weeks). Sommer and Lerchl (2006) increased magnetic field exposure to 10,000 mG and exposed some of the animals only during the night to test the hypothesis that nighttime exposure may have a stronger effect than continuous exposure. Magnetic fields did not influence body weight, time to tumor, cancer incidence, or survival time in this study. In another study of lymphatic system cancers, researchers treated newborn mice with DMBA and magnetic fields up to 3,500 mG (Negishi et al., 2008). The authors reported that the percentage of mice with lymphoma/lymphatic leukemia was not higher in magnetic field-exposed groups, compared to the sham-exposed group.

A recent study by Bernard et al. (2008) provides a significant development, in that it is the first study to use an animal model of ALL, the leukemia type that has been associated with high magnetic field exposure in children. All rats were exposed to BNU to initiate the leukemogenic process, and a sub-group of rats was exposed to 1,000 mG 18 hours per day for 52 weeks. No difference in leukemia incidence was observed between the BNU-treated group exposed to magnetic fields and the BNU-treated unexposed group. This study supports the hypothesis that magnetic fields do not affect the development of ALL and provides additional support to the conclusion that experimental data is not supportive for a role of magnetic fields in the incidence of childhood leukemia. The researchers followed guidelines for the experimentation and care of laboratory animals and conducted the analyses blind to the treatment group. Experience with this strain of rat is limited, however, so it is unclear whether the results are more or less reliable than other animal models; replication is required.

Thus, aside from the most recent replication of enhanced mammary carcinogenesis in a specific sub-strain of rats in a German laboratory, recent studies provide further evidence against a role for magnetic fields as a co-carcinogen (i.e., agents that enhance the effect of known carcinogens). These studies strengthen the conclusion that there is inadequate evidence of carcinogenicity from *in vivo* research, although independent confirmation of the German results is of high priority.

Table 6. Relevant *in vivo* studies of carcinogenesis published after WHO report

Authors	Year	Study
Bernard et al.	2008	Assessing the potential Leukemogenic effects of 50 Hz and their harmonics using an animal leukemia model.
Chung et al.	2008	Lack of a co-promotion effect of 60 Hz rotating magnetic fields on n-ethyl-n-nitrosourea induced neurogenic tumors in F344 rats.
Fedrowitz and Löscher	2008	Exposure of Fischer 344 rats to a weak power frequency magnetic field facilitates mammary tumorigenesis in the DMBA model of breast cancer.
Negishi et al.	2008	Lack of promotion effects of 50 Hz magnetic fields on 7,12-dimethylbenz(a)anthracene-induced malignant lymphoma/lymphatic leukemia in mice
Sommer and Lerchl	2006	50 Hz magnetic fields of 1 mT do not promote lymphoma development in AKR/J mice.

In vitro studies of carcinogenesis

What did the WHO and other scientific panels conclude with respect to *in vitro* studies of carcinogenesis?

In vitro studies are widely used to investigate the mechanisms for effects that are observed in humans and animals. The relative value of *in vitro* tests to human health risk assessment, however, is much less than that of *in vivo* and epidemiology studies. Responses of cells and tissues outside the body may not always reflect the response of those same cells if maintained in a living system, so the relevance of *in vitro* studies cannot be assumed (IARC, 1992).

The IARC and other scientific review panels that systematically evaluated *in vitro* studies concluded that there is no clear evidence indicating how ELF magnetic fields could adversely affect biological processes in cells (IARC, 2002; ICNIRP, 2003; NRPB, 2004). The WHO panel reviewed the *in vitro* research published since the time of these reviews and reached the same conclusion. The WHO noted that previous studies have not indicated a genotoxic effect of ELF magnetic fields on mammalian cells, however a recent series of experiments reported DNA damage in human fibroblasts exposed intermittently to 50 Hz magnetic fields (Ivancsits et al., 2002a,b; Ivancsits et al., 2003a,b). These findings have not been replicated by other laboratories (Scarfi et al., 2005), and the WHO recommended continued research in this area. Recently, investigators reported that they were unable to confirm any evidence for damage to DNA in cells exposed to magnetic fields over a range of exposures from 50 to 10,000 mG (Burdak-Rothkamm et al., 2009). Research in the field of *in vitro* genotoxicity of magnetic fields combined with known DNA-damaging agents is also recommended, following suggestive findings from several laboratories. As noted by the SSI, however, the levels at which these effects were observed are much higher than the levels we are exposed to in our everyday environments and are, therefore, not directly relevant to questions about low-level, chronic exposures (SSI, 2007). *In vitro* studies investigating other possible mechanisms, including gene activation, cell proliferation, apoptosis, calcium signaling, intercellular communication, heat shock protein expression and malignant transformation, have produced “inconsistent and inconclusive” results, according to the WHO (p. 347, WHO, 2007a).

Reproductive and developmental effects

What was previously known about reproductive and developmental effects and what did the WHO report conclude?

Two studies received considerable attention because of a reported association between peak magnetic field exposure greater than approximately 16 mG and miscarriage: a prospective cohort study of women in early pregnancy (Li et al., 2002) and a nested case-control study of women who miscarried compared to their late-pregnancy counterparts (Lee et al., 2002).

These two studies improved on the existing body of literature because average exposure was assessed using 24-hour personal magnetic field measurements (early studies on miscarriage were limited because they used surrogate measures of exposure, including visual display terminal use, electric blanket use or wire code data). Following the publication of these two studies, however, a hypothesis was put forth that the observed association may be the result of behavioral differences between women with "healthy" pregnancies that went to term (less physically active) and women who miscarried (more physically active) (Savitz, 2002). It was proposed that physical activity is associated with an increased opportunity for peak magnetic field exposures, and the nausea experienced in early, healthy pregnancies and the cumbersomeness of late, healthy pregnancies would reduce physical activity levels, thereby decreasing the opportunity for exposure to peak magnetic fields. Furthermore, nearly half of the miscarriages reported in the cohort by Li et al. had magnetic field measurements taken after miscarriage occurred, when changes in physical activity may have already occurred, and all measurements in Lee et al. occurred post-miscarriage.

The scientific panels that have considered these two studies concluded that the possibility of this bias precludes making any conclusions about the effect of magnetic fields on miscarriage (NRPB, 2004; FPTRPC, 2005; WHO, 2007a). The WHO concluded, "There is some evidence for increased risk of miscarriage associated with measured maternal magnetic field exposure, but this evidence is inadequate" (p. 254, WHO 2007a). The WHO stated that, given the potentially high public health impact of such an association, further epidemiologic research is recommended.

What relevant studies have been published since the WHO report?

No new original studies on magnetic field exposure and miscarriage have been conducted; however, recent methodological studies evaluated the likelihood that the observed association was due to the proposed bias.

It is not possible to directly "test" for the effects of this bias in the original studies, but two recent analyses examined whether reduced physical activity was associated with a lower probability of encountering peak magnetic fields (Mezei et al., 2006; Savitz et al., 2006). In a seven-day study of personal magnetic field measurements in 100 pregnant women, Savitz et al. reported that active pregnant women were more likely to encounter peak magnetic fields. In addition, an analysis by Mezei et al. of pre-existing databases of magnetic field measurements among pregnant and non-pregnant women found that increased activity levels were associated with peak magnetic fields (Mezei et al., 2006). These findings are broadly supportive of the hypothesis that reduced activity among women in early pregnancies because of nausea and in later pregnancies because of cumbersomeness may explain the observed association between peak magnetic fields and miscarriage. As noted in a recent commentary on this issue, however, the possibility that there is a relationship between peak magnetic field exposure and miscarriage still cannot be excluded and further research that accounts for this possible bias should be conducted (Neutra and Li, 2008; Mezei et al., 2006). There remains no biological basis to indicate that magnetic field exposure increases the risk of miscarriage (WHO, 2007a).

An additional study was recently published related to developmental outcomes. Fadel et al. (2006) conducted a cross-sectional study in Egypt of 390 children 0-12 years of age living in an area within 50 meters of an electrical power line and 390 children 0-12 years of age living in a region with no power lines in close proximity. Measurements were taken as proxies of growth retardation, and radiological assessments were performed on carpal bones. The authors reported that children living in the region near power lines had a statistically significant lower weight at birth and a reduced head and chest circumference and height at all ages. The authors concluded that "exposure to low frequency electromagnetic fields emerged [*sic*] from high voltage electric power lines increases the incidence of growth retardation among children" (p. 211). However, this conclusion fails to adequately take into account the many limitations of their cross-sectional analysis (namely, inadequate control for the possible confounding effects of nutritional and SES status) and the pre-existing body of literature, which does not support such an association (WHO, 2007a).

The recent research does not provide sufficient evidence to alter the conclusion that the evidence for developmental or reproductive effects is inadequate. Recent studies of animals *in vivo* also do not provide evidence to change the conclusions expressed by the WHO (Al-Akhras et al., 2006; Anselmo et al., 2006; Okundan et al., 2006; Kim et al., 2009).

Table 7. Relevant studies of reproductive and developmental effects published after WHO report

Authors	Year	Study
Al-Akhras et al.	2006	Influence of 50 Hz magnetic field on sex hormones and other fertility parameters of adult male rats.
Anselmo et al.	2006	Influence of a 60 Hz, 3 microT, electromagnetic field on the reflex maturation of Wistar rats offspring from mothers fed a regional basic diet during pregnancy.
Fadel et al.	2006	Growth assessment of children exposed to low frequency electromagnetic fields at the Abu Sultan area in Ismailia (Egypt).
Kim et al.	2009	Effects of 60 Hz 14 µT magnetic field on the apoptosis of testicular germ cell in mice.
Mezei et al.	2006	Analyses of magnetic-field peak-exposure summary measures.
Okundan et al.	2006	DEXA analysis on the bones of rats exposed in utero and neonatally to static and 50 Hz electric fields.
Savitz et al.	2006	Physical activity and magnetic field exposure in pregnancy.

Neurodegenerative disease

What was previously known about neurodegenerative disease and what did the WHO report conclude?

Research into the possible effect of magnetic fields on the development of neurodegenerative diseases began in 1995, and the majority of research since then has focused on Alzheimer's disease and a specific type of motor neuron disease called amyotrophic lateral sclerosis (ALS), which is also known as Lou Gehrig's disease. The inconsistency of the Alzheimer's disease studies prompted the NRPB to conclude that there is "only weak evidence to suggest that it [ELF magnetic fields] could cause Alzheimer's disease" (p. 20, NRPB, 2001). Early studies on ALS, which had no obvious biases and were well conducted, reported an association between ALS mortality and estimated occupational magnetic field exposure. The review panels, however, were hesitant to conclude that the associations provided strong support for a causal relationship. Rather, they felt that an alternative explanation (i.e., electric shocks received at work) may be the source of the observed association.

The majority of the more recent studies discussed by the WHO reported statistically significant associations between occupational magnetic field exposure and mortality from Alzheimer's disease and ALS, although the design and methods of these studies were relatively weak (e.g., disease status was based on death certificate data, exposure was based on incomplete occupational information from census data, and there was no control for confounding factors).

Furthermore, there was no biological data to support an association between magnetic fields and neurodegenerative diseases. The WHO panel concluded that there is "inadequate" data in support of an association between magnetic fields and Alzheimer's disease or ALS.[19] The panel recommended more research in this area using better methods; in particular, studies that enrolled incident Alzheimer's disease cases (rather than ascertaining cases from death certificates) and studies that estimated electrical shock history in ALS cases were recommended.

What relevant studies have been published since the WHO report?

Numerous studies have been published since the WHO report. Two occupational cohorts were followed for neurodegenerative diseases – approximately 20,000 railroad workers in Switzerland (Röösli et al., 2007b) and over 80,000 electrical and generation workers in the UK (Sorahan and Kheifets, 2007). Two case-control studies collected incident cases of Alzheimer's disease and estimated occupational magnetic field exposure (Davanipour et al., 2007; Seidler et al., 2007), and a meta-analysis was conducted of occupational magnetic field exposure and Alzheimer's disease studies (García et al., 2008). The first study of non-occupational exposure followed the Swiss population to evaluate associations with residential distance to power lines and death due to neurodegenerative diseases (Huss et al., 2009).

García et al. (2008) identified 14 epidemiologic studies with information on Alzheimer's disease and occupational EMF exposure; the WHO considered the majority of these studies in their 2007 review. A statistically significant association between Alzheimer's disease and occupational EMF exposure was observed for both case-control and cohort studies (OR =2.03, 95% CI=1.38-3.00 and RR =1.62, 95% CI=1.16-2.27, respectively), although the results from the individual studies were so different that the authors cautioned against the validity of these combined results. While some subgroup analyses had statistically significant increased risks and were not significantly heterogeneous between studies, the findings were contradictory between study design types (e.g., elevated pooled risk estimates were reported for *men* in cohort studies and elevated pooled risk estimates were reported for *women* in case-control studies).

[19] After considering the entire body of literature and its limitations, the WHO report concluded, "When evaluated across all the studies, there is only very limited evidence of an association between estimated ELF exposure and [Alzheimer's] disease risk" (p. 194, WHO 2007a).

The authors concluded that their results suggest an association between Alzheimer's disease and occupational magnetic field exposure, but noted the numerous limitations associated with these studies, including the difficulty of assessing EMF exposure during the appropriate time period, case ascertainment issues due to diagnostic difficulties, and differences in control selection. They recommended further research that uses more advanced methods.

An earlier publication by the same group of investigators documented the relatively poor quality of the studies included in the meta-analysis. Santibáñez et al. (2007) evaluated studies related to occupational exposures and Alzheimer's disease, which included seven of the studies in the García et al. meta-analysis. Two epidemiologists blindly evaluated each of these studies using a questionnaire to assess the possibility of a number of biases, with a score assigned to each study that represents the percentage of possible points that the study obtained (range 0 – 100%). Only one of the seven studies obtained a score above 50% (a retrospective cohort study by Savitz et al. in 1998), and disease and exposure misclassifications were the most prevalent biases.

Davanipour et al. (2007) extended the early hypothesis-generating study by Sobel et al. (1996) by collecting cases from eight California Alzheimer's Disease Diagnostic and Treatment Centers. Self-reported primary occupation was collected from patients with verified diagnoses of Alzheimer's disease and compared to occupational information collected from persons diagnosed with other dementia-related problems at the Centers. The results of this study were consistent with the previous studies by Sobel et al.; cases were approximately twice as likely to be classified as having medium/high magnetic field exposures, compared with controls. The strengths of this study included its large size and self-reported occupational information. The main limitation of this study was that the exposure assessment only considered a person's primary occupation, classified as low, medium or high magnetic field exposure. The WHO noted limitations of the 1996 publication that are relevant to this publication as well, including the use of controls with dementia (which some studies report have an increased risk of Alzheimer's disease) and the classification of seamstresses, dressmakers and tailors as "high exposure" occupations, which drives the increase in risk.

Seidler et al. (2007) conducted a similar case-control study in Germany, except cases included all types of dementia (55% of which had Alzheimer's disease). Cumulative magnetic field exposure was estimated from occupational histories taken from proxy respondents, and no difference was reported between cases of dementia or probable Alzheimer's disease and controls, although an association was reported among electrical and electronics workers. The authors reported that exposure misclassification was likely to be a significant problem, and concluded that their results indicate a strong effect of low-dose EMF is "rather improbable" (p. 114).

Death from several neurodegenerative conditions was also evaluated in the cohort of more than 20,000 Swiss railway workers described above (Röösli et al., 2007b). Magnetic field exposure was characterized by specific job titles as recorded in employment records; stationmasters were considered to be in the lowest exposure category and were, therefore, used as the reference group. Train drivers were considered to have the highest exposure, and shunting yard engineers and train attendants were considered to have exposure intermediate to stationmasters and train drivers. Cumulative magnetic field exposure was also estimated for each occupation using on-site measurements and modeling of past exposures. The authors reported an excess of senile dementia disease among train drivers, compared to station masters, however, the difference was not statistically significant. The association was larger when restricted to Alzheimer's disease, but was still not statistically significant (hazard ratio [HR]=3.15, 95% CI=0.90-11.04); an association was observed between cumulative magnetic field exposure and Alzheimer's disease/senile dementia. No elevation in mortality was reported for multiple sclerosis, Parkinson's disease, or ALS among train drivers, shunting yard engineers, or train attendants, compared with stationmasters, nor were more deaths from these causes observed for higher estimated magnetic field exposures. Similar to another recent Swedish study (Feychting et al., 2003), the authors reported that recent exposure was more strongly associated with Alzheimer's disease than past exposure.

There are several strengths of this study relative to the existing body of data. First, there is little turnover among Swiss railway employees, which means that study participants are enrolled in the cohort and possibly exposed for long periods of time. The wide variation in exposure levels between different occupations in the same industry allows for comparison of similar workers with different levels of exposure. Another advantage is that the company kept detailed registers of employees, which means that there is less potential for bias in the enumeration of the cohort and reconstruction of exposures. Finally, the authors reported that exposures to chemicals or electric shocks, which often occur in other occupational settings (for example, in electric utility workers or welders), are rare in this occupation.

Sorahan and Kheifets (2007) followed a cohort of approximately 84,000 electrical and generation workers in the UK for deaths attributed to neurodegenerative disease on death certificates. Cumulative magnetic field exposure was calculated for each worker, using job and facility information. The authors reported that the cohort did not have a significantly greater number of deaths due to Alzheimer's disease or motor neuron disease, compared to the general UK population. They also reported that persons with higher estimated magnetic field exposures did not have a consistent excess of death due to Alzheimer's disease or motor neuron disease, compared to persons with lower estimated magnetic field exposure. A statistically significant excess of deaths due to Parkinson's disease was observed in the cohort, although there was no association between calculated magnetic field exposure and Parkinson's disease. The authors concluded "our results provide no convincing evidence for an association between occupational exposure to magnetic fields and neurodegenerative disease" (p. 14). This result is consistent with two other Alzheimer's mortality follow-up studies of electric utility workers in the US (Savitz et al., 1998) and Denmark (Johansen and Olsen, 1998). The findings may be limited by the use of death certificate data, but are strengthened by the detailed exposure assessment.

Another cohort study conducted in Switzerland linked all persons older than 30 years of age at the 2000 census with a national database of death certificates from 2000 through 2005 (Huss et al., 2009). Residential location was also extracted from 1990 and 2000 census data and the closest distance of a person's home in 2000 to nearby 220-380 kV transmission lines was calculated. The authors reported that persons living within 50 meters of these high-voltage transmission lines were more likely to have died from Alzheimer's disease, compared to those living farther than 600 meters, although chance could not be ruled out as an explanation (HR=1.24, 95% CI=0.80-1.92). The association was stronger for persons that lived at the residence for at least 15 years (HR=2.00, 95% CI=1.21-3.33). Associations of similar magnitude were reported for senile dementia and residence within 50 meters of a high-voltage line. No associations were reported beyond 50 meters for Alzheimer's disease or senile dementia, and no associations were reported at any distance for Parkinson's disease, ALS, or multiple sclerosis.

The study's main limitation is the use of residential distance from transmission lines as a proxy for magnetic-field exposure (Maslanyj et al, 2009). It is also limited by the use of death certificate data, which are known to under-report Alzheimer's disease, and the lack of a full residential and occupational history. Furthermore, while the underlying cohort was very large, relatively few cases of Alzheimer's disease lived within 50 meters of a high-voltage transmission line – 20 cases total and 15 cases who lived at the residence for at least 15 years. This means that misclassification of a small number of cases could have a large impact on the risk estimate.

In summary, two cohort studies of the Swiss population of relatively high quality were recently followed for death due to neurodegenerative disease. Röösli et al. (2007b) reported an association between Alzheimer's disease/senile dementia and occupational magnetic-field exposure, while Huss et al. (2009) reported an association between Alzheimer's disease/senile dementia and living within 50 meters of a high-voltage transmission line for at least 15 years. Neither study reported an association with any other neurodegenerative disease, including ALS. A cohort of utility workers, however, did not confirm an association with Alzheimer's disease mortality and magnetic field exposure. The meta-analysis and supporting evaluation of study quality by García, Santibáñez and colleagues confirmed that the associations reported in previous occupational studies are highly inconsistent and the studies have many limitations (Santibáñez et al., 2007; García et al., 2008).

The main limitations of these studies include the difficulty in diagnosing Alzheimer's disease; the difficulty of identifying a relevant exposure window given the long and nebulous course of this disease; the difficulty of estimating magnetic field exposure prior to appearance of the disease; the under-reporting of Alzheimer's disease on death certificates; crude exposure evaluations that are often based on the recollection of occupational histories by friends and family given the cognitive impairment of the study participants; and the lack of consideration of both residential and occupational exposures or confounding variables.

The recent epidemiologic studies do not alter the conclusion that there is "inadequate" data on Alzheimer's disease or ALS. While a good number of studies have been published since the WHO report, little progress has been made on clarifying these associations. Further research is still required, particularly on electrical occupations and ALS (Kheifets et al., 2008). There is currently no body of *in vivo* research to suggest an effect, and a recent study reported no effect of magnetic fields on ALS progression (Poulletier de Gannes et al., 2008). These conclusions are consistent with the recent review by the SCENIHR (SCENIHR, 2009).

Table 8. Relevant studies of neurodegenerative disease published after WHO report

Authors	Year	Study
Davanipour et al.,	2007	A case-control study of occupational magnetic field exposure and Alzheimer's disease: results from the California Alzheimer's Disease Diagnosis and Treatment Centers.
García, et al.	2008	Occupational exposure to extremely low frequency electric and magnetic fields and Alzheimer disease: a meta-analysis.
Huss, et al.	2009	Residence near power lines and mortality from neurodegenerative diseases: longitudinal study of the Swiss population.
Poulletier de Gannes et al.	2008	Amyotrophic lateral sclerosis (ALS) and extremely-low frequency (ELF) magnetic fields: a study in the SOD-1 transgenic mouse model.
Röösli, et al.	2007b	Mortality from neurodegenerative disease and exposure to extremely low-frequency magnetic fields: 31 years of observations on Swiss railway employees.
Santibáñez, et al.	2007	Occupational risk factors in Alzheimer's disease: a review assessing the quality of published epidemiological studies.
Seidler et al.	2007	Occupational exposure to low frequency magnetic fields and dementia: a case-control study.
Sorahan and Kheifets	2007	Mortality from Alzheimer's, motor neurone and Parkinson's disease in relation to magnetic field exposure: findings from the study of UK electricity generation and transmission workers, 1973-2004.

3 Possible Effects of ELF Electric and Magnetic Fields on Implanted Cardiac Devices

The sensing system of pacemakers and other implanted cardiac devices (ICD) is designed to be responsive to the heart's electrical signal. For this reason, other electrical signals can potentially interfere with the normal functioning of pacemakers and ICDs, a phenomenon called electromagnetic interference (EMI). Most sources of EMF are too weak to affect a pacemaker or ICD; however, EMF from certain sources, e.g., some appliances and industrial equipment, may cause interference. This section considers potential electromagnetic interference with implanted cardiac devices such as pacemakers and defibrillators.

In the presence of electromagnetic fields, devices can respond in different ways, defined as modes. The likelihood of interference occurring, and the mode of the response depend on the strength of the interference signal, the patient's orientation in the electromagnetic field, the exact location of the device and the variable parameters of the device that are specific to a patient. Experimental research has been conducted to assess whether interference may occur when currents are induced in the patient's body by environmental electric and magnetic fields.

We performed an extensive search on PubMed for literature related to the effects of EMI on pacemakers and ICDs dating back to 1990. The studies (Toivonen et al., 1991; Astridge et al., 1993; Scholten et al., 2001) showed that the unipolar pacemakers, in general, were sensitive to electric fields of approximately 1 kV/m and above. Bipolar devices, which are specifically designed to reduce the effects of EMI, were much less sensitive and interference effects were observed at electric field strengths of 4-5 kV/m and above.

To prevent against pacemaker EMI, the American Conference of Governmental Industrial Hygienists (ACGIH) and the Electric Power Research Institute (EPRI) suggest that exposures be kept below 1.5-2 kV/m for electric fields and the ACGIH recommends 1 G for magnetic fields (ACGIH 2001, EPRI 2004). These recommendations are general in nature and do not address the fact that classes of pacemakers from some manufacturers are quite immune to interference even at levels much greater than the above recommendations. All standards recommend that the patient consult their physicians and the respective pacemaker manufacturer before following the standard guidelines.

Out of the approximately 12 cardiac device manufacturers only 2, Boston Scientific and Medtronic, are known to provide a general guideline for electric and magnetic field exposure limits (Hauser, 2007). Boston Scientific recommends values below 1-4 kV/m and 1 G at 60 Hz, based in part on the guidelines issued by ACGIH and EPRI (Boston Scientific, 2006). Medtronic recommends an electric field exposure below 6 kV/m for their implanted devices.

In order to reduce the potential effects of environmental exposure to electric and magnetic fields, the Center for Devices and Radiological Health of the United States Food and Drug Administration (FDA) has issued guidelines for both the development of pacemakers and the design of new electrical devices to minimize susceptibility to electrical interference from any source. Pacemakers today are designed to filter out electrical stimuli from sources other than the heart, e.g., the muscles of the chest, currents encountered from touching household appliances, or currents induced by external electric or magnetic fields. Used in both temporary and permanent pacemakers, these electrical filters increase the pacemaker's ability to distinguish extraneous signals from legitimate cardiac signals (Toivonen et al., 1991). Furthermore, most circuitry of modern pacemakers is encapsulated by titanium metal, which insulates the device by shielding the pacemaker's pulse generator from electric fields. Some pacemakers may also be programmed to automatically pace the heart if interference from electric and magnetic fields is detected (fixed pacing mode). This supports cardiac function and allows the subject to feel the pacing and move away from the source.

Due to recent design improvements, many pacemakers currently in use would not be susceptible to low intensity electric fields. There remains a very small possibility that some pacemakers, particularly those of older design and with single-lead electrodes (i.e., unipolar devices), may sense potentials induced on the electrodes and leads of the pacemaker and provide unnecessary stimulation to the heart.

In summary, interference from strong electric fields is theoretically possible under certain circumstances. The likelihood of interference occurring is low, however, particularly with respect to sources that produce low levels of electric fields and when modern devices are implanted. It is recommended that concerned patients contact their doctor to discuss the make and model of their implanted device, their clinical condition, and any lifestyle factors that put them in close contact with strong fields.

4 Fauna and Flora Research

Fauna

Our previous report concluded that the research to date did not suggest that electric or magnetic fields result in any adverse effects on the health, behavior or productivity of fauna, including livestock such as cows, sheep, and pigs, and a variety of small mammals, deer, elk, birds and bees. The research indicates that some species of animals, unlike humans, are able to detect magnetic fields at levels that may be associated with transmission lines, and this detection may be important for navigational purposes in particular species such as birds. Detection, however, does not imply that the fields result in any effects, or that these effects are adverse. Furthermore, studies of small mammals and birds associated with the research programs by the U.S. Navy and the Bonneville Power Administration reported that there were not any changes in the movement patterns of these animals to suggest that they were avoiding areas near high-voltage rights-of-way (ROW), nor were there any physiological changes or alterations in homing behavior. Reports by two investigators found that commercial honeybee hives can be impacted by EMF from transmission lines because of a current induced by metal parts on the hive; however, this effect is easily remedied and does not apply to wild bees. In summary, the research did not suggest that EMF exposure, or audible noise, would cause any harm to fauna living in the vicinity of high-voltage transmission lines.

Subsequent to Exponent's 2007 report, one study has been published on the possible effects of AC EMF on fauna (Burchard et al., 2007). This study is the most recent publication in a long series of controlled studies at McGill University on the possible effects of strong and continuous EMF exposure on the health, behavior and productivity of dairy cattle (Burchard et al., 1996; Burchard et al., 1998a,b,c; Burchard et al., 1999; Rodriquez et al., 2002; Burchard et al., 2003; Rodriquez et al., 2003; Burchard et al., 2004; Rodriguez et al., 2004). The goal of the research program was to assess whether EMF exposure could mimic the effect of days with long periods of light and *increase* milk production and feed intake through a hormonal pathway involving melatonin. In previous studies, some differences were reported between EMF-exposed and unexposed cows; however, they were not reported consistently between studies, the changes were still within the range of what is considered normal, and it did not appear that the changes were adverse in nature or had any ecological significance. The study by Burchard et al. in 2007 differed from previous studies in that the exposure was restricted to magnetic fields; the outcomes evaluated included the hormones progesterone, melatonin, prolactin, and insulin-like growth factor 1 (IGF-1), as well as feed consumption. No significant differences in melatonin levels, progesterone levels, or feed intake were reported. Significant decreases in prolactin and IGF-1 levels were reported, which is inconsistent with the authors' theory that EMF exposure may increase these hormone levels.

Thus, similar to the previous studies by this group of investigators, Burchard et al. (2007) did not report findings that suggest magnetic fields cause changes in the melatonin pathway that could result in effects on reproduction or production. The authors concluded the following: "The absence of abnormal clinical signs and the absolute magnitude of the significant changes detected during MF [magnetic field] exposure, make it plausible to preclude any major animal health hazard" (p. 471).

Flora

The previous report described the body of research on the possible effects of EMF on forest species and agriculture crops, concluding that researchers have found no adverse effects on plant responses at the levels of EMF produced by high-voltage transmission lines, excluding some corona-related effects from high-voltage lines on the growth of nearby trees.

A recent study by Huang and Wang (2008) evaluated the effects of magnetic fields induced by an inverter system on the early seed germination of mung beans. The exposures were applied at six different frequencies between 10-60 Hz, producing magnetic field levels from 6-20 mG. At 20 and 60 Hz, magnetic field exposure enhanced early growth of the mung beans, while magnetic fields induced by other frequencies had an inhibitory effect on early growth of the mung beans.

5 Standards and Guidelines

Following a thorough review of the research, scientific agencies develop exposure standards to protect against known health effects. The major purpose of a weight-of-evidence review is to identify the lowest exposure level below which no health hazards have been found (i.e., a threshold). Exposure limits are then set well below the threshold level to account for any individual variability or sensitivities that may exist.

Several scientific organizations have published guidelines for exposure to EMF based on acute health effects that can occur at very high field levels. The ICNIRP reviewed the epidemiologic and experimental evidence through 1997 and concluded that there was insufficient evidence to warrant the development of standards or guidelines on the basis of hypothesized long-term adverse health effects such as cancer; rather, the guidelines put forth in their 1998 document set limits to protect against acute health effects (i.e., the stimulation of nerves and muscles) that occur at much higher field levels. The ICNIRP recommends a residential screening value of 833 mG and an occupational exposure screening value of 4,200 mG (ICNIRP, 1998). If exposures exceed these screening values, then additional dosimetry evaluations are needed to determine whether basic restrictions on induced current densities are exceeded.

The International Committee on Electromagnetic Safety (ICES) also recommends limiting magnetic field exposures at high levels because of the risk of acute effects, although their guidelines are higher than ICNIRP's guidelines; the ICES recommends a residential exposure limit of 9,040 mG and an occupational exposure limit of 27,100 mG (ICES, 2002). The ICNIRP and ICES guidelines provide guidance to national agencies and only become legally binding if a country adopts them into legislation. The WHO strongly recommends that countries adopt the ICNIRP guidelines, or use a scientifically sound framework for formulating any new guidelines (WHO, 2006).

There are no national or state standards in the United States limiting exposures to ELF fields based on health effects. Two states, Florida and New York, have enacted standards to limit magnetic fields at the edge of the right-of-way from transmission lines (150 mG and 200 mG, respectively) (NYPSC, 1978; FDER, 1989; NYPSC, 1990; FDEP, 1996). The basis for limiting magnetic fields from transmission lines was to maintain the "status quo" so that fields from new transmission lines would be no higher than those produced by existing transmission lines.

Table 9. Screening guidelines for EMF exposure

Exposure (60 Hz)	Electric field	Magnetic field
ICNIRP		
Occupational	8.3 kV/m	4.2 G (4,200 mG)
General Public	4.2 kV/m	0.833 G (833 mG)
ICES		
Occupational	20 kV/m	27.1 G (27,100 mG)
General Public	5 kV/m^	9.040 G (9,040 mG)

Sources: ICNIRP, 1998; ICES, 2002
^Within power line right-of-ways, the guideline is 10 kV/m under normal load conditions.

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Appendix 1 – WHO Fact Sheet

Fact sheet N°322
June 2007

Electromagnetic fields and public health
Exposure to extremely low frequency fields

The use of electricity has become an integral part of everyday life. Whenever electricity flows, both electric and magnetic fields exist close to the lines that carry electricity, and close to appliances. Since the late 1970s, questions have been raised whether exposure to these extremely low frequency (ELF) electric and magnetic fields (EMF) produces adverse health consequences. Since then, much research has been done, successfully resolving important issues and narrowing the focus of future research.

In 1996, the World Health Organization (WHO) established the International Electromagnetic Fields Project to investigate potential health risks associated with technologies emitting EMF. A WHO Task Group recently concluded a review of the health implications of ELF fields (WHO, 2007).

This Fact Sheet is based on the findings of that Task Group and updates recent reviews on the health effects of ELF EMF published in 2002 by the International Agency for Research on Cancer (IARC), established under the auspices of WHO, and by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 2003.

ELF field sources and residential exposures

Electric and magnetic fields exist wherever electric current flows - in power lines and cables, residential wiring and electrical appliances. **Electric** fields arise from electric charges, are measured in volts per metre (V/m) and are shielded by common materials, such as wood and metal. **Magnetic** fields arise from the motion of electric charges (i.e. a current), are expressed in tesla (T), or more commonly in millitesla (mT) or microtesla (µT). In some countries another unit called the gauss, (G), is commonly used (10,000 G = 1 T). These fields are not shielded by most common materials, and pass easily through them. Both types of fields are strongest close to the source and diminish with distance.

Most electric power operates at a frequency of 50 or 60 cycles per second, or hertz (Hz). Close to certain appliances, the magnetic field values can be of the order of a few hundred microtesla. Underneath power lines, magnetic fields can be about 20 µT and electric fields can be several thousand volts per metre. However, average residential power-frequency magnetic fields in homes are much lower - about 0.07 µT in Europe and 0.11 µT in North America. Mean values of the electric field in the home are up to several tens of volts per metre.

Task group evaluation

In October 2005, WHO convened a Task Group of scientific experts to assess any risks to health that might exist from exposure to ELF electric and magnetic fields in the frequency range >0 to 100,000 Hz (100 kHz). While IARC examined the evidence regarding cancer in 2002, this Task Group reviewed evidence for a number of health effects, and updated the evidence regarding cancer. The conclusions and recommendations of the Task Group are presented in a WHO Environmental Health Criteria (EHC) monograph (WHO, 2007).

Following a standard health risk assessment process, the Task Group concluded that there are no substantive health issues related to ELF electric fields at levels generally encountered by members of the public. Thus the remainder of this fact sheet addresses predominantly the effects of exposure to ELF magnetic fields.

Short-term effects

There are established biological effects from acute exposure at high levels (well above 100 µT) that are explained by recognized biophysical mechanisms. External ELF magnetic fields induce electric fields and currents in the body which, at very high field strengths, cause nerve and muscle stimulation and changes in nerve cell excitability in the central nervous system.

Potential long-term effects

Much of the scientific research examining long-term risks from ELF magnetic field exposure has focused on childhood leukaemia. In 2002, IARC published a monograph classifying ELF magnetic fields as "possibly carcinogenic to humans". This classification is used to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals (other examples include coffee and welding fumes). This classification was based on pooled analyses of epidemiological studies demonstrating a consistent pattern of a two-fold increase in childhood leukaemia associated with average exposure to residential power-frequency magnetic field above 0.3 to 0.4 µT. The Task Group concluded that additional studies since then do not alter the status of this classification.

However, the epidemiological evidence is weakened by methodological problems, such as potential selection bias. In addition, there are no accepted biophysical mechanisms that would suggest that low-level exposures are involved in cancer development. Thus, if there were any effects from exposures to these low-level fields, it would have to be through a biological mechanism that is as yet unknown. Additionally, animal studies have been largely negative. Thus, on balance, the evidence related to childhood leukaemia is not strong enough to be considered causal.

Childhood leukaemia is a comparatively rare disease with a total annual number of new cases estimated to be 49,000 worldwide in 2000. Average magnetic field exposures above 0.3 µT in homes are rare: it is estimated that only between 1% and 4% of children live in such conditions. If the association between magnetic fields and childhood leukaemia is causal, the number of cases worldwide that might be attributable to magnetic field exposure is estimated to range from 100 to 2400 cases per year, based on values for the year 2000, representing 0.2 to 4.95% of the total incidence for that year. Thus, if ELF magnetic fields actually do increase the risk of the disease, when considered in a global context, the impact on public health of ELF EMF exposure would be limited.

A number of other adverse health effects have been studied for possible association with ELF magnetic field exposure. These include other childhood cancers, cancers in adults, depression, suicide, cardiovascular disorders, reproductive dysfunction, developmental disorders, immunological modifications, neurobehavioural effects and neurodegenerative disease. The WHO Task Group concluded that scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukaemia. In some instances (i.e. for cardiovascular disease or breast cancer) the evidence suggests that these fields do not cause them.

International exposure guidelines

Health effects related to short-term, high-level exposure have been established and form the basis of two international exposure limit guidelines (ICNIRP, 1998; IEEE, 2002). At present, these bodies consider the scientific evidence related to possible health effects from long-term, low-level exposure to ELF fields insufficient to justify lowering these quantitative exposure limits.

WHO's guidance

For high-level short-term exposures to EMF, adverse health effects have been scientifically established (ICNIRP, 2003). International exposure guidelines designed to protect workers and the public from these effects should be adopted by policy makers. EMF protection programs should include exposure measurements from sources where exposures might be expected to exceed limit values.

Regarding long-term effects, given the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukaemia, the benefits of exposure reduction on health are unclear. In view of this situation, the following recommendations are given:

- Government and industry should monitor science and promote research programmes to further reduce the uncertainty of the scientific evidence on the health effects of ELF field exposure. Through the ELF risk assessment process, gaps in knowledge have been identified and these form the basis of a new research agenda.
- Member States are encouraged to establish effective and open communication programmes with all stakeholders to enable informed decision-making. These may include improving coordination and consultation among industry, local government, and citizens in the planning process for ELF EMF-emitting facilities.
- When constructing new facilities and designing new equipment, including appliances, low-cost ways of reducing exposures may be explored. Appropriate exposure reduction measures will vary from one country to another. However, policies based on the adoption of arbitrary low exposure limits are not warranted.

Further reading

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Appendix 2 – Comment on the BioInitiative Report

Background

In August 2007, an *ad hoc* group of 14 scientists and public health and policy "experts" published a report to "assess scientific evidence on health impacts from electromagnetic radiation below current public exposure limits and evaluate what changes in these limits are warranted now to reduce possible public health risks in the future" (p. 4). The individuals who comprised this group did not represent any well-established regulatory agency, nor were they convened by a recognized scientific authority. The report (hereafter referred to as the BioInitiative report) is a collection of 17 sections on various topics each authored by one to three persons from the working group. The research on both ELF and radio frequency (RF) EMF was addressed, with major portions of the report focused largely or entirely on RF research. With regard to ELF-EMF, the epidemiologic literature related to childhood cancers, Alzheimer's disease and breast cancer was discussed, as well as the experimental data for a number of mechanistic hypotheses.

Conclusions and comments

The authors of the BioInitiative Report contended that the standard procedure for developing exposure guidelines – i.e., to set guidelines where adverse health effects have been established by using a weight-of-evidence approach – is not appropriate and should be replaced by a process that sets guidelines at exposure levels where biological effects have been reported in some studies, but not substantiated in a rigorous review of the science or linked to adverse health effects.

Based on this argument, the main conclusion of the BioInitiative report was that existing standards for exposure to ELF-EMF are insufficient because "effects are now widely reported to occur at exposure levels significantly below most current national and international limits" (Table 1-1). Specifically, the authors concluded that there was strong evidence to suggest that magnetic fields were a cause of childhood leukemia based on epidemiologic findings. The report recommended the following:

> ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor … While new ELF limits are being developed and implemented, a reasonable approach

> would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction. It is also recommended that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant. (p. 22)

The recommendations made in the BioInitiative report are not based on appropriate scientific methods and, therefore, do not warrant any changes to the conclusions from the numerous scientific agencies that have already considered this issue. These organizations are consistent in their conclusions that the research does not support the setting of exposure standards at these low levels of magnetic field exposure.

The World Health Organization (WHO) published the most recent weight-of-evidence review in June 2007 and concluded the following:

> Everyday, low-intensity ELF magnetic field exposure poses a possible increased risk of childhood leukaemia, but the evidence is not strong enough to be considered causal and therefore ELF magnetic fields remain classified as possibly carcinogenic. (p. 357)

The report continued:

> Given the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukaemia and the limited potential impact on public health, the benefits of exposure reduction on health are unclear and thus the cost of reducing exposure should be very low. (p. 372)

The WHO made no recommendations for exposure standards at the magnetic field levels where an association has been reported in some epidemiologic studies of childhood leukemia. In a fact sheet created for the general public and published on their website, the WHO stated,

> When constructing new facilities and designing new equipment, including appliances, low-cost ways of reducing exposures may be explored…However, policies based on the adoption of arbitrary low exposure limits are not warranted.[20]

The conclusions in the BioInitiative report deviate substantially from those of reputable scientific organizations because they were not based on standard, scientific methods. Valid scientific conclusions are based on weight-of-evidence reviews, which entail a systematic evaluation of the entire body of scientific evidence in three areas of research (i.e., epidemiology, *in vivo* research and *in vitro* research) by a panel of experts in these relevant disciplines. The report by the BioInitiative working group does not represent a valid weight-of-evidence review for the following key reasons:

[20] http://www.who.int/mediacentre/factsheets/fs322/en/index.html

1. **Review panels should consist of a multidisciplinary team of experts that reach consensus statements by collaboratively contributing to and reviewing the final work product.** This process ensures that overall conclusions represent a valid and balanced view of each relevant area of research. The document released by the BioInitiative working group was a compilation of sections, with each authored by one to three members of the group. It does not appear that the report was developed collaboratively or reviewed in its entirety by each member.

2. **Valid conclusions about causality are based on systematic evaluations of three lines of evidence - epidemiology, *in vivo* research and *in vitro* research.** The conclusions in the BioInitiative report are not based on this multidisciplinary approach. In particular, little attention is provided to the results from whole animal *in vivo* studies on cancer and disproportionate weight is given to the results of *in vitro* studies reporting biological effects.

3. **The entire body of evidence to date should be considered when drawing conclusions regarding the strength of evidence in support of a hypothesis.** The BioInitiative report is not a comprehensive review of the cumulative evidence. Rather, results from specific studies are cited, but no rationale is provided for their inclusion relative to the many other relevant, published studies.

4. **The evidence from each study must be critically evaluated to determine its validity and the degree to which it is relevant and able to support or refute the hypothesis under question.** The significance of the results reported in any study depend on the validity of the methods used in that study, so weight-of-evidence reviews must include an evaluation of the strengths and limitations of each study. In some discussions, the report claimed to use a weight-of-evidence approach, but the individual sections of the report provide little evidence that the strengths and limitations of individual studies (e.g., the quality of exposure assessment, sample size, biases, and confounding factors) were systematically evaluated.

5. **Support for a causal relationship is based on consistent findings from methodologically sound epidemiologic studies that are coherent with the results reported from *in vivo* and *in vitro* studies**. The BioInitiative group often arrived at conclusions about causality by considering only a few studies from one discipline, with no consideration of the significance and validity of the study's results.

In summary, the authors of this report largely ignored basic scientific methods that should be followed in the review and evaluation of scientific evidence. These methods are fundamental to scientific inquiry and are not, as the BioInitiative report states, "unreasonably high."

The policy responses proposed in the report are cast as consistent with the precautionary principle, i.e., taking action in situations of scientific uncertainty before there is strong proof of harm. A central tenet of the precautionary principle is that precautionary recommendations are proportional to the perceived level of risk and that this perception is founded largely on the weight of the available scientific evidence. The BioInitiative report recommends precautionary measures on the basis of argument, rather than sound peer-reviewed scientific evidence.

Unlike the BioInitiative report, the WHO report was the product of a multidisciplinary scientific panel assembled by an established public health agency that followed appropriate scientific methods, including the systematic and critical examination of all the relevant evidence. The recommendations from the WHO report (pp. 372-373) are presented below:

- Policy-makers should establish guidelines for ELF field exposure for both the general public and workers. The best source of guidance for both exposure levels and the principles of scientific review are the international guidelines.
- Policy-makers should establish an ELF EMF protection programme that includes measurements of fields from all sources to ensure that the exposure limits are not exceeded either for the general public or workers.
- Provided that the health, social and economic benefits of electric power are not compromised, implementing very low-cost precautionary procedures to reduce exposures is reasonable and warranted.
- Policy-makers and community planners should implement very low-cost measures when constructing new facilities and designing new equipment including appliances.
- Changes to engineering practice to reduce ELF exposure from equipment or devices should be considered, provided that they yield other additional benefits, such as greater safety, or involve little or no cost.
- When changes to existing ELF sources are contemplated, ELF field reduction should be considered alongside safety, reliability and economic aspects.
- Local authorities should enforce wiring regulations to reduce unintentional ground currents when building new or rewiring existing facilities, while maintaining safety. Proactive measures to identify violations or existing problems in wiring would be expensive and unlikely to be justified.

- National authorities should implement an effective and open communication strategy to enable informed decision-making by all stakeholders; this should include information on how individuals can reduce their own exposure.

- Local authorities should improve planning of ELF EMF-emitting facilities, including better consultation between industry, local government, and citizens when siting major ELF EMF-emitting sources.

- Government and industry should promote research programmes to reduce the uncertainty of the scientific evidence on the health effects of ELF field exposure.

Appendix G

Greenhouse Gases

Big Eddy- Knight CO_2 Emissions for 6 months of Transmission Line Construction

Note: Only Vehicle round trips/day or 6 months and distance need to be changed to calculate emissions

CO_2				
Vehicle round trips/day	**Distance (miles)**	**Miles/ 6 months**	**Gallons/year***	***CO_2 Emissions in Metric tons CO_2/year****
16	80	233,600	40,276	**409**

*Gallons/year is calculated using a fuel economy factor of 5.8 mpg for heavy trucks (more than 26,000 lbs)

**CO_2 Emission Factor for Diesel Fuel No 1 and 2 = 10.15 kg CO_2/gallon

CH_4					
Vehicle round trips/day	**Distance (miles)**	**Miles/year**	**Gallons/mile***	**CH_4 Emissions in Metric tons**	***CO_2e Emissions in Metric tons/year****
16	80	233,600	1,191	0.001	**0.03**

*Gallons/mile is calculated using a CH_4 emission factor of 0.0051 g/mi for all model years of diesel heavy-duty vehicles

**CO_2 equivalent conversion factor for CH_4 is 21 GWP

NO_2					
Vehicle round trips/day	**Distance (miles)**	**Miles/year**	**Gallons/mile***	**CH_4 Emissions in Metric tons**	***CO_2e Emissions in Metric tons/year****
16	80	233,600	1,121	0.001	**0.35**
				Total CO_2 Emissions over one year of transmission line construction in metric tons/year	***409.38***

*Gallons/mile is calculated using a NO_2 emission factor of 0.0048 g/mi for all model years of diesel heavy-duty vehicles

**CO_2 equivalent conversion factor for NO_2 is 310 GWP

Big Eddy- Knight CO2 Emissions for 6 months for Operations and Maintenance

CO_2				
Vehicle round trips/year	**Distance (miles)**	**Miles/year**	**Gallons/year***	***CO_2 Emissions in Metric tons CO_2/year****
3	80	240	30	**0.3**
Helicopter round trips/year	**Distance (miles)**	**Miles/year**	**Gallons/year*****	***CO_2 Emissions in Metric tons CO_2/year******
2	60	120	44	**0.4**
			Total CO_2	**0.7**

*Gallons/year is calculated using a fuel economy factor of 8.0 mpg for medium trucks (more than 26,000 lbs)

**CO_2 Emission Factor for Motor gasoline = 8.81 kg CO_2/gallon

***Gallons/year is calculated using a fuel economy factor of 2.7 mpg (2.35 Nautical Miles/g) for a helicopter

****CO_2 Emission Factor for Aviation gasoline = 8.32 kg CO_2/gallon

CH_4					
Vehicle round trips/year	**Distance (miles)**	**Miles/year**	**Gallons/mile***	**CH_4 Emissions in Metric tons**	***CO_2e Emissions in Metric tons/year****
3	80	240	0.24	0.000000	**0.000005**
Helicopter round trips/year	**Distance (miles)**	**Gallons/year*****	**Grams/year******	**CH_4 Emissions in Metric tons**	***CO_2e Emissions in Metric tons/year****
2	60	44	313	0.0000	**0.001**
				Total CH_4	**0.001005**

*Gallons/mile is calculated using a CH_4 emission factor of 0.0010 g/mi for model years 1996-2004 diesel light trucks

**CO_2 equivalent conversion factor for CH_4 is 21 GWP

***Gallons used per year = miles per year/2.7 mpg for helicopter

****Grams/year is calculated using an emission factor of 7.04 grams/gallon fuel for aviation gasoline.

N_2O					
Vehicle round trips/year	**Distance (miles)**	**Miles/year**	**Gallons/mile***	**N_20 Emissions in Metric tons**	***CO_2e Emissions in Metric tons/year****
3	160	480	0.72	0.000001	**0.0002**
Helicopter round trips/year	**Distance (miles)**	**Gallons/year*****	**Grams/year******	**N_20 Emissions in Metric tons**	***CO_2e Emissions in Metric tons/year****
2	130	96	11	0.00010	**0.030**
				Total N_2O	**0.0302**
				Total CO_2 Emissions over one year of transmission line operation and maintenance in metric tons/year	***0.7312***

*Gallons/mile is calculated using a N_20 emission factor of 0.0015 g/mi for model years 1996-2004 diesel light trucks

**CO_2 equivalent conversion factor for NO_2 is 310 GWP
***Gallons used per year = miles per year/2.7 mpg for helicopter
****Grams/year is calculated using an emission factor of 0.11 grams/gallon fuel for aviation gasoline.

The following table is a summary of unit conversions and assumptions required to calculate CO_2 emissions associated with tree harvesting.

Coefficient	**Unit**	**Source**
300	Horse power	Assumed
2,545	(British thermal unit/hour)/horse power	---
2	hours/tree	Assumed
138,000	BTU/gallon-diesel	EPA 2005
10.1	kg-$CO_{2\text{-equiv}}$/gallon-diesel	EPA 2005
35%	Efficiency	Assumed

Appendix H

Disclosure Forms

NEPA Financial Disclosure Statement for Preparation of the Environmental Impact Statement for the Proposed Big Eddy-Knight Transmission Project

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." 46 FR 18026- 18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: [check either (a) or (b) to assure consideration of your proposal]

(a) ✓ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ____________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.

2.

3.

Certified by:

[signature]

Signature

Richard Oestman, Principal, ICF International

Name

1/29/10

Date

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(a) ___X___ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) _________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.

2.

3.

Certified by:

[signature]
Signature

T. DAN BRACKEN
Name

2/2/2010
Date

NEPA Financial Disclosure Statement for Preparation of the Environmental Impact Statement for the Proposed Big-Eddy-Knight Transmission Project

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Financial or Other Interests:

1.

2.

3.

Certified by:

Kathleen Concannon
Signature

KATHLEEN CONCANNON
Name

2/1/10
Date

NEPA Financial Disclosure Statement for Preparation of the Environmental Impact Statement for the Proposed Big Eddy-Knight Transmission Project

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." 46 FR 18026- 18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: [check either (a) or (b) to assure consideration of your proposal]

(a) ______X______ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ____________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.

2.

3.

Certified by:

[signature]
Signature

LEROY P. SANCHEZ
Name

JUNE 2, 2010
Date

NEPA Financial Disclosure Statement for Preparation of the Environmental Impact Statement for the Proposed Big Eddy-Knight Transmission Project

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Financial or Other Interests:

1.

2.

3.

Certified by:

Kara A Hempy-Mayer
Signature

Kara Hempy-Mayer
Name

1/29/10
Date

Appendix I

Washington Department of Natural Resources Lands Analysis

Appendix I
Washington Department of Natural Resources Lands Analysis

As described in Chapter 6, Washington EFSEC, Oregon DOE, and other state agencies have provided BPA with potentially applicable state substantive standards that they believe apply to the proposed project. Inclusion of these standards in the EIS helps BPA understand these standards and aids state agencies in their review of the proposed project. By identifying and considering these standards as early as possible, the proposed project can be designed to be consistent or compatible with these standards to the maximum extent practicable.

In addition to the incorporation of state standards into the EIS and project design, BPA recognizes that when a state agency owns property that BPA proposes to cross with its proposed transmission line and associated facilities, that agency may need to comply with certain state or local laws or regulations before it can agree to allow BPA use of their property. As discussed in Section 3.1 Land Use and Recreation of the EIS, the Washington Department of Natural Resources (DNR) is a state agency that manages property crossed by the project. To assist DNR in its compliance efforts for DNR lands potentially crossed by the proposed project, BPA has included this Appendix I to provide additional information, where available, for these lands.

Some of the information included in this appendix reflects the expected negotiation of a Washington Statewide Rights-of-Way Memorandum of Agreement (MOA) between BPA and DNR. This MOA will cover certain issues related to all DNR lands that are encumbered with BPA easements. It is the mutual goal of BPA and DNR to address BPA transmission line operations and maintenance compatibility with trust land management and to complete the MOA prior to December 31, 2011. It is expected that this MOA will, at a minimum, address the following elements:

a. Integration of State and Federal Requirements;
b. Danger trees;
c. Vegetation management;
d. Access road management, maintenance, repair, and cost sharing;
e. Dispute resolution;
f. Communications/notification;
g. Liability;
h. Situations where additional right-of-way and/or mitigation is needed for transmission operations, such as safety zones and vegetation removal for clear safe backlines;
i. Third party use (authorized and unauthorized); and
j. Safety.

This appendix also reflects two other agreements between BPA and DNR: an Appraisal Memorandum of Understanding (Appraisal MOU) and a Land Exchange Agreement. The Appraisal MOU was finalized on August 1, 2010 and describes the process BPA would use to appraise DNR lands crossed by the proposed project.

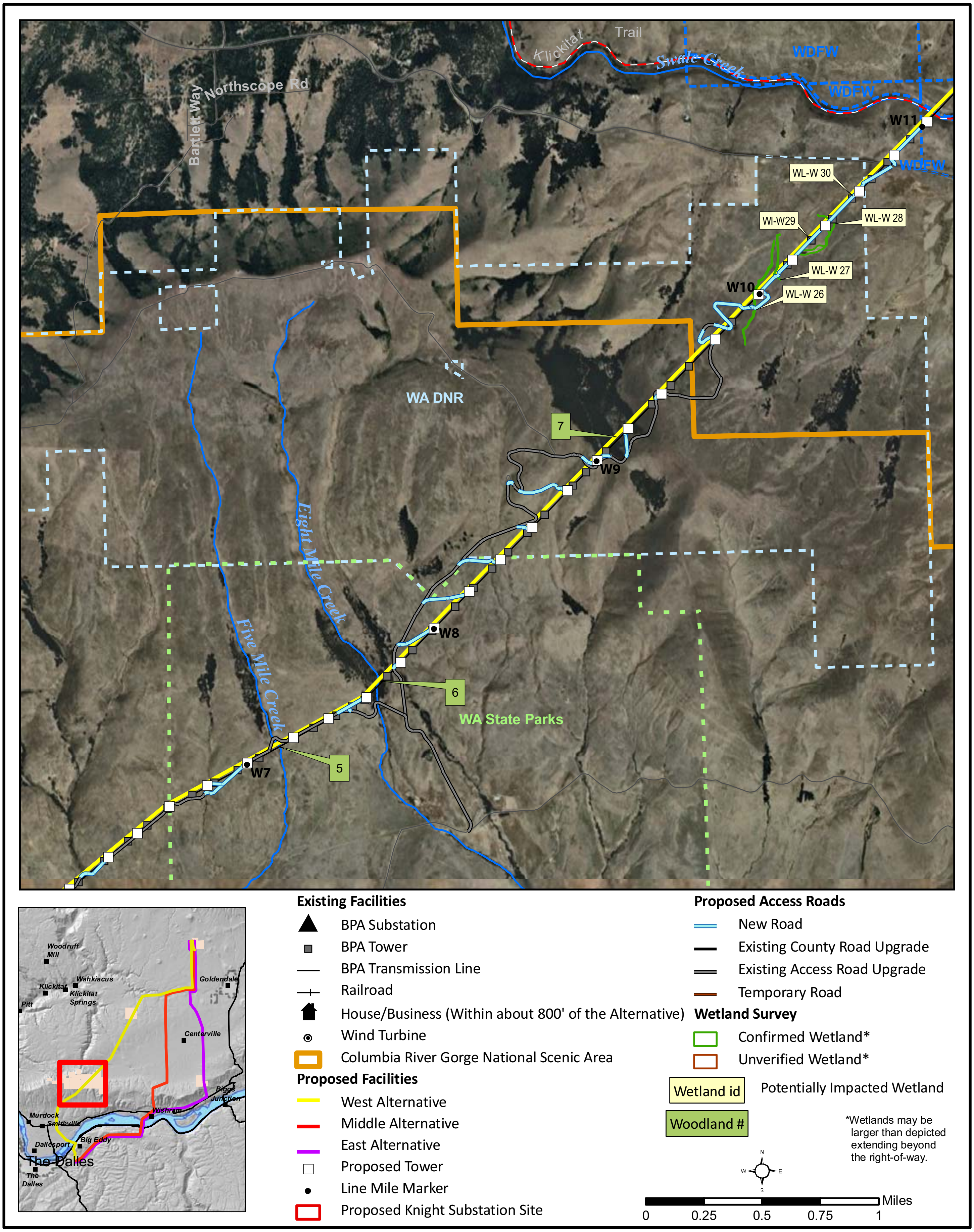
The following sections of this appendix provide more detailed information on DNR lands relevant to the proposed Big Eddy-Knight Transmission Project. Section I.1 describes the specific DNR properties that could be affected by the proposed project, and Section I.2 discusses potential impacts to these properties. Section I.3, at the end of this appendix, lists possible measures that could be undertaken to lessen or avoid these potential impacts.

I.1 DNR Land Parcels Potentially Impacted

In Klickitat County, DNR manages four parcels potentially crossed by the proposed project (see Table I-1 and Maps I-1 thru I-4). BPA's preferred East Alternative with Substation Site 1 would impact Parcel 3 with the proposed line and Parcel 4 with a substation access road. Table I-2 identifies the project components potentially located on the four DNR parcels for all the action alternatives and the possible right-of-way needs. Table I-3 identifies the permanent footprint impacts due to towers and roads as well as the temporary disturbance areas (construction areas around towers, counterpoise and temporary roads).

Table I-1. DNR Land Parcels within the Project Area

Parcel	Township, Section, Range	Land Use	Alternative	Location (Line Mile)
Parcel 1	T03N, R14E, Sections 28, 32, 33	Recreation and Conservation (Columbia Hills Natural Area Preserve) total 3,600 acres	West	W8.5–10.5
Parcel 2	T04N, R14E, Section 36	Washington State Trust Lands – Leased Agriculture and Dispersed Recreation total 633 acres	West	W16–17
Parcel 3	T03N, R15E, Section 36	Washington State Trust Lands – Wind Power Production total 483 acres	East	E15
Parcel 4	T05N, R15E, Section 36	Washington State Trust Lands- Leased Agriculture and Dispersed Recreation total 544 acres	West, Middle, East, Substation 2	WM26, E28, Substation Site 2



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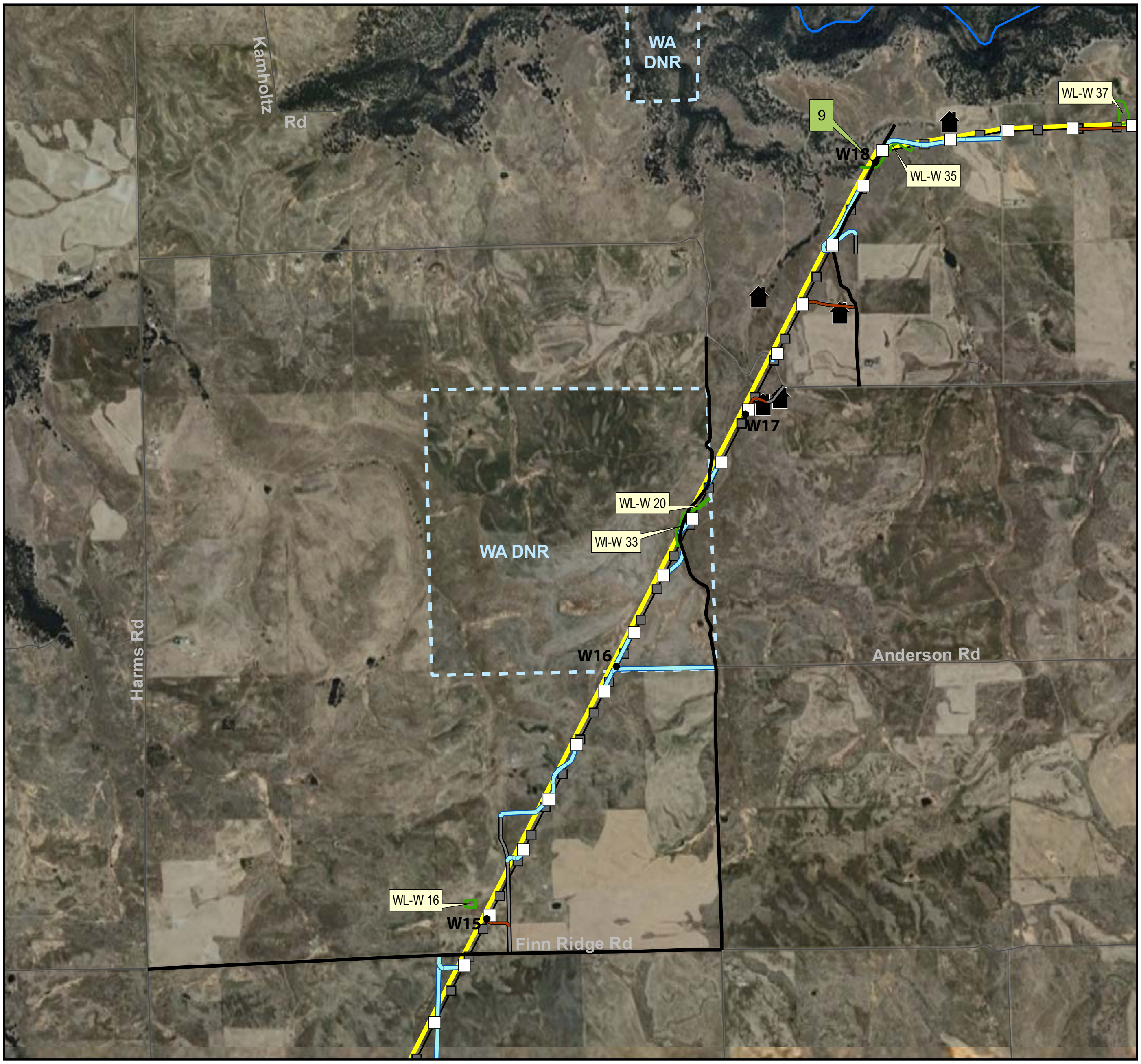
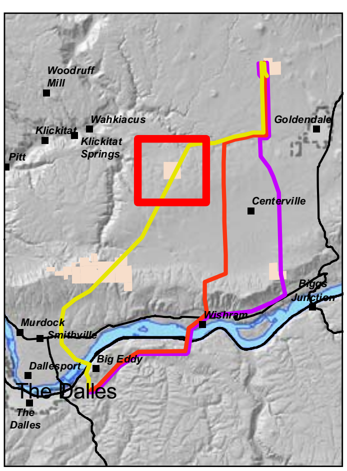
Map I-1. DNR Parcel 1





Existing Facilities

- BPA Substation
- BPA Tower
- BPA Transmission Line
- Railroad
- House/Business (Within about 800' of the Alternative)
- Wind Turbine
- Columbia River Gorge National Scenic Area

Proposed Facilities

- West Alternative
- Middle Alternative
- East Alternative
- Proposed Tower
- Line Mile Marker
- Proposed Knight Substation Site

Proposed Access Roads

- New Road
- Existing County Road Upgrade
- Existing Access Road Upgrade
- Temporary Road

Wetland Survey

- Confirmed Wetland*
- Unverified Wetland*
- Wetland id — Potentially Impacted Wetland
- Woodland #

*Wetlands may be larger than depicted extending beyond the right-of-way.

N W E S

0 0.25 0.5 0.75 1 Miles

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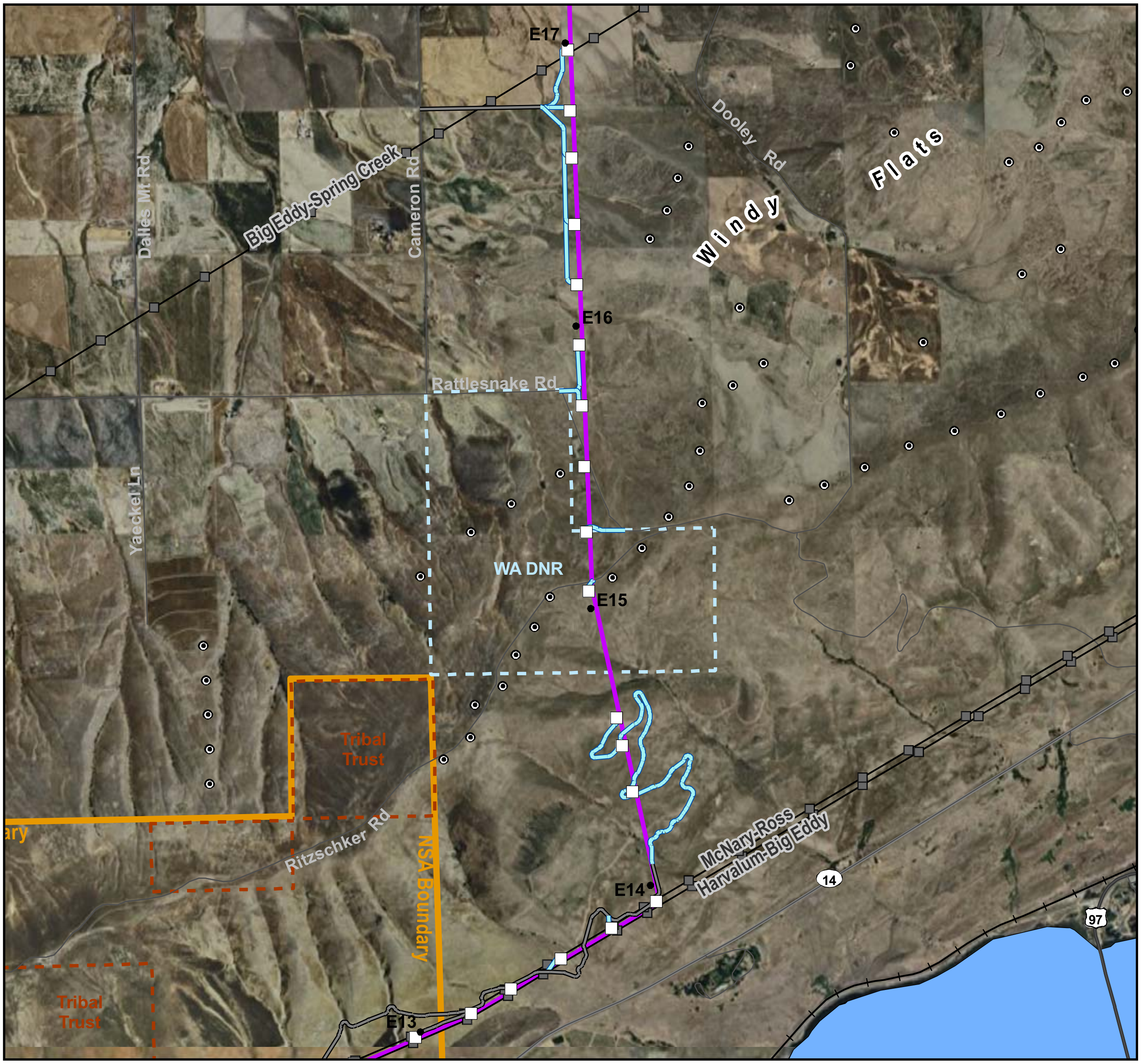
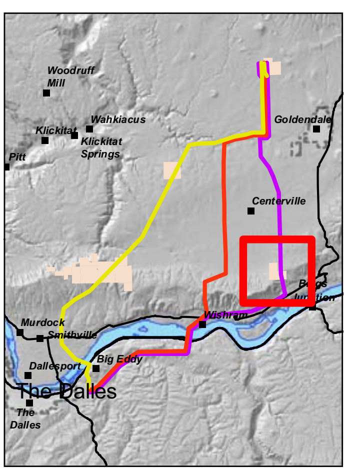
Map I-2. DNR Parcel 2





Existing Facilities

- BPA Substation
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- Railroad
- House/Business (Within about 800' of the Alternative)
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- West Alternative
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N S W E

0 0.25 0.5 0.75 1 Miles

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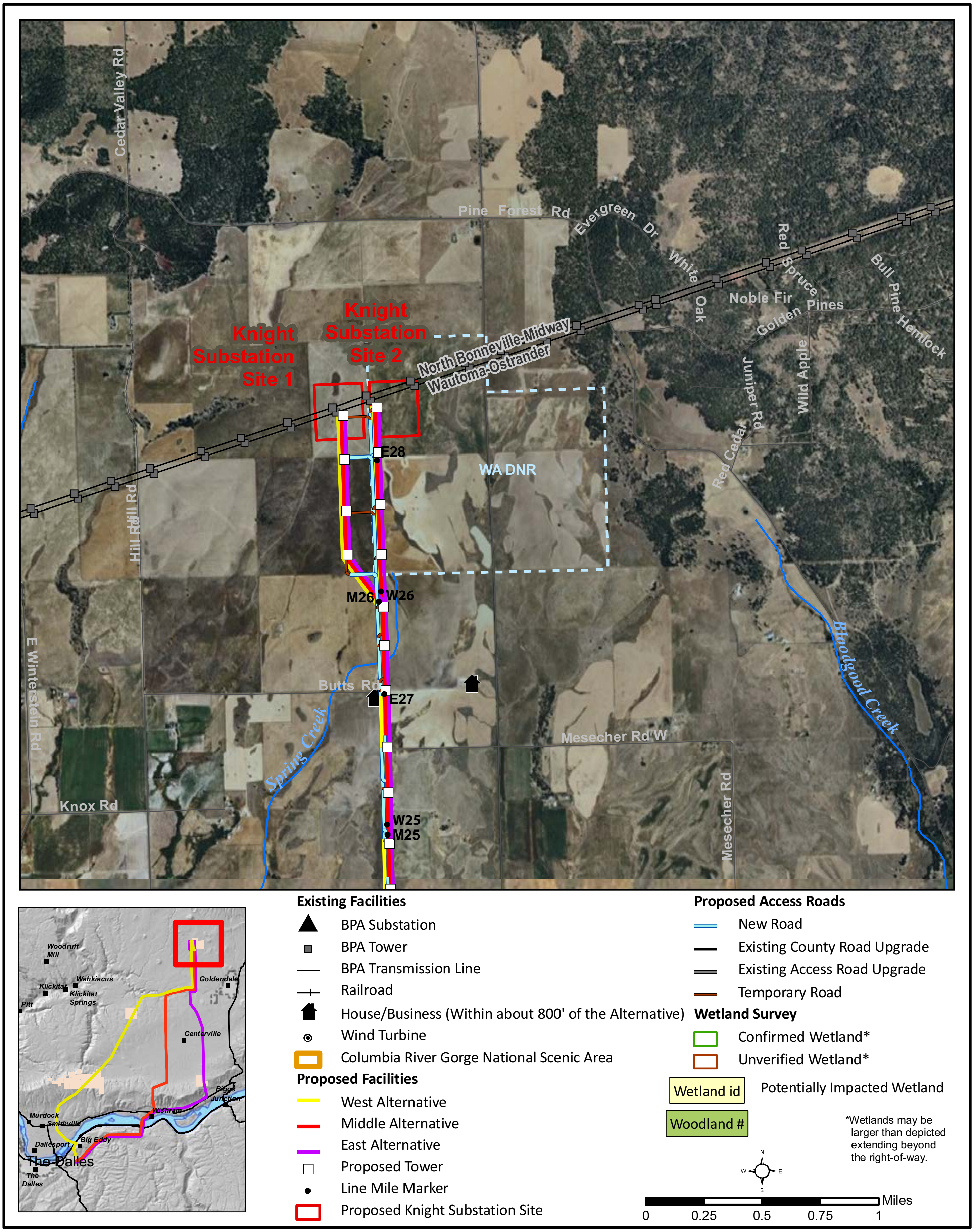
Map I-3. DNR Parcel 3



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Map I-4. DNR Parcel 4

Table I-2. Project Components Potentially Located on DNR Parcels

Parcel	Miles of Line	Number of New Towers	New Right-of-Way (acres)	Existing Right-of-Way (acres)	New Roads (miles)	Upgrade Existing Roads (miles)	Substation (acres)
Parcel 1	2	10	13–40	27	2	2	–
Parcel 2	0.8	3	5–14	9	0.7	0.8	–
Parcel 3	0.5	1	9	0	0.04	0	–
Parcel 4 with Substation	0.7	4	13	15	0.7	0	30
Parcel 4 without Substation	–	–	–	15	0.7	–	–

Table I-3. Impacts by DNR Parcel

	Permanent Impacts					Temporary Impacts		
Parcel	Towers (acres)[2]	New Roads (acres)	Upgrade Existing Roads (acres)	Substation (acres)	Total Permanent Impacts (acres)	Towers (acres)[2]	Temporary Roads (acres)	Total Temporary Impacts (acres)
Parcel 1	1–2	7	8	–	17	4–16	0	4–16
Parcel 2	0.4–0.5	3	3	–	6	1–5	0	1–5
Parcel 3	0.1	0.2	0	–	0.3	0.4	0	0.4
Parcel 4 with Substation	0.5–0.7	2	0	30	32–33	2	0.3	2
Parcel 4 without Substation	–	5	–	–	–	–	–	–

I.2 Resource Impacts

The following discussions focus on the environmental resources that DNR has stated requires additional information to aid the agency in its statutory and regulatory compliance efforts for DNR parcels potentially crossed by the proposed project. General resource impacts that occur due to the project are described in Chapter 3 of this EIS; the information below addresses the site specific impacts on the DNR parcels. Also, Chapter 3 of the EIS provides analysis for the environmental resources not specifically addressed in this appendix, including DNR lands.

I.2.1 Land Use and Recreation

The vicinity of the proposed project, including the general vicinity of the four parcels of DNR lands, is sparsely populated with development mainly limited to rural homes, ranches, and farms. The four DNR parcels are located on gently rolling to moderately hilly plateaus. Parcel 1 is a dedicated preserve under the Washington Natural Area Preserves Act, for the preservation of high quality and rare natural areas, as well as threatened and endangered species as part of the Washington Natural Heritage Program (WNHP) (WNHP 2007, 2009b). While preservation is its primary mission, the preserve is also used for research, education, and recreation. Recreation in the preserve consists primarily of hiking, wildflower viewing, and wildlife observation along The Dalles Mountain Road. DNR Parcels 2, 3, and 4 are Washington State Trust Lands managed by DNR. Parcels 2 and 4 are leased for agriculture and allow for dispersed recreation (hunting, fishing, etc.), and Parcel 3 is leased for wind production as part of the Windy Flats Energy Production Area and may also be used for range.

Section 3.1 Land Use and Recreation of the EIS provides an analysis of the project's potential impacts on land use along the proposed project, including on the four DNR parcels potentially affected by the project, and identifies measures to lessen or avoid impacts that would also apply to the four DNR parcels.

Impacts to land use would include limitations of use within the right-of-way, removal of land from use due to tower footprints, roads, and Knight Substation, disruption of use due to the presence of the line through properties, and disturbance during maintenance and construction activities.

Use limitation within the right-of-way would include keeping the right-of-way clear of all structures, fire hazards, tall-growing vegetation and any other use that may interfere with the safe operation or maintenance of the line. Buildings could not be constructed within the right-of-way.

While BPA would obtain the right through its easements to keep the right-of-way clear of vegetation and structures, BPA could enter into agreements with DNR for low-growing vegetation that does not interfere with BPA's safe operation and maintenance of its transmission facilities. DNR would coordinate with BPA prior to planting to ensure that the use is safe, compatible and does not create an interference. Most crops could be grown safely under the transmission line. However, orchards, Christmas trees, tall-growing landscape or natural vegetation, and structure–supported crops (i.e., trellises) would require special consideration.

Many uses would not be restricted, but certain precautions would need to be taken. For example, no object should be raised higher than 14 feet above the ground within the right-of-way (i.e., when moving irrigation pipes, they should be kept low and parallel to the ground); ground elevation should not be altered (such as piling of dirt within the right-of-way); irrigation spray should not create a continuous stream onto the conductors or towers; fences should be grounded; and installing underground pipes or cables through the right-of-way needs to be coordinated with BPA so as not to interfere with transmission line grounding systems and tower footings. Vehicles and large equipment that do not exceed more than 14 feet in height, such as harvesting combines, cranes derricks and booms could be operated safely under the line where it passes over roads, driveways, parking lots, cultivated fields or grazing lands.

BPA does not restrict land uses outside the right-of-way. This is true of all lands adjacent to the proposed corridor including DNR lands. Land uses such as growing crops, grazing livestock, state and county roads, electric transmission lines, and outdoor recreational sports and activities would continue. Some temporary impacts may occur during construction of the transmission line as discussed in Section 3.1.2 of the EIS. Placement of the transmission line would not limit development outside the right-of-way including agricultural use, residential development, wind power production, or solar energy or communication sites. Within Klickitat County, private lands crossed by the action alternatives are zoned rural center, open space and extensive agricultural use. Much of the area is in an energy overlay zone. DNR lands, as managed by the State of Washington, are not subject to local zoning regulations.

The land uses on the DNR parcels include non-irrigated crop land, rangeland (the wind production area appears as rangeland as it is multi use), and Conservation/Recreation. See Table I-4 for acreages of impacts to various land uses, prime farm land, and farmland of statewide importance.

Table I-4. Land Use Impacts and New Right-of-Way by DNR Parcel

Land Use	Permanent Impacts by Parcel (acres)				Temporary Impacts by Parcel (acres)				New Right-of-Way by Parcel (acres)			
	1	2	3	4	1	2	3	4	1	2	3	4
Non-Irrigated Cropland	0	0	0	32	0	1	0.4	0.04	0	0	0	13
Rangeland	0	4	0.3	1	0	0	0	2	0	4–13	9	0
Conservation/ Recreation	14–15	0	0	0	4–5	0	0	0	13–40	0	0	0
Totals by Type of Impact	14–15	4	0.3	33	4–5	1	0.4	2	13–40	4–13	9	13
Prime Farmland	0	0	0	31	0	0	0	1–2	0	0	0	10
Farmland of Statewide Importance	6	2	0.2	0.5	2–4	0.4–1.0	0.4	0.5–0.6	6–19	2–6	6	3

I.2.2 Geology and Soils

Section 3.4 Geology and Soils of the EIS provides an analysis of the potential impacts on geology and soils along the project (routing alternatives and substation sites), and identifies measures to lessen or avoid potential geologic hazards and soil impacts. The analysis in Section 3.4 includes a general assessment of geologic hazards for the four DNR parcels potentially affected by the proposed project, and the identified measures to lessen or avoid potential geologic hazards would also apply to the four DNR parcels. In addition, Map I-5 series of this appendix displays the liquefaction risks and faults found within the project area, including the four DNR parcels.

Additional geology and soils information is continuing to be obtained using geologic hazard assessments, including on-the-ground field assessments. The geologic hazard assessments have included the review of liquefaction hazard mapping, geologic maps for fault locations, and aerial photographs combined with surface condition assessments at proposed tower locations and surrounding terrain for landslide hazard assessment. Geological soil testing will be performed at representative tower locations to help determine appropriate tower footings for a given soil type or hazard. Geologic and soil hazard areas are avoided where possible, and where avoidance is not possible, towers and roads would be designed to address the applicable hazard.

Landslides. In Washington, landslide areas along the project occur along the Columbia Hills (see Map I-5). The West Alternative crosses a large inactive landslide on Washington Parks and DNR lands between line miles W7.6-8.4. Small landslides may also be associated with the headwaters of drainages on the north flank of the Columbia Hills near line mile W9.5.

Landslide areas along the East Alternative in Washington occur in the Wishram area and just south of the DNR Parcel 3.

As discussed in Section 3.4.2 of the EIS, because road development has the potential to cause erosion or landslides, road grades on all lands crossed by the proposed project would be varied depending on the erosion potential of the soil and roads would be rocked where needed for dust abatement, stability, load bearing, and seasons of use. Final design measures would take slopes, soil types, bedrock, the presence of bedrock hollows or inner gorges, and other factors into account based on site-specific information.

Seismic. Various faults are located along the project routes (see Map I-5). Earthquakes occurring in the Northwest could cause ground shaking or ground failure – landslides or liquefaction (severe settling of soil) – in large landslide areas, in floodplain sediments and alluvial fill in the Swale Creek Valley, and in floodplain sediments around Fifteenmile Creek in Oregon and the Little Klickitat River in Washington. All facilities would be built to applicable seismic standards and combined wind- and ice-loading tower design criteria typically exceed earthquake-induced loads.

Liquefaction. Liquefaction hazards occur where the combination of fine-grained cohesionless soils and high water table conditions occur. Generally, transmission towers are likely to survive settlement associated with liquefaction with only minor structural damage. It is BPA's policy to avoid placing towers in areas where liquefaction might occur, such as stream crossings.

Liquefaction hazards were identified where the Middle and East alternatives cross Swale Creek (see Map I-5). Test pits would be excavated at tower sites in these areas to further investigate subsurface conditions and verify no liquefaction hazard exists. If a potential liquefaction hazard is found, the liquefiable soils would most likely be excavated to bedrock and replaced with non-liquefiable backfill.

I.2.3 Vegetation

Section 3.3 of the EIS provides an analysis of the project's potential impacts on vegetation in the project vicinity for all routing alternatives, including on the four DNR parcels potentially affected by the proposed project, and identifies measures to lessen or avoid impacts that would also apply to the four DNR parcels. Table I-5 displays the potential impacts to vegetation at each of the four DNR parcels that could be affected by the proposed project.

Four special-status species associated with high-quality grasslands have mapped occurrences on Columbia Hills Natural Area Preserve Parcel 1; clustered lady's-slipper (*Cypripedium fasciculatum*), Douglas' draba (*Cusickiella douglasii*), hot-rock penstemon (*Penstemon deustus* var. *variabilis*), and obscure buttercup (*Ranunculus triternatus* (ORNHIC 2007 and WNHP 2009c). Vegetation surveys conducted of the proposed transmission line corridors in spring 2010 only found the obscure buttercup. Because of the unusual spring weather (early heat, then a late snow) it is assumed that the field surveys missed the plant flowering times of the other three special species grassland plants and their presence could not be verified.

Because both the park and preserve biologists have recorded their presence, it is assumed that all four of the special-status grassland type species occur in this area.

Table I-5. Vegetation Impacts and Right-of-Way by DNR Parcel

	Permanent Impacts (acres)				Temporary Impacts (acres)				New Right-of-Way (acres)			
Parcel #:	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Vegetation Cover Types												
Shrub-Steppe	0	0	0	0	2	0	0	0	0	0	0	0
Grassland	13–14	0	0	0	0.04	0	0	0	12–36	0	0	0
Idaho Fescue-Houndstongue Hawkweed[1]	0	3–7	0	0	0	0	0	0	0	0	0	0
Disturbed Shrub-Steppe/ Grassland	0	0.4–0.7	1–2	10.4	0	4	0.3	1	0–0.01	4–13	9	0

[1] Priority ecosystem associated with grasslands

As discussed in Section 3.3.2, the proposed project could result in the spread of noxious weeds, especially along newly constructed access roads. To control or contain noxious weeds on DNR parcels potentially crossed by the proposed project, BPA would undertake actions in coordination with DNR at four stages of the proposed project: pre-construction, construction, immediate post-construction, and maintenance.

Pre-Construction. The MOA between DNR and BPA and/or easement document for any DNR parcels affected would outline measures for weed control (see Table I-7 for Potential Measures on DNR Parcels). As part of BPA's noxious weed management, BPA contracted with Klickitat County to conduct a noxious weed survey in spring 2010 along the proposed alternatives to help determine infestation locations and appropriate mitigation measures needed for construction. However, because BPA did not have permission to enter the DNR parcels, the inventory in those areas was conducted from public access where available. If noxious weeds are currently on the DNR property, BPA and DNR could decide to apply herbicides prior to construction to help reduce spread during construction. Construction specifications will contain provisions stating how the noxious weeds would be controlled or contained including provisions outlined in the MOA.

All proposed actions to control or eradicate noxious weeds would comply with the Carson-Foley Act (P.L. 90-583), the Federal Noxious Weed Act (P.L. 93-629), and other applicable State and Federal regulations.

Construction. During construction, BPA would implement noxious weed control measures specified in the construction specifications which would include establishing vehicle and equipment washing stations in strategic locations to reduce the possibility of seed being carried to areas that do not have infestations, as well as reseeding disturbed areas to limit noxious weed germination. To ensure that the desired level of noxious weed control is being carried out, the BPA field inspector and the land liaison representative would monitor the program. For DNR land, BPA will coordinate these efforts with DNR as specified in the MOA or easement agreement.

Immediate Post-Construction. Upon completion of construction, the maintenance of the transmission line and its associated access roads and rights-of-way would become the responsibility of BPA Transmission Line Maintenance with the assistance of the BPA Regional Natural Resource Specialist. Before the line is released for future maintenance, a detailed post-construction field review would be conducted with DNR, the BPA field inspector, and the BPA Regional Natural Resource Specialist. Specific weed control measures would be agreed upon and responsibilities, including funding, assigned to the participating organization.

Maintenance. Over the long-term, vegetation (including noxious weeds) on DNR land would be managed by the BPA Regional Natural Resource Specialist along the right-of-way as guided by BPA's Transmission System Vegetation Management Program EIS, agreements made with DNR, and input from the Klickitat County weed board.

I.2.4 Water Resources, Wetlands, and Fish

Sections 3.5 and 3.7 of the EIS provides an analysis of the project's potential impacts on water resources, wetlands, and fish in the project vicinity for all three routing alternatives, including on the four DNR parcels potentially affected by the proposed project, and identifies measures to lessen or avoid impacts that would also apply to the four DNR parcels.

There are no perennial water bodies or floodplains located on the four DNR parcels where the proposed transmission line would cross. Proposed access roads would not cross drainages on any DNR parcels and no culverts would be installed.

Wetlands are found on Parcels 1 and 2. On Parcel 1, about 3.2 acres in five different wetlands could be permanently impacted by fill (dirt, rock, or concrete) required for tower footings and upgrading or building new access roads (see Section 3.5, Table 3-19); on Parcel 2 about 1.0 acre in two different wetlands could be permanently impacted. Impacts would vary depending on wetland quality (or "functional level"). Wetlands along Parcel 1 were ranked low or were not ranked because the wetland function could not be assessed and wetlands in Parcel 2 were ranked moderate. There would be no impacts to wetlands on Parcels 3 or 4.

As discussed in Section 3.5.1, if project-generated sediment were to reach an intermittent stream, it would have little effect, if any, and would likely be indiscernible from existing conditions within a few hundred feet. As there are no drainages on DNR parcels, there would be no impacts to fish.

I.2.5 Cultural Resources

Section 3.8 of the EIS provides an analysis of the project's potential impacts on cultural resources in the project vicinity for all three routing alternatives, including on the four DNR parcels potentially affected by the proposed project, and identifies measures to lessen or avoid impacts that would also apply to the four DNR parcels.

Cultural resource surveys were not conducted on DNR lands due to the lack of permission to enter the properties. Additional surveys of the alternatives, including DNR lands, will be conducted winter/spring 2011. Cultural resources will be avoided where possible and mitigation measures have been identified to reduce or eliminate adverse impacts (see Table 3.8.2). BPA will coordinate with DNR to avoid and minimize impacts to cultural resources.

I.2.6 Socioeconomics

Section 3.9 of the EIS provides an analysis of the project's potential impacts on socioeconomics and public facilities in the project vicinity for all three routing alternatives, including on the four DNR parcels potentially affected by the proposed project, and identifies measures to lessen or avoid impacts that would also apply to the DNR parcels.

Several of the DNR parcels are Washington State Trust Lands managed by DNR. The State Trust Lands are held in trust by the state and leased to private farmers either on a cash rent or sharecrop basis (McKay 2010), or to a wind developer (i.e., Windy Flats). The primary beneficiaries of State Trust Lands are public schools (kindergarten through 12th grade), which receive over 78 percent of the funds. In 2009, over 5.6 million acres were in State Trust Lands, and provided over $192 million in state revenues (DNR 2010).

As discussed above in Section I.2.2, Land Use and Recreation, DNR Parcels 2, 3, and 4 are Washington State Trust Lands managed by DNR. Parcel 2 is leased for range land and Parcel 4 is leased for range and crop production. Parcel 3 is leased for wind production as part of the Windy Flats Energy Production Area and may also be used for range.

As shown in Table I-4, permanent removal of land from use from construction of transmission tower footings and new access roads on DNR land used for grazing leases would be 4 acres (Parcel 2), 0.3 acres (Parcel 3) and 1 acre (Parcel 4). Parcel 4 is also used for crop production in the area of Substation Site 2, which would permanently remove 30 acres from use. These totals represent a relatively small portion of the DNR parcels (see Section I-1 for total parcel acreages).

It is estimated that cash rents for range land are about $2/acre·year, while crop land rents are between $30 and $40 per acre, per year (acre·year). Sharecrop returns to DNR range from 30 to 35 percent of the crop, which results in $10 to $70 per acre·year,

Based on the cash rents and sharecrop returns, the amount of DNR revenue lost to towers and access roads is estimated to be $12 per year for Parcel 2 (West Alternative) and $0.60 per year for Parcel 3 (based on the impacts to range land; East Alternative). If any of the alternatives connect to Substation Site 2, they would impact additional State Trust Lands by about $210 per year.

Crops lost to temporary construction activity would result in about $273 annually during construction for the action alternatives; this amount would be compensated in addition to the purchase of the property or easement. If any of the land is held in CRP, federal payments made to the state would be affected if all or a portion of the land had to be taken out of CRP. Placement of transmission lines would not necessarily affect CRP status and no loss in value from construction activities would be expected for CRP land. Because the East Alternative would be routed to avoid conflicts with existing wind turbines already developed on Parcel 3, there would be no additional wind development revenue loss expected.

I.2.7 Transportation

Section 3.10 of the EIS provides an analysis of the project's potential impacts on transportation in the project vicinity for all three routing alternatives, including on the four DNR parcels potentially affected by the proposed project, and identifies measures to lessen or avoid impacts that would also apply to the four DNR parcels.

Table I-2 displays the proposed miles and acres of new access roads and those needing improvement located on the four DNR parcels that could be affected by the proposed project. Table I-6 displays the general characteristics of access road easements proposed to be located on the four DNR parcels that could be affected by the proposed project. This table identifies the type, length, and width of the proposed easements and what type of use is expected (joint or BPA exclusive use).

During construction, unavoidable transportation impacts would consist of minor delays and interruptions to local traffic, with a relatively low increase in daily traffic volume on highways. Operation and maintenance traffic over the life of the line would be only a few maintenance vehicles once a year, and helicopters twice a year.

A discussion of BPA's access road system for the proposed project is included in Section 2.3.4, Access Roads, of the EIS. This discussion includes a general description of the width, location, type of road improvement, and construction equipment that would be used. Use of temporary roads within agricultural fields is also discussed. For the DNR parcels, BPA would acquires rights (easements for line access roads and fee title for substation access roads), and develop and maintain permanent access suitable for travel by wheeled vehicles to each transmission line structure site, substation or other transmission facility. Existing public and private roads and transmission line rights-of-way would be used for access where reasonably possible. See Section 3.1 Land Use and Recreation for a discussion about possible unauthorized access and use of BPA roads.

As part of BPA's Transmission Engineering Manual, BPA has an Access Road Planning and Design Manual (BPA, 1987). This comprehensive manual includes BPA's access road policy and standards regarding the design and construction of access roads that also would be used for proposed access roads on and adjacent to the four DNR parcels.

Environmental, engineering, economic, and maintenance factors are considered in locating and designing access roads. Access road planning, as described in the BPA Manual, takes into account many factors including seasonal constraints for construction, steep slopes, present and potential land uses, soil conditions, soil erosion potential, water quality impacts, visual impacts, and impacts to cultural resources. The BPA Manual also describes erosion and sediment control methods that are implemented. Erosion control is a very important factor in planning, designing, constructing and maintaining access roads. Erosion must be controlled during and after construction to prevent road damage, to avoid undue increases in stream turbidity and sedimentation, and soil deposition outside of the road right-of-way. Well designed and constructed erosion control measures would reduce road maintenance costs and provide a reliable road in the event of emergency work on the transmission line. Drainage structures including culverts, intercepting dips, water bars, and gravel surfacing are elements of erosion control, as is seeding.

Access road planning and design are important elements of transmission project development and to be effective must begin at the earliest stage of project planning. Well developed access road plans and designs minimize construction and maintenance costs, environmental impacts, and costly delays because of late changes in access road routing. Access road plans and designs are developed using landowner, environmental, construction, and maintenance input. For the DNR parcels, access road plans and designs would also be coordinated with the appropriate DNR engineer.

Table I-6. Proposed Access Roads located on DNR Parcels

DNR Parcel	Legal Description	Land Use	Type of Easement	Length of Easement (feet)	Width of Easement (feet)	Anticipated Road Use
Parcel 1	Sec 28 T3N R14E	Columbia Hills Preserve	Permanent Road	2,040	50	BPA Use - Road AZH-10-AR-3
Parcel 1	Sec 28 T3N R14E		Permanent Road	1,620	50	BPA Use - Road AZH-11-AR-1
Parcel 1	Sec 32 T3N R14E		Permanent Road	360	50	BPA Use - Road AZH-9-AR-2
Parcel 1	Sec 32 T3N R14E		Permanent Road	1,375	50	BPA Use - Road AZH-9-AR-3
Parcel 1	Sec 32 T3N R14E		Permanent Road	970	50	BPA Use - Road AZH-9-AR-4
Parcel 1	Sec 32 T3N R14E		Permanent Road	1,545	50	BPA Use - Road AZH-9-AR-5
Parcel 1	Sec 32 T3N R14E		Permanent Road	1,775	50	BPA Use - Road AZH-10-AR-1
Parcel 1	Sec 32 T3N R14E		Permanent Road	1,025	50	BPA Use - Road AZH-10-AR-2
Parcel 1	Sec 33 T3N R14E		Permanent Road	1,925	50	BPA Use - Road AZH-10-AR-2
Parcel 1	Sec 32 T3N R14E	Existing Road	None: Existing Road (Stacker Mt Microwave Rd)	5,810	60	Joint Use - Stacker Mt Microwave Rd
Parcel 2	Sec 36 T4N R14E	Agriculture	Permanent Road	330	50	BPA Use - AZH-16-AR-2P1
Parcel 2	Sec 36 T4N R14E		Permanent Road	1,580	50	BPA Use - AZH-16-AR-2P2
Parcel 2	Sec 36 T4N R14E		Permanent Road	700	50	BPA Use - AZH-16-AR-3
Parcel 2	Sec 36 T4N R14E		Permanent Road	670	50	BPA Use - AZH-17-AR-1
Parcel 2	Sec 36 T4N R14E		Permanent Road	350	50	BPA Use - W17-AR-2
Parcel 2	Sec 36 T4N R14E	Existing Road	None: Existing Road (Ahola Rd)	4,390	60	Joint Use - Ahola Rd

DNR Parcel	Legal Description	Land Use	Type of Easement	Length of Easement (feet)	Width of Easement (feet)	Anticipated Road Use
Parcel 3	Sec 36 T3N R15E	Windy Flats	Permanent Road	3,035	50	BPA Use - Road AZE-15-AR-4
Parcel 3	Sec 36 T3N R15E		Permanent Road	420	50	BPA Use - Road AZE-15-AR-5
Parcel 3	Sec 36 T3N R15E		Permanent Road	895	50	BPA Use - Road AZE-16-AR-1
Parcel 3	Sec 36 T3N R15E	Existing Road	None: Existing Road (Haystack Butte Road)	1,800	60	Joint Use - Road HAST-SAR-P9 (Haystack Butte Rd)
Parcel 4	Sec 36 T5N R15E	Agriculture	Permanent Easement (Route of Travel)	2,625	50	BPA Use - Tower access E 28/4
Parcel 4	Sec 36 T5N R15E	Agriculture[1]	Permanent Road	2,685	50	BPA Use - Knight-SAR-1
Parcel 4	Sec 36 T5N R15E	Agriculture[2]	Permanent Road	3,900	50	BPA Use - Knight Substation Access

[1] This road would lead to Knight Substation Site 1.
[2] This road would lead to Knight Substation Site 2.

I.3 Potential Measures on DNR lands

In addition to mitigation measures identified in Chapter 3 of the EIS, the measures outlined in Table I-7 could be implemented to further reduce or avoid potential impacts on DNR lands.

Table I-7. Potential Measures on DNR Parcels

Measure	Implementation
Implement the MOA with DNR that reduces noxious, invasive and undesirable species and works towards compatible and native species vegetation on DNR lands. The MOA also will provide coordination between DNR and BPA for the use of herbicides on lands where DNR uses herbicides and minimizes the use of herbicides on lands where DNR does not use herbicides.	Washington Statewide Rights-of-Way MOA/DNR Easement Document
Implement the MOA with DNR to jointly maintain mutually beneficial roads that ensures payments by the parties for their joint use and their need for a permanent transportation system.	Washington Statewide Rights-of-Way MOA/DNR Easement Document
Commit to coordinating road design with DNR.	Washington Statewide Rights-of-Way MOA/DNR Easement Document
Coordinate with DNR regarding the 1989 DNR Agricultural and Grazing lands Policy Plan and related Resource Management Plans for individual parcels during construction and maintenance of the line and access roads over DNR trust lands.	Washington Statewide Rights-of-Way MOA
Implement the Appraisal MOU with DNR to pay fair market value for impacts to trust lands.	Appraisal MOU

Measure	Implementation
Utilize the Appraisal MOU with DNR to assess the value for any reduction in CRP acreage due to construction of access roads or towers.	Appraisal MOU
Work with DNR concerning a possible cooperative agreement for the control of unauthorized public access and use on state lands that could result from the proposed project. The agreement could address various provisions related to unauthorized access, such as additional measures to be taken to discourage unauthorized use of the project corridor and associated access roads, periodic inspection for unauthorized access and any resulting damage, and repair of any damage from unauthorized access. BPA will strive to design the corridor to prevent trespass and provide signs that discourage unauthorized use of the corridor.	Washington Statewide Rights-of-Way MOA (see McNary-John Day Maintenance and Operations Agreement) /DNR Easement Document
Mark the easement corridor in strategic locations on DNR land so that BPA, contractors, adjacent landowners and the public can clearly recognize when they are within the corridor to prevent uncompensated corridor expansion, vegetation management conflicts, and to reduce trespass.	Washington Statewide Rights-of-Way MOA (see McNary-John Day Maintenance and Operations Agreement) /DNR Easement Document
Develop a mutually agreeable fire prevention and suppression plan with DNR that addresses managing and controlling the risks associated with wildland fire due to construction, operation, and maintenance of the transmission line.	Washington Statewide Rights-of-Way MOA (see McNary-John Day Maintenance and Operations Agreement) /DNR Easement Document

LEGEND

	WEST	MIDDLE	EAST
MILEPOST	8	8	8
ROUTE & BUFFER			
STRUCTURE			

POTENTIAL HAZARDS

GRAVEL PIT

SLIDE OR SLIP

WET SPOT

MINE / QUARRY

ROCK OUTCROP

STONY SPOT

FAULTS

FOLDS

SOIL HAZARD

SEVERE

1OO YEAR FLOOD EVENT AREA

WETLAND AREA

LANDSLIDES (Debris Flow Direction)

LIQUEFACTION

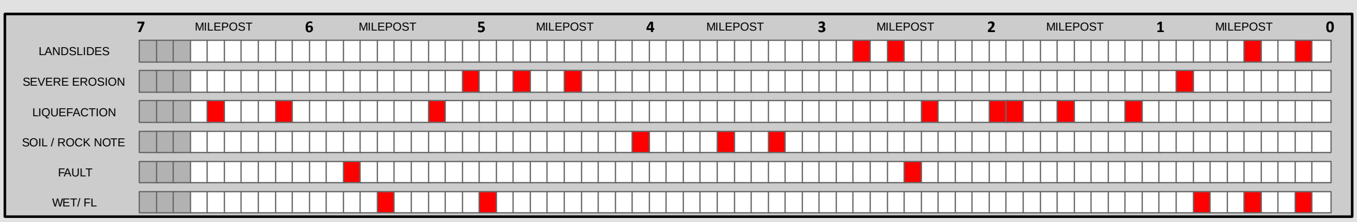
VERY LOW

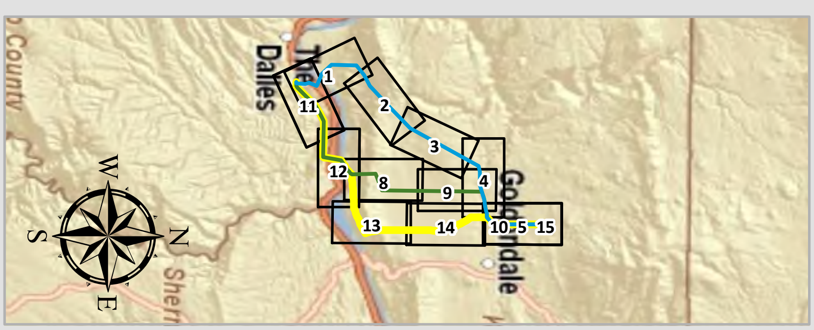
LOW TO MODERATE

MODERATE TO HIGH

POTENTIAL HAZARD KEY BY MILEPOST

Gray = Not Evaluated On This Sheet   Red = Potential Hazard Present Within Corridor   White = Potential Hazard Not Observed





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POTENTIAL HAZARDS STRIP MAP LEGEND

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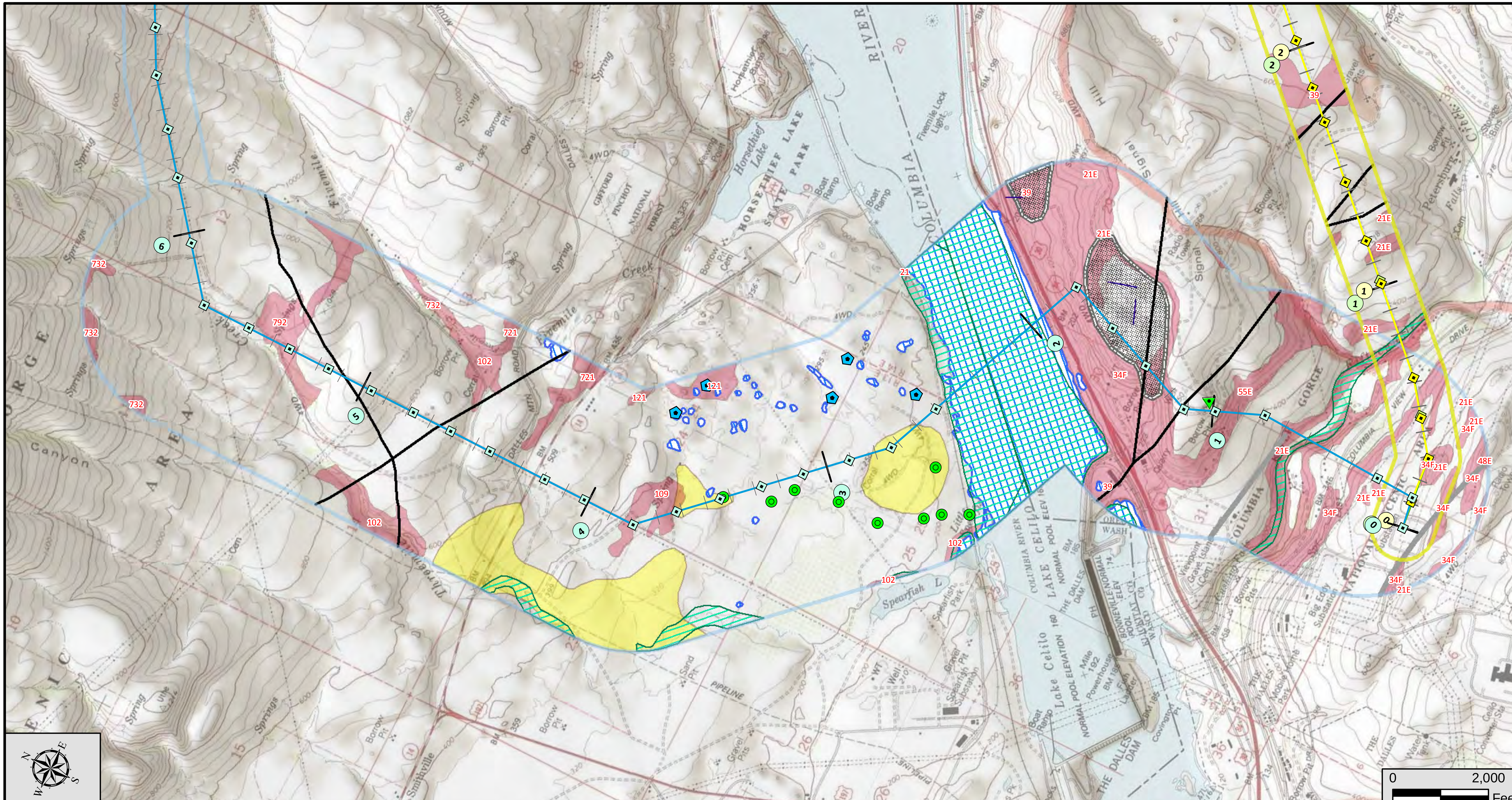

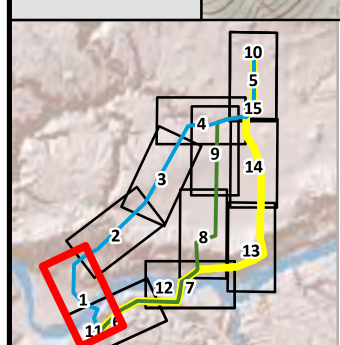

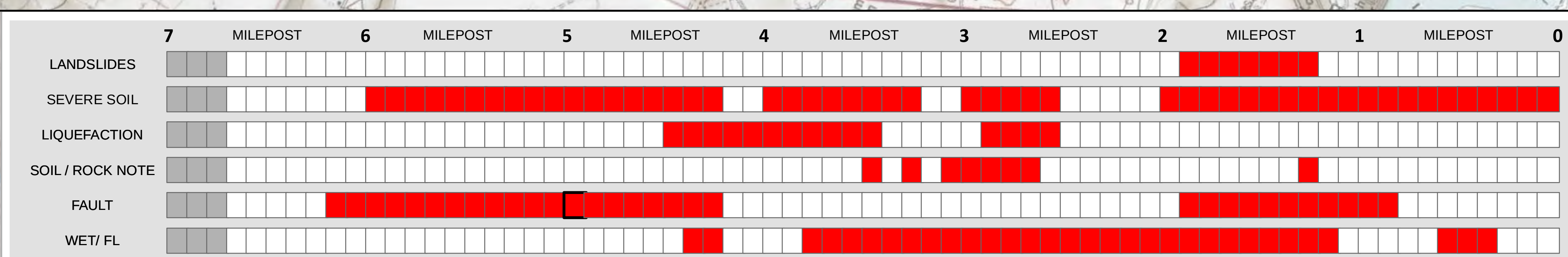

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HYDROLOGIC STRIP MAP WEST ROUTE

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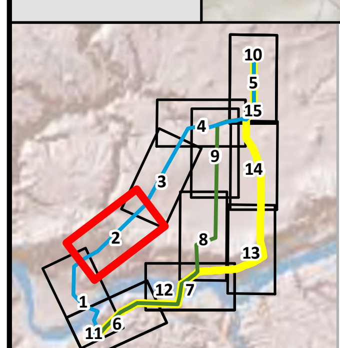

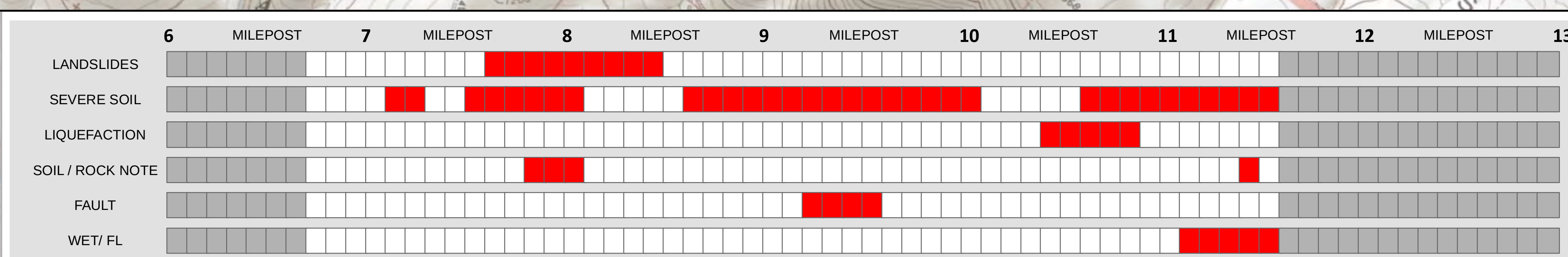

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HYDROLOGIC STRIP MAP
WEST
ROUTE

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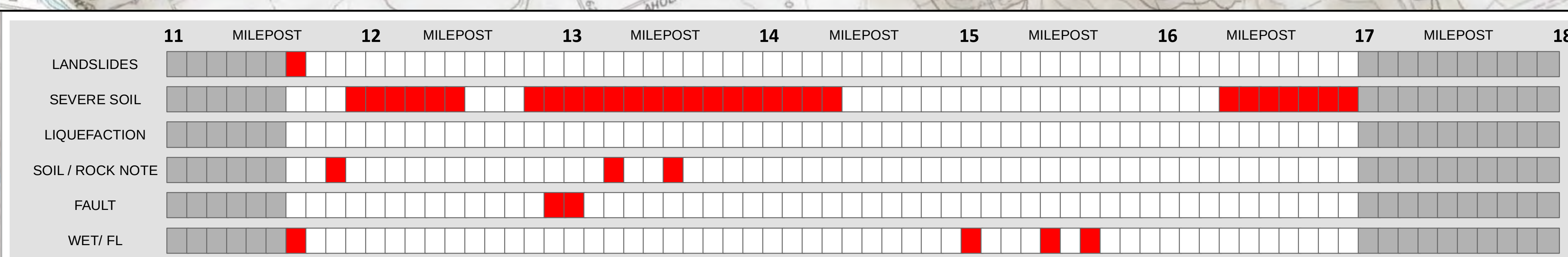

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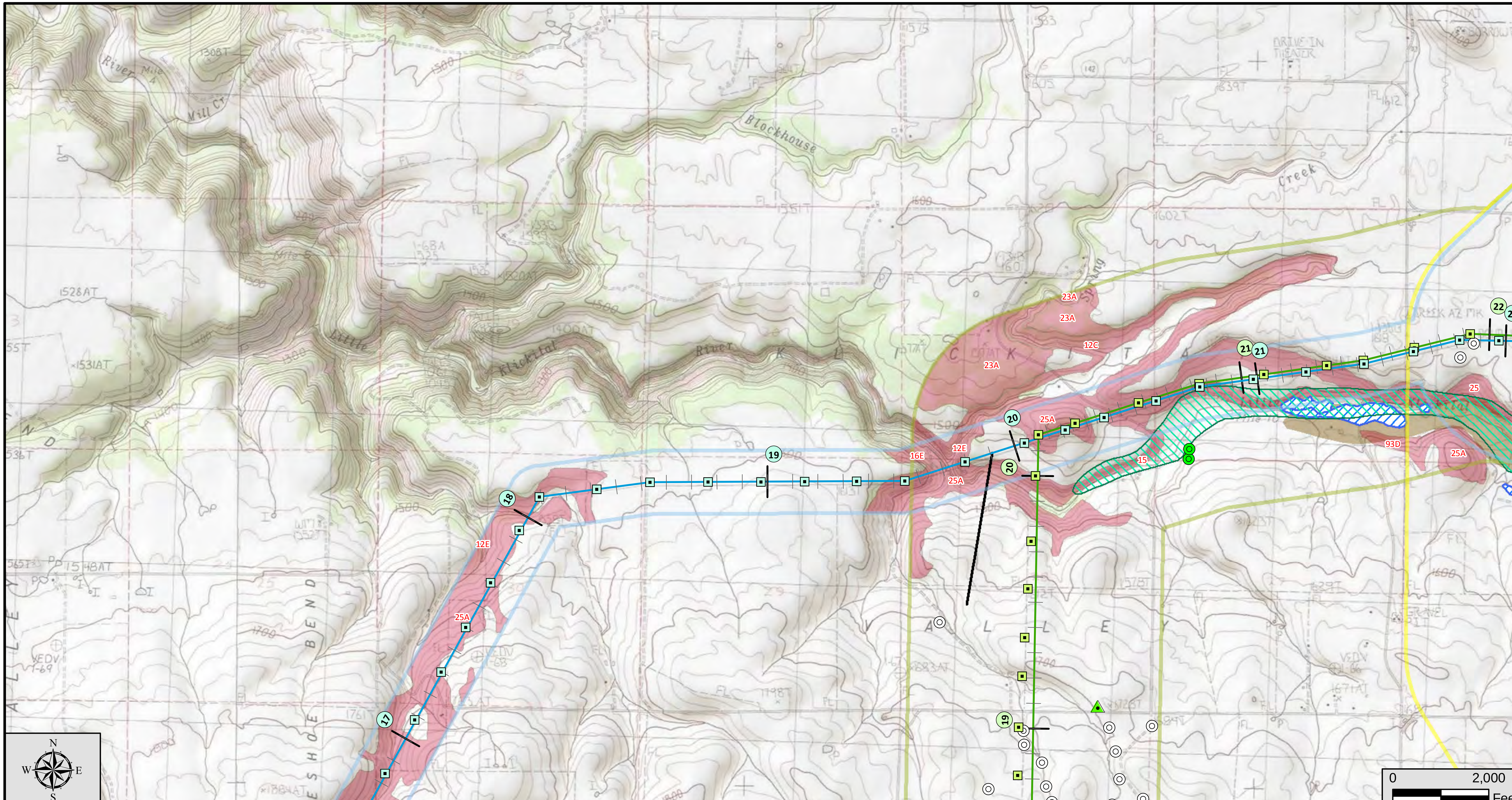

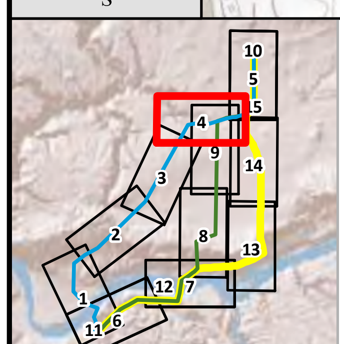

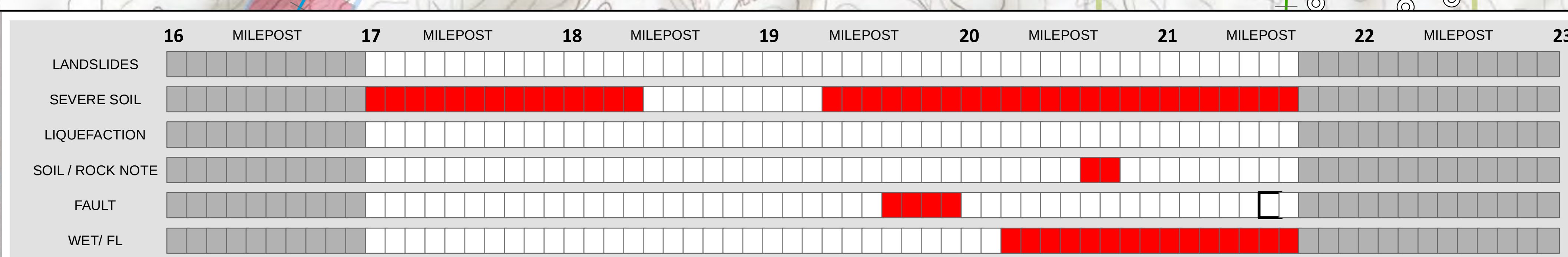

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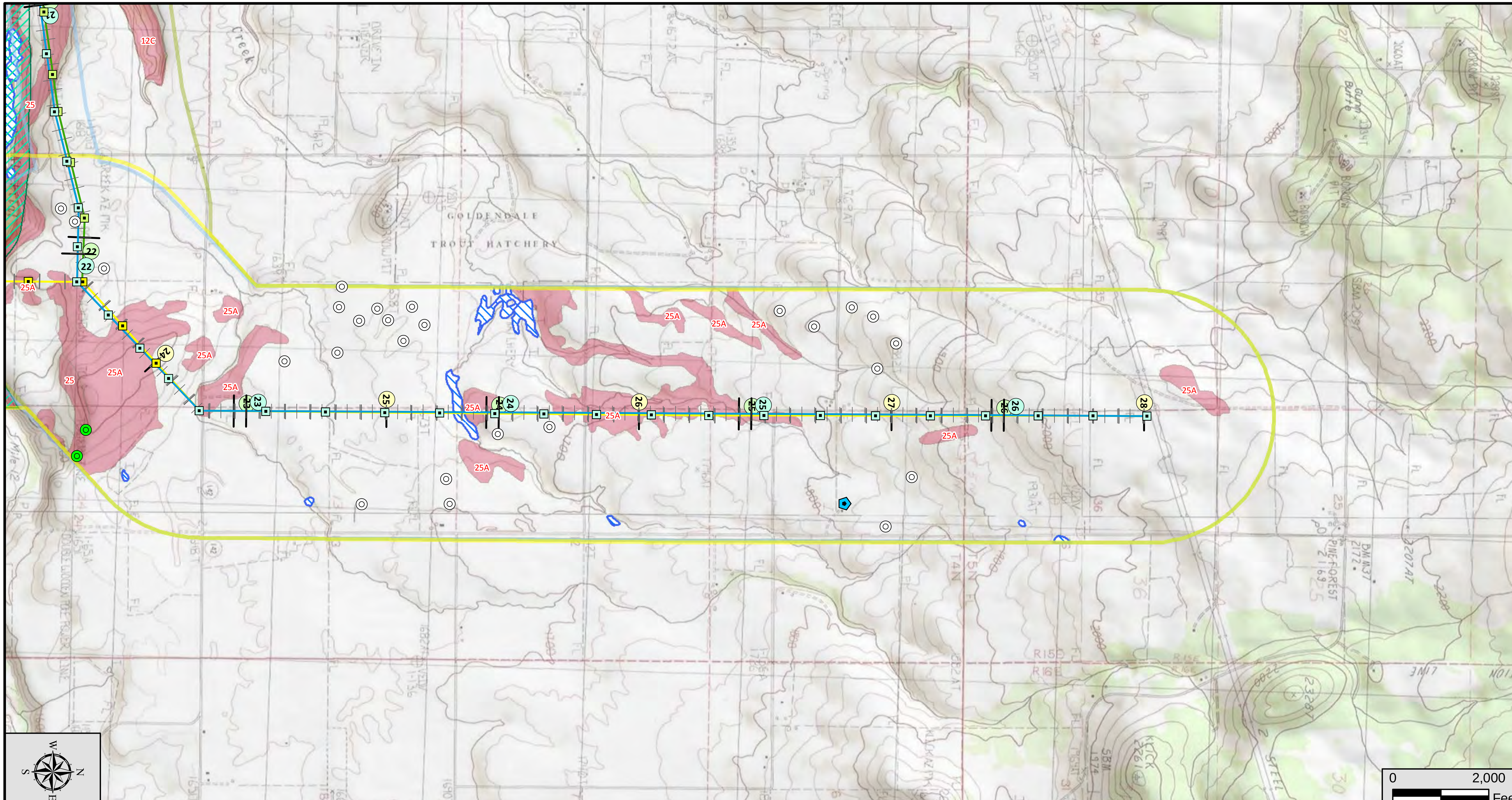

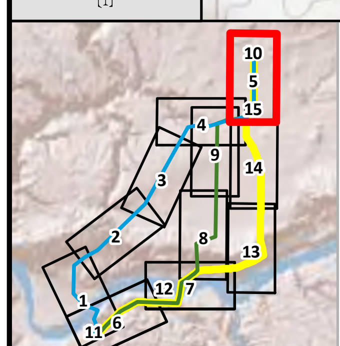

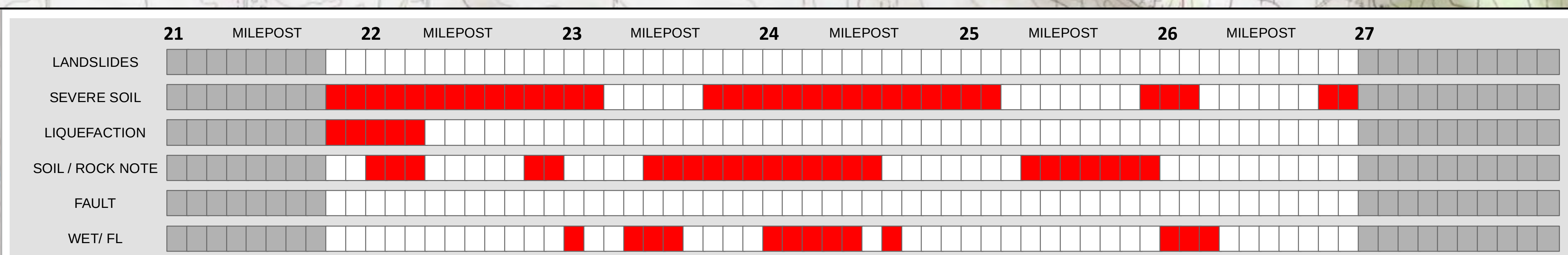

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HYDROLOGIC STRIP MAP
WEST
ROUTE

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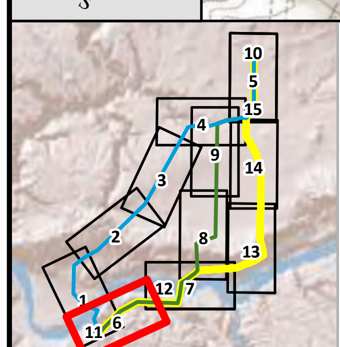

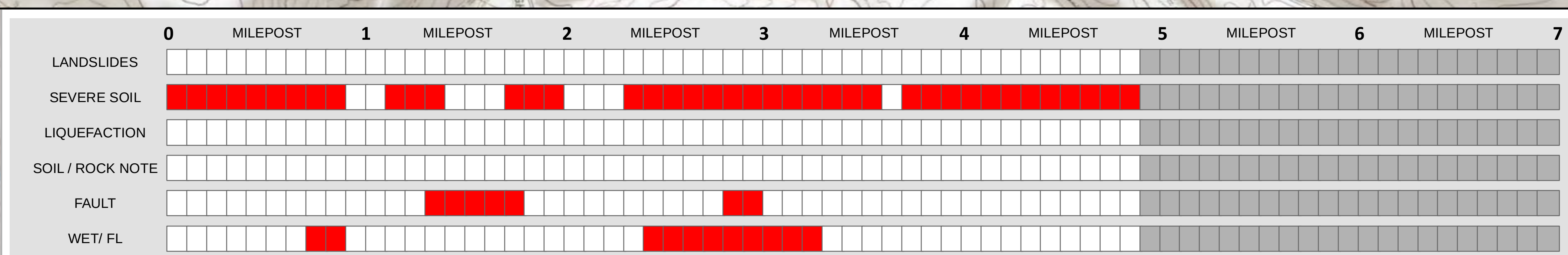

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HYDROLOGIC STRIP MAP MIDDLE ROUTE

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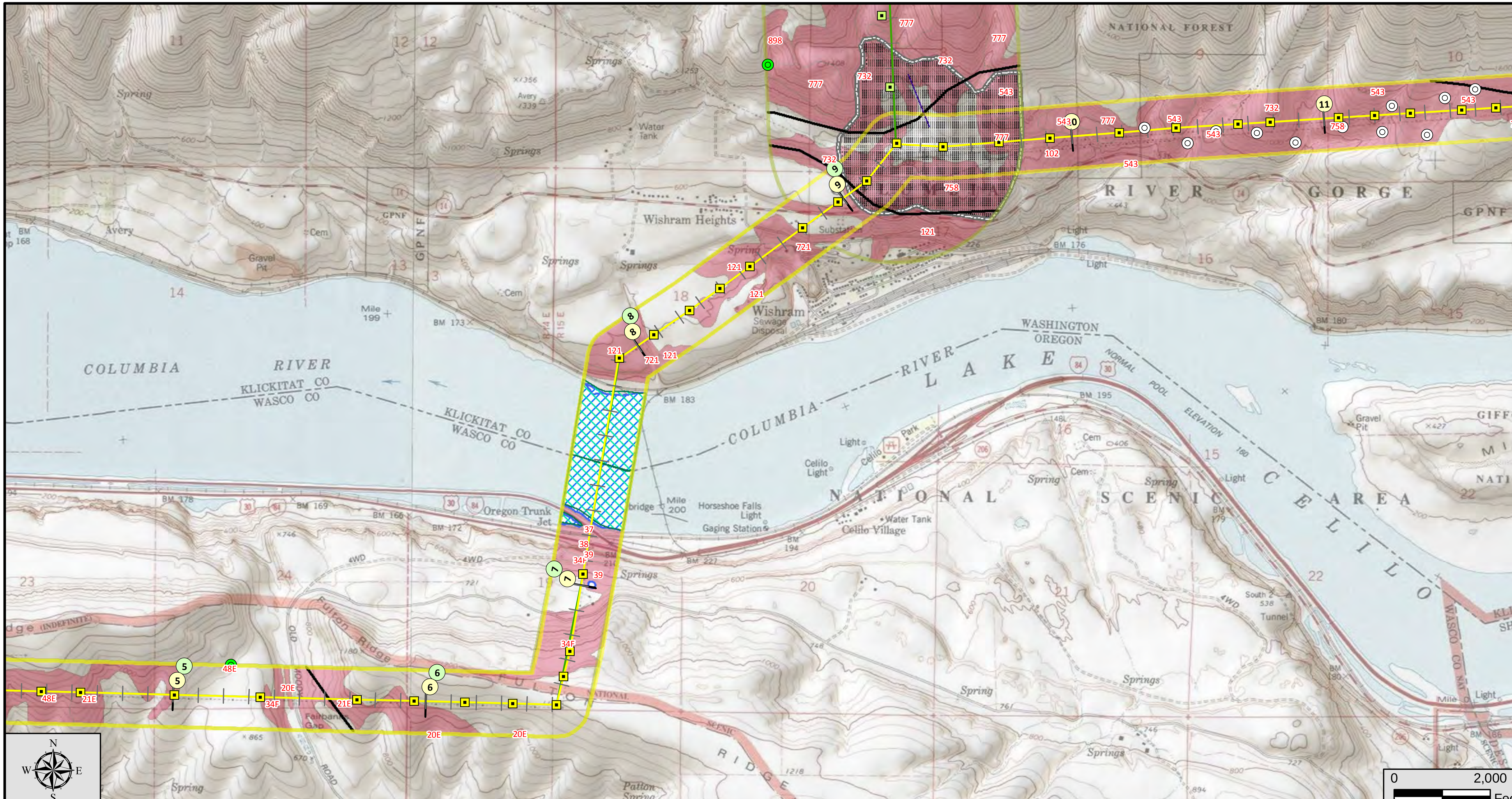

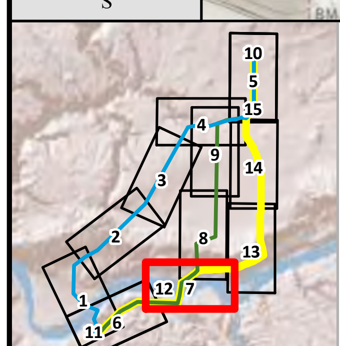

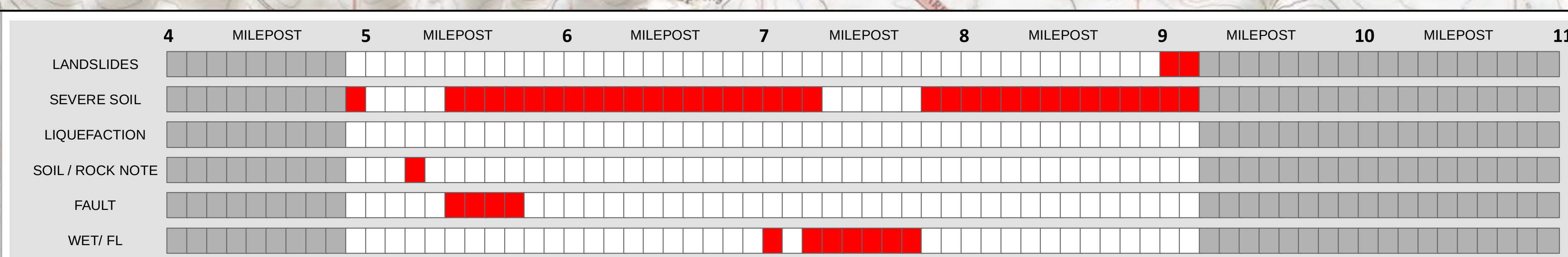

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HYDROLOGIC STRIP MAP
MIDDLE
ROUTE

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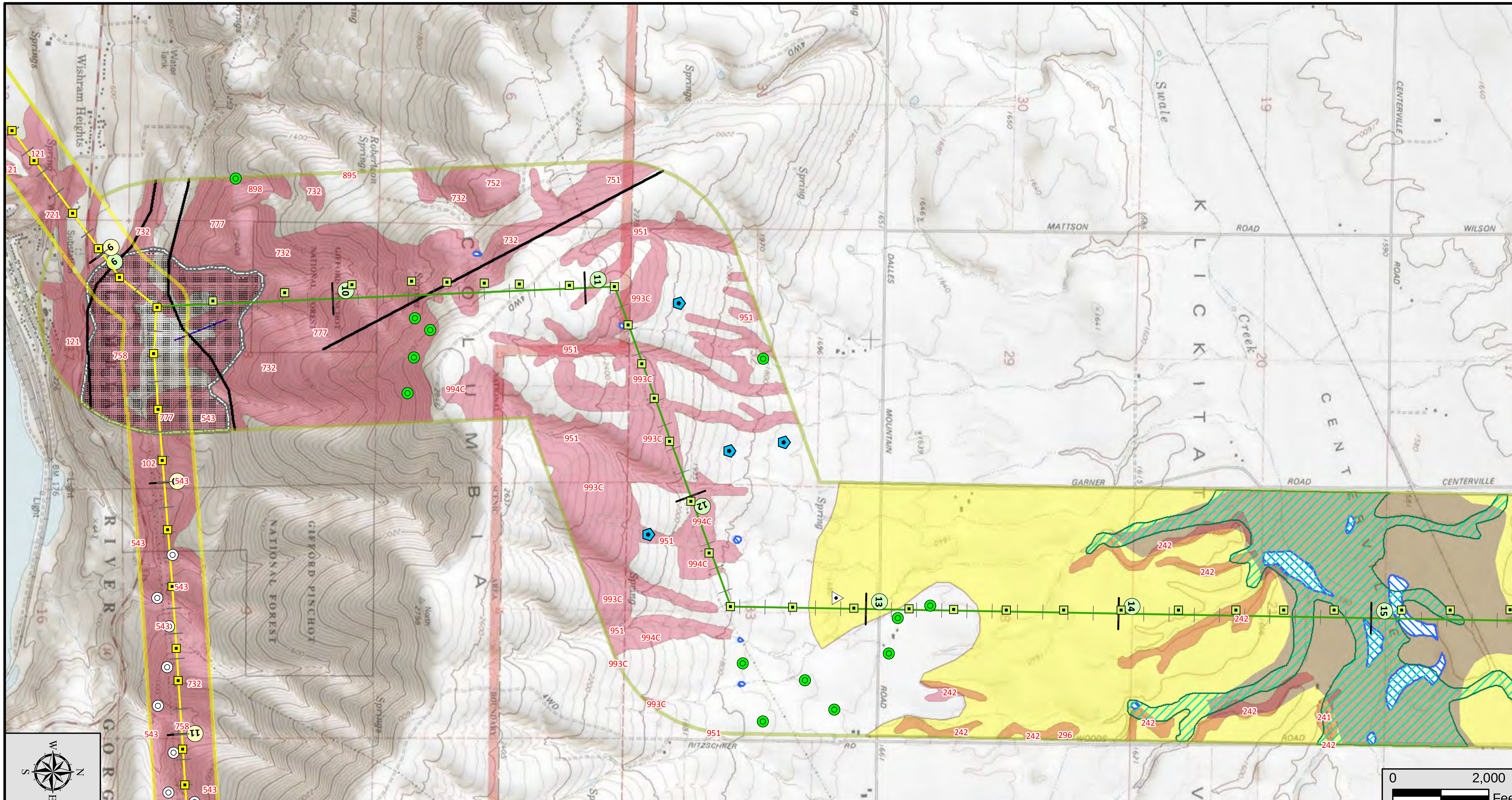

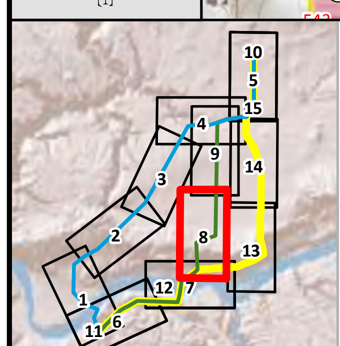

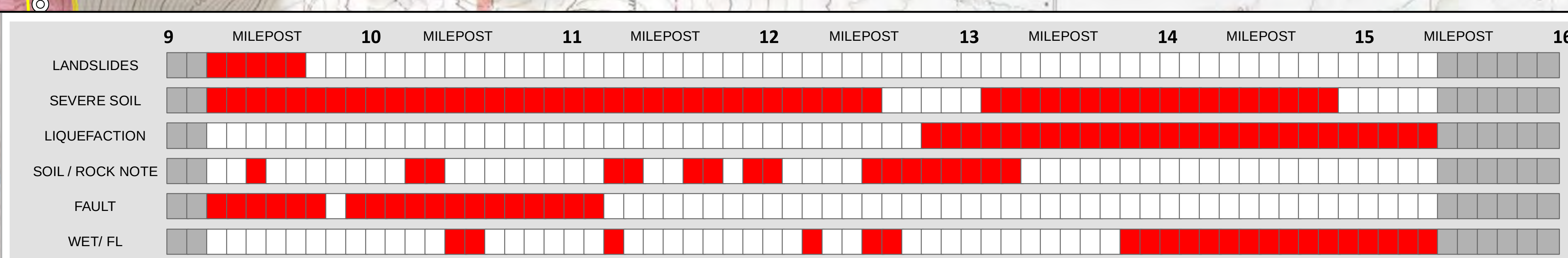

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HYDROLOGIC STRIP MAP MIDDLE ROUTE

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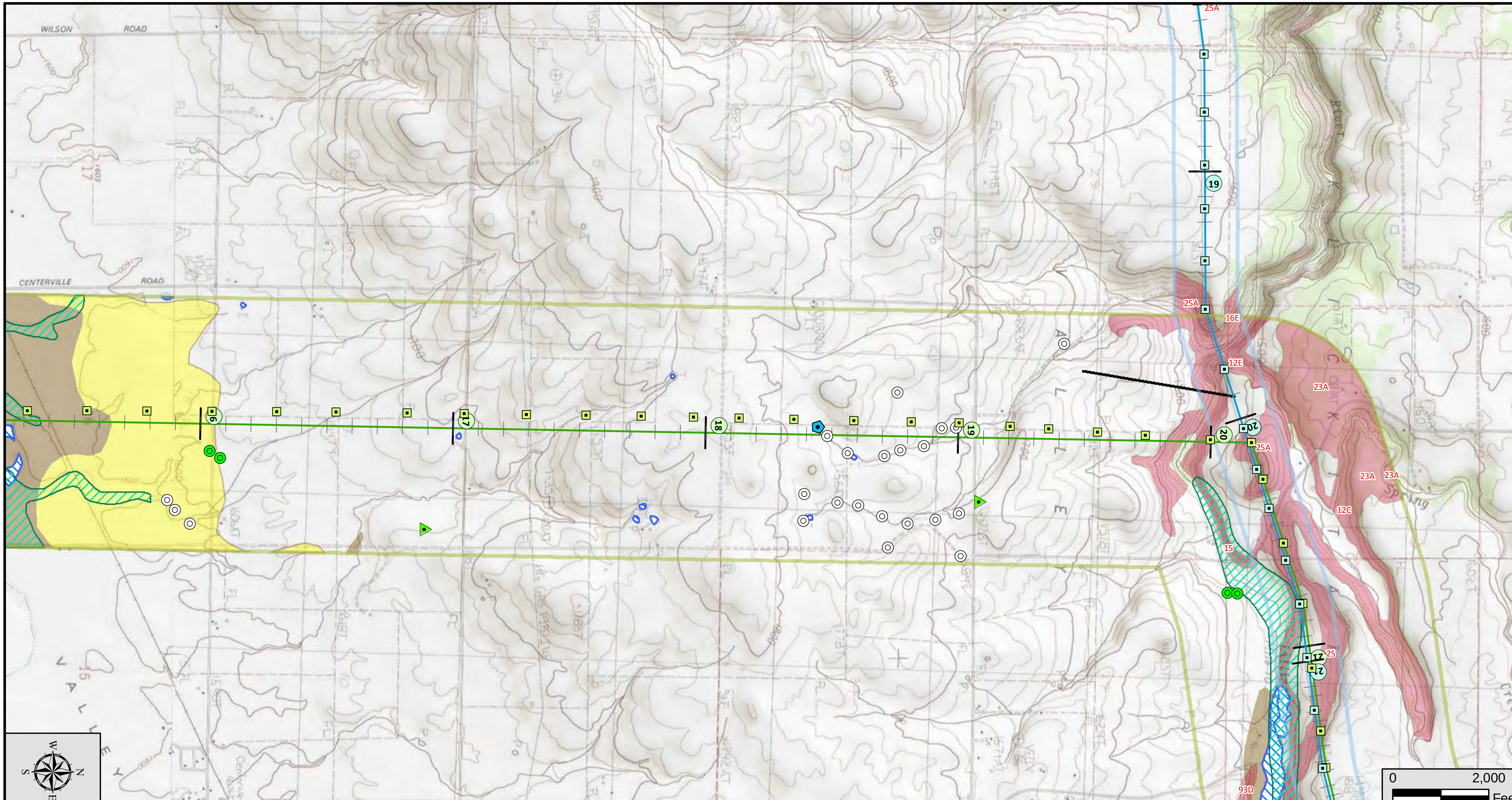

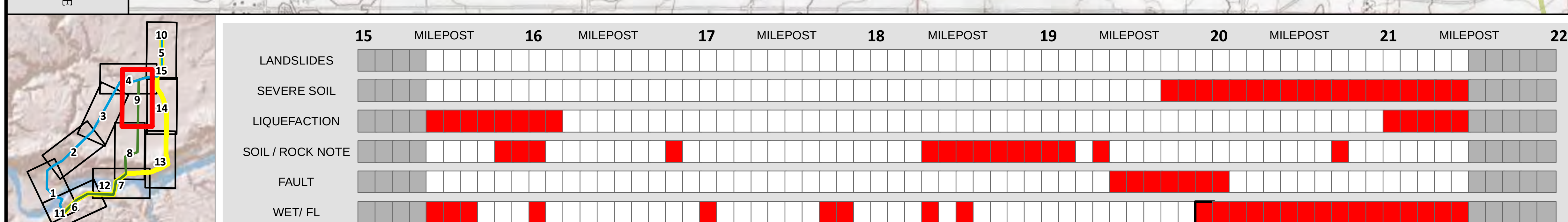

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Big Eddy - Knight 500 kv
Transmission Line Project

HYDROLOGIC STRIP MAP MIDDLE ROUTE

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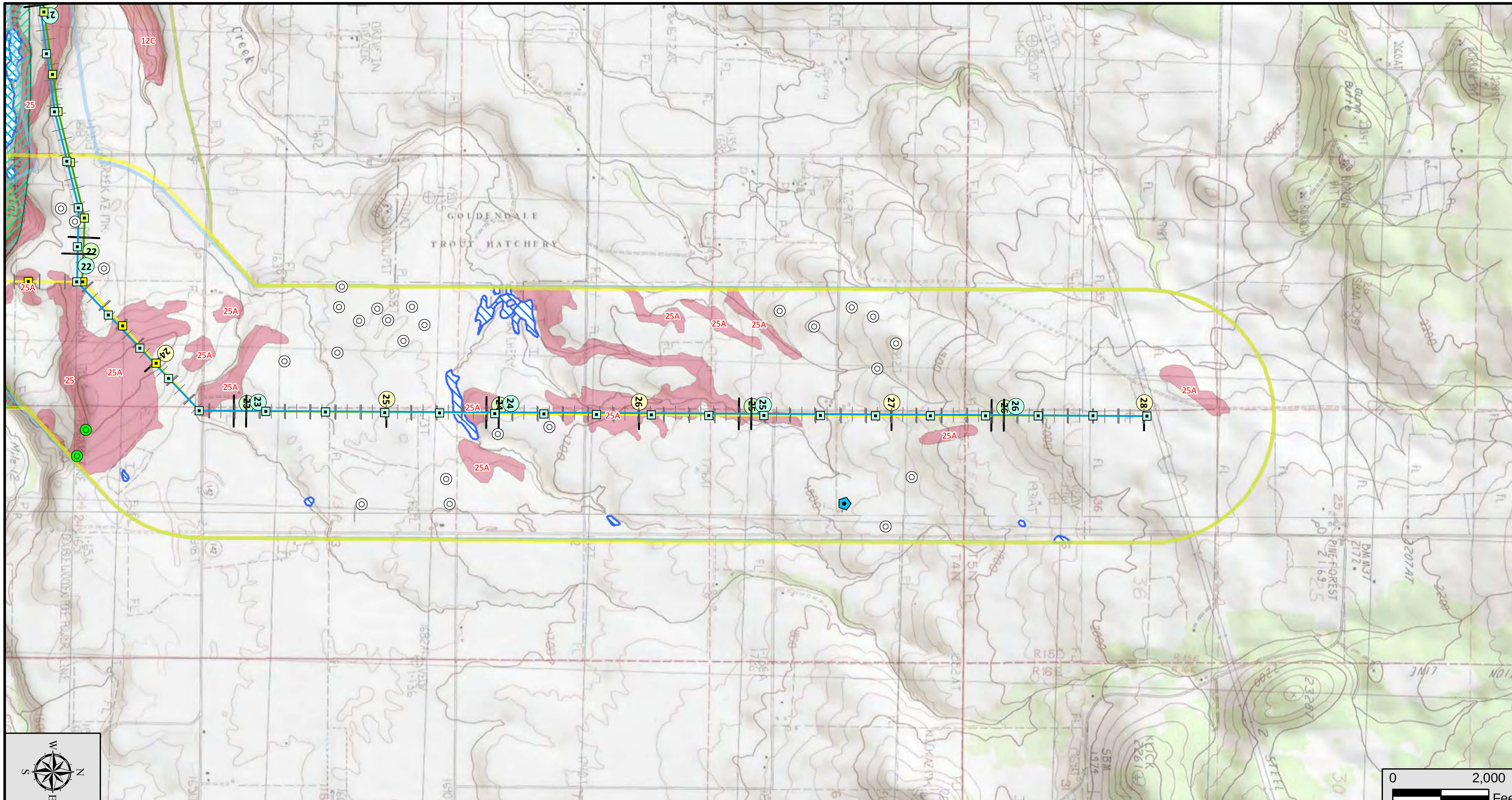

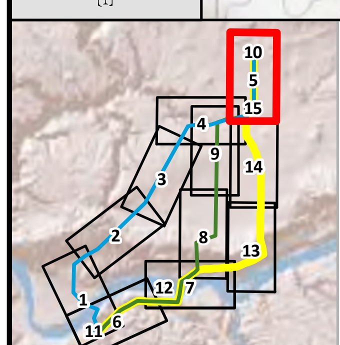

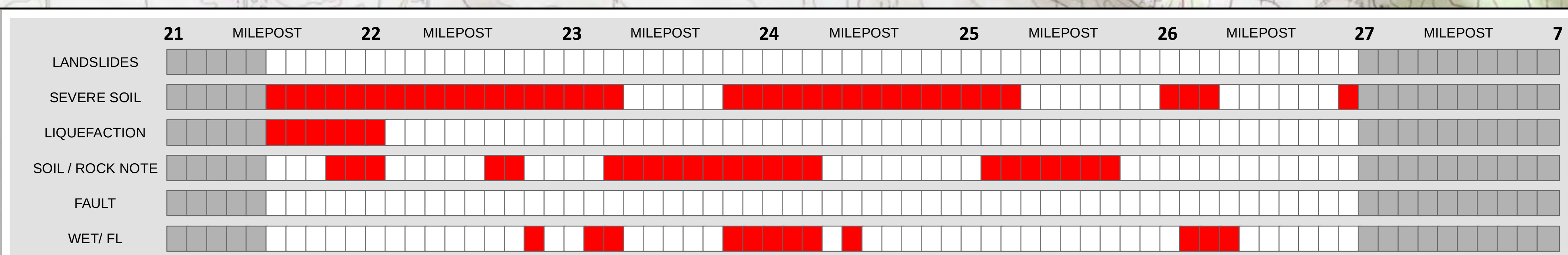

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Big Eddy - Knight 500 kv
Transmission Line Project

HYDROLOGIC STRIP MAP MIDDLE ROUTE

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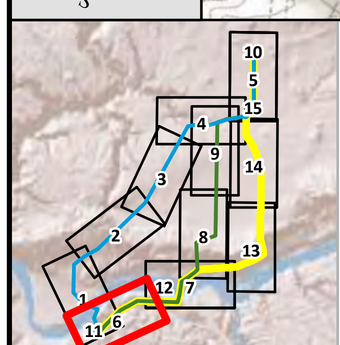

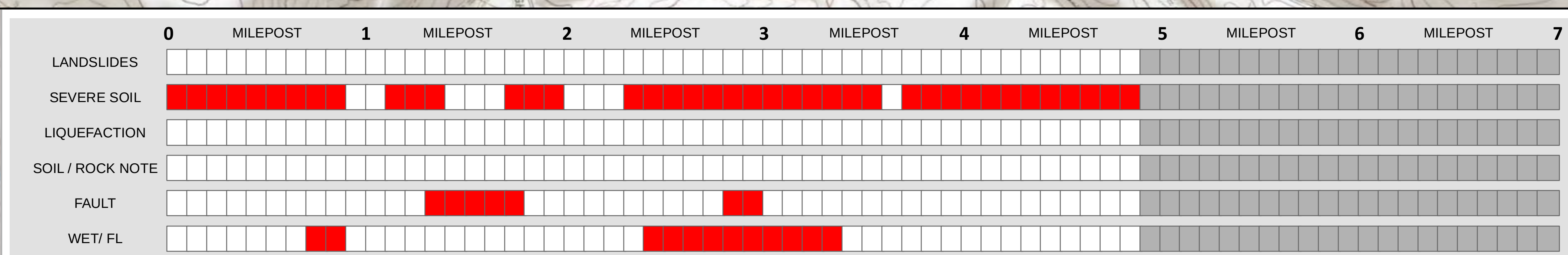

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Big Eddy - Knight 500 kv
Transmission Line Project

HYDROLOGIC STRIP MAP
EAST
ROUTE

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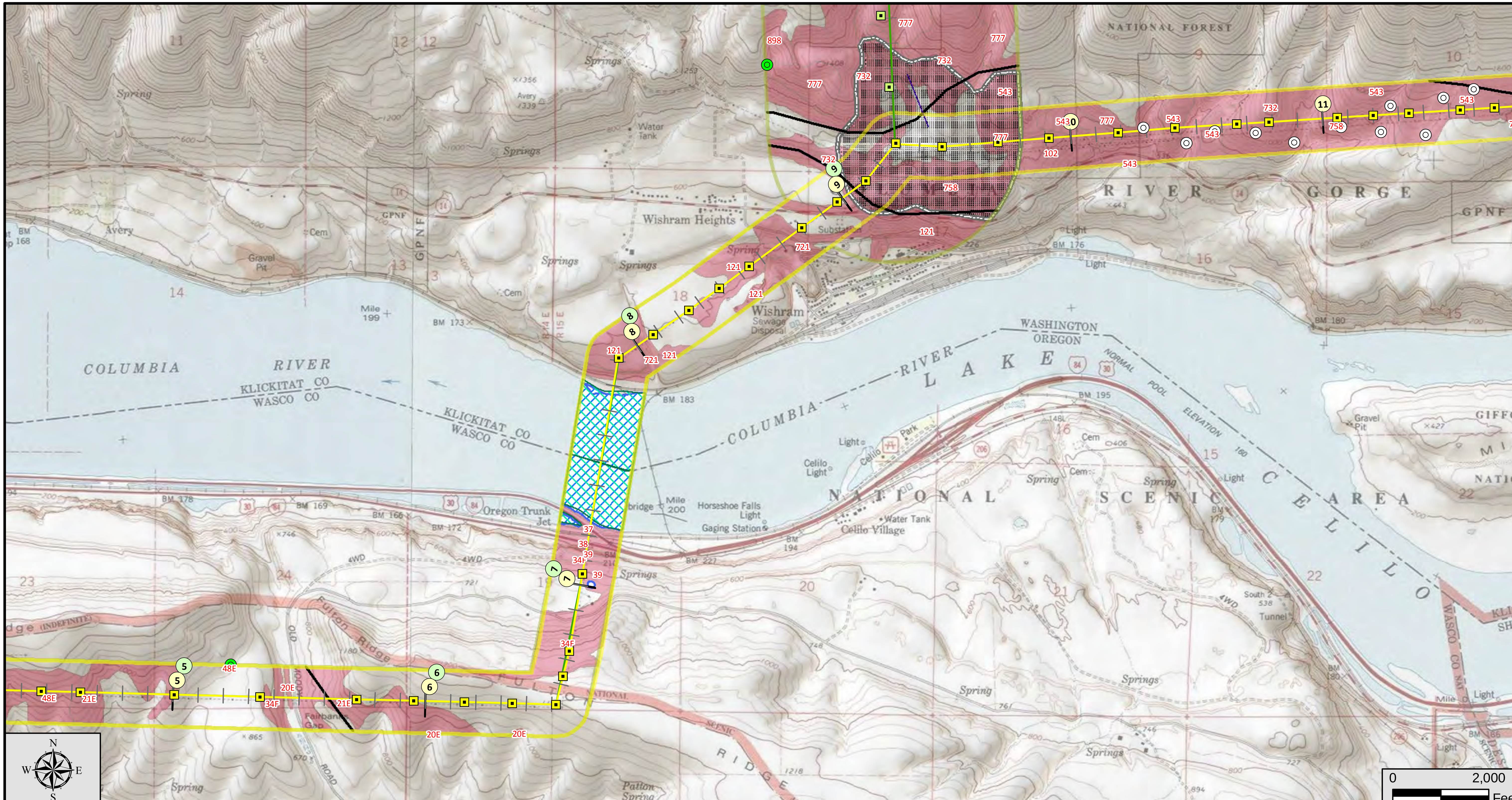

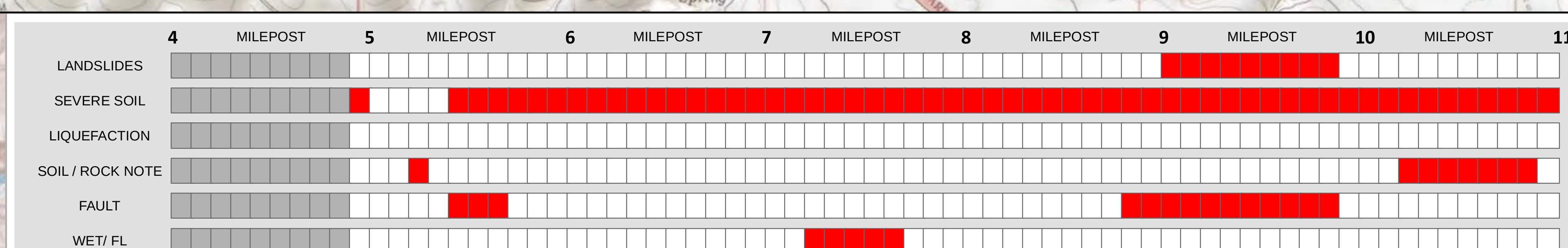

Bonneville Power Administration
Big Eddy - Knight 500 kv
Transmission Line Project

HYDROLOGIC STRIP MAP EAST ROUTE

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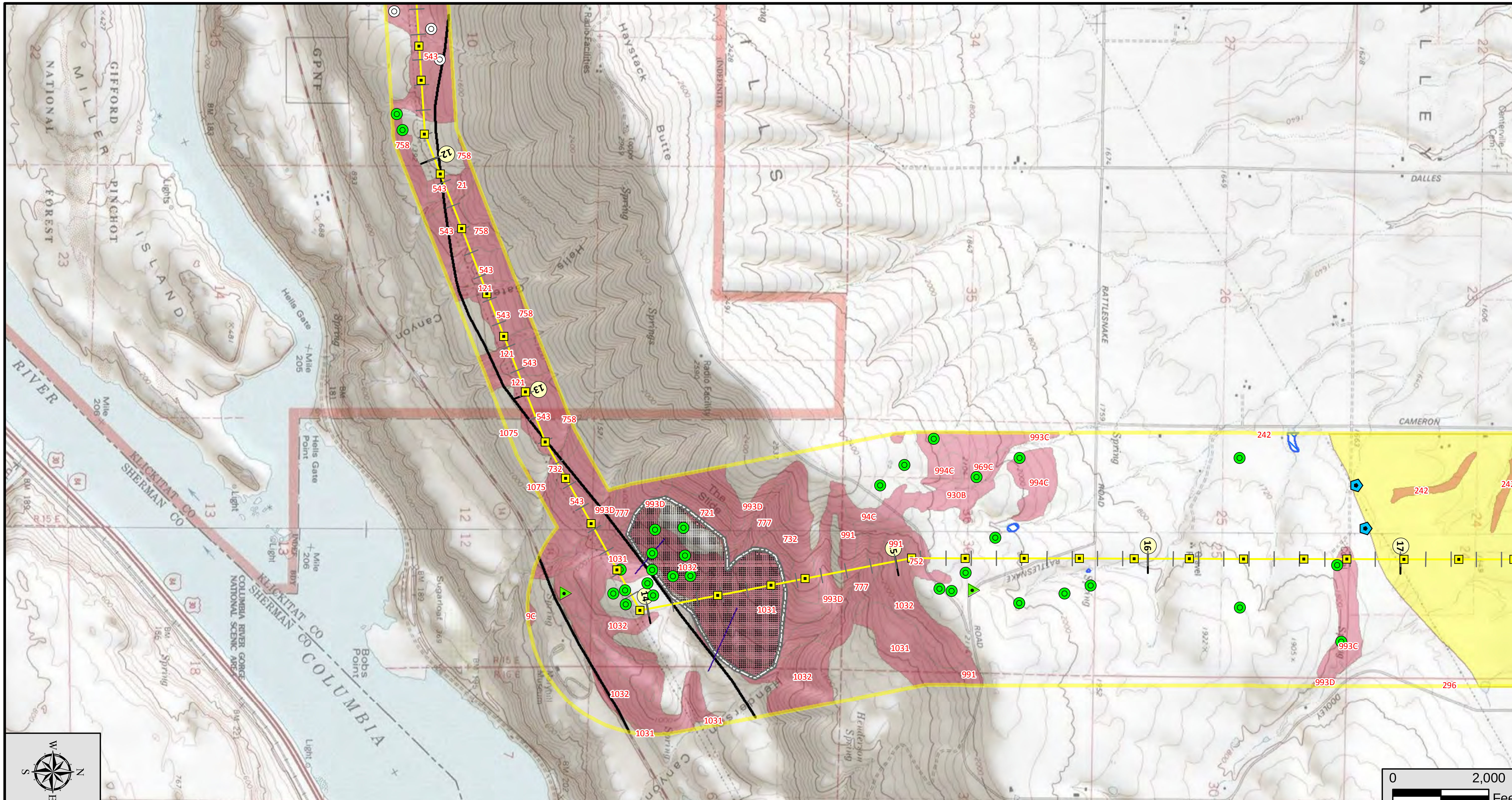

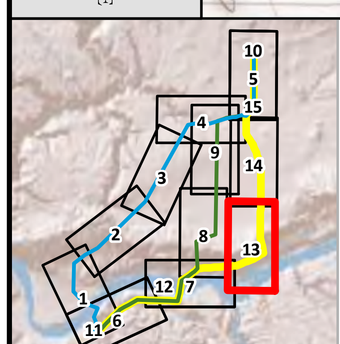

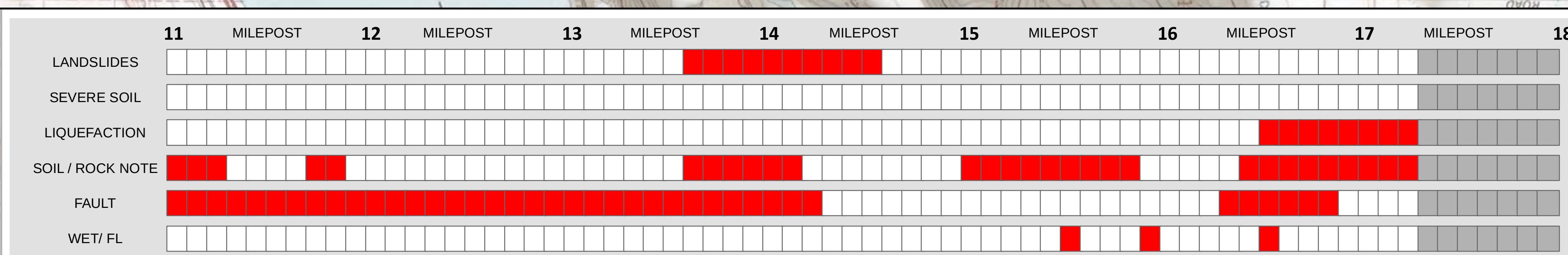

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Big Eddy - Knight 500 kv
Transmission Line Project

HYDROLOGIC STRIP MAP EAST ROUTE

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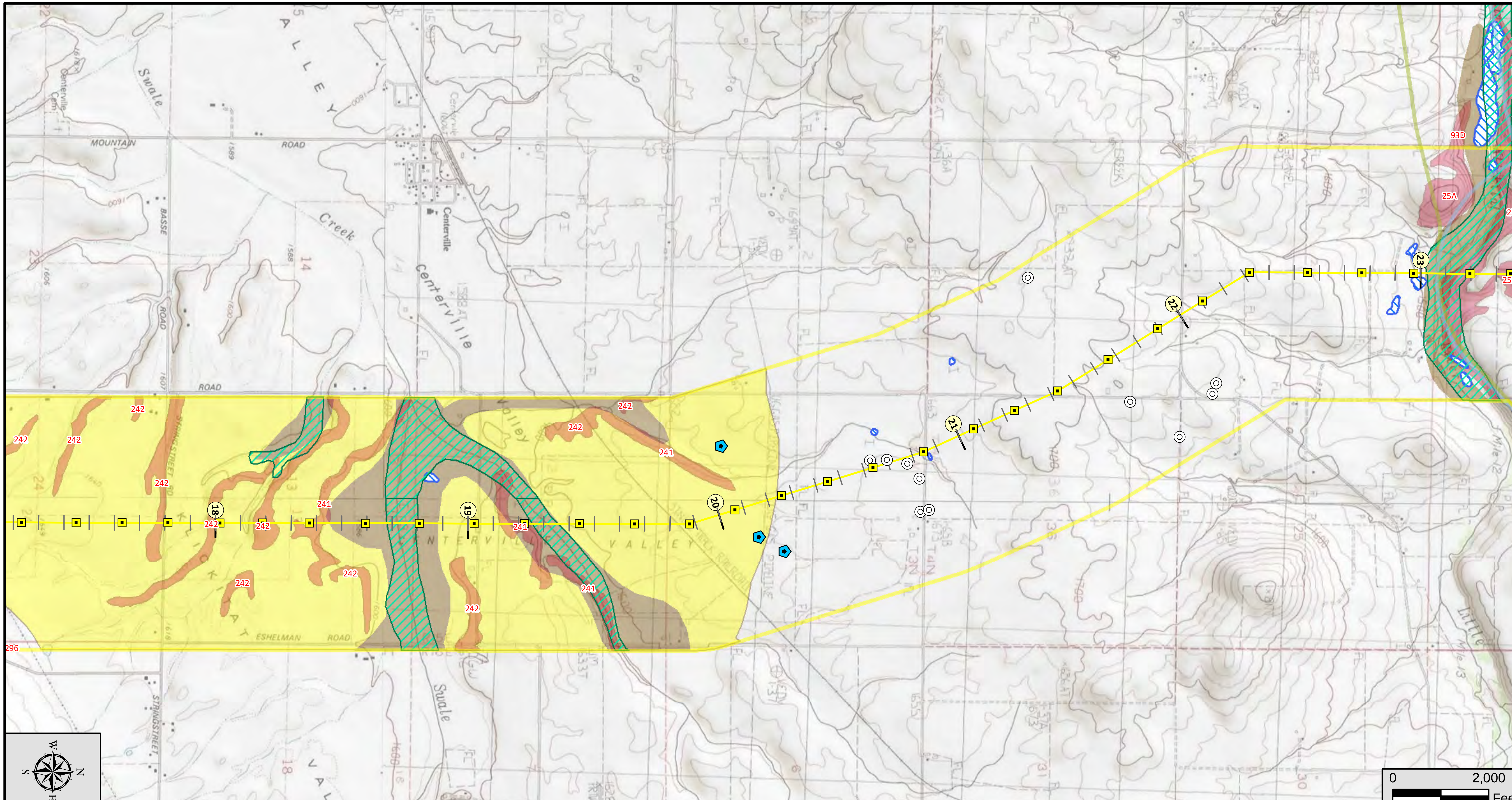
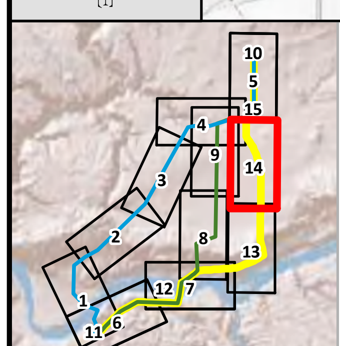
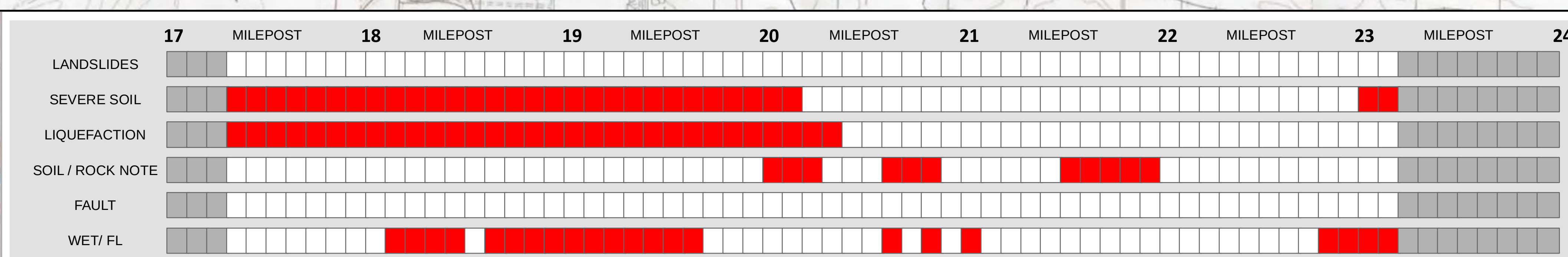






Bonneville Power Administration
Big Eddy - Knight 500 kv
Transmission Line Project

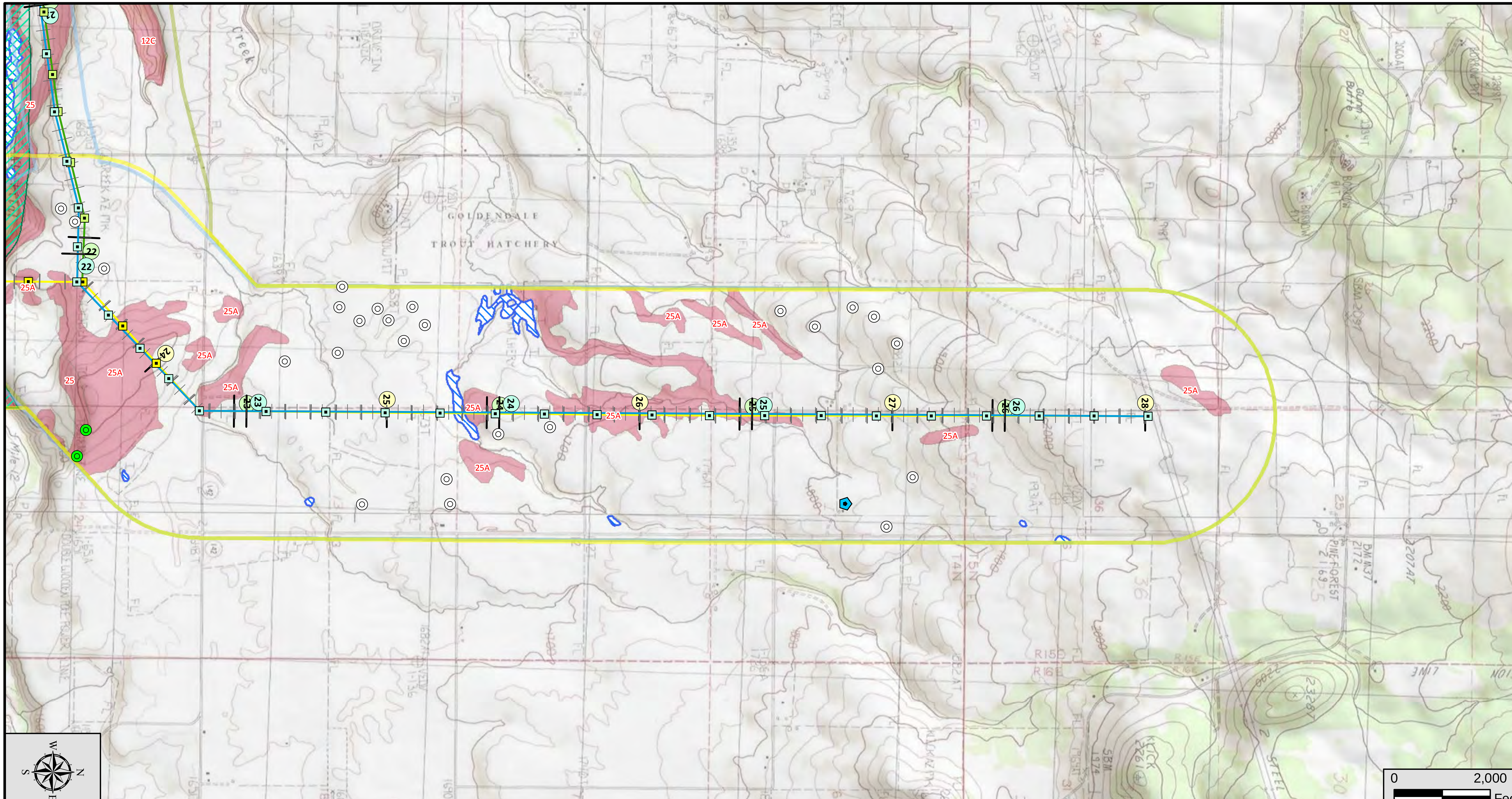
HYDROLOGIC STRIP MAP EAST ROUTE

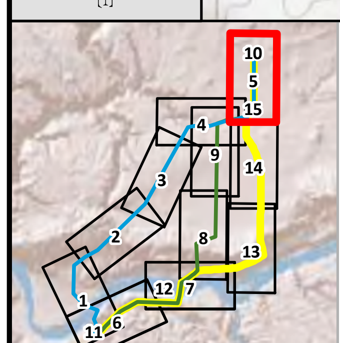
April 2010

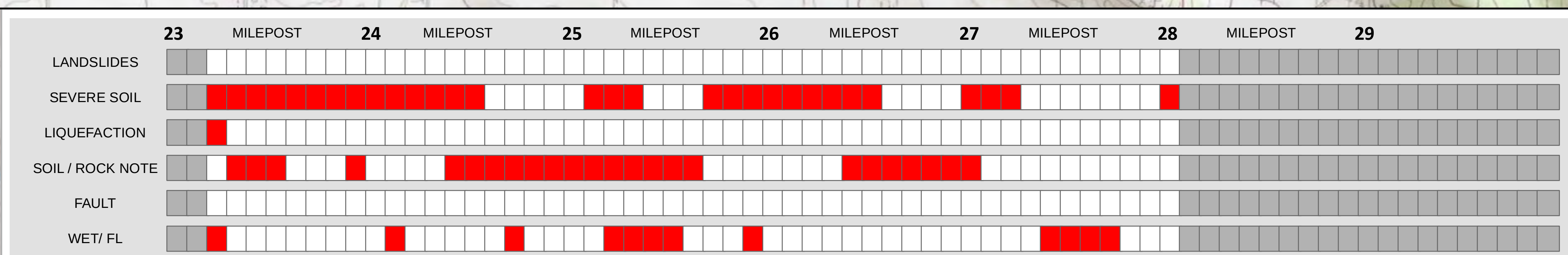
21-1-21287-001

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Map I-5
Sheet 14 of 15







Bonneville Power Administration
Big Eddy - Knight 500 kv
Transmission Line Project

HYDROLOGIC STRIP MAP
EAST
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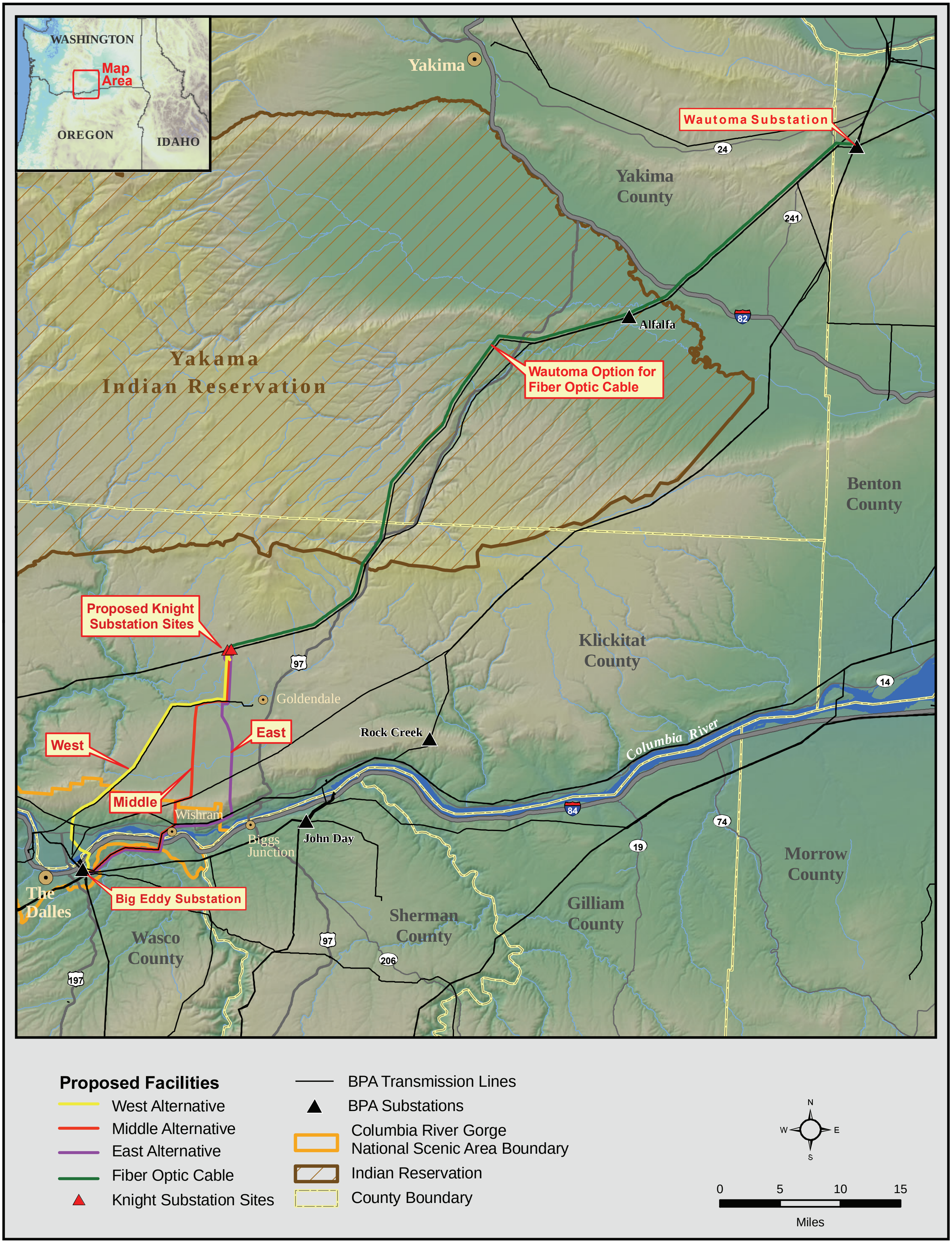
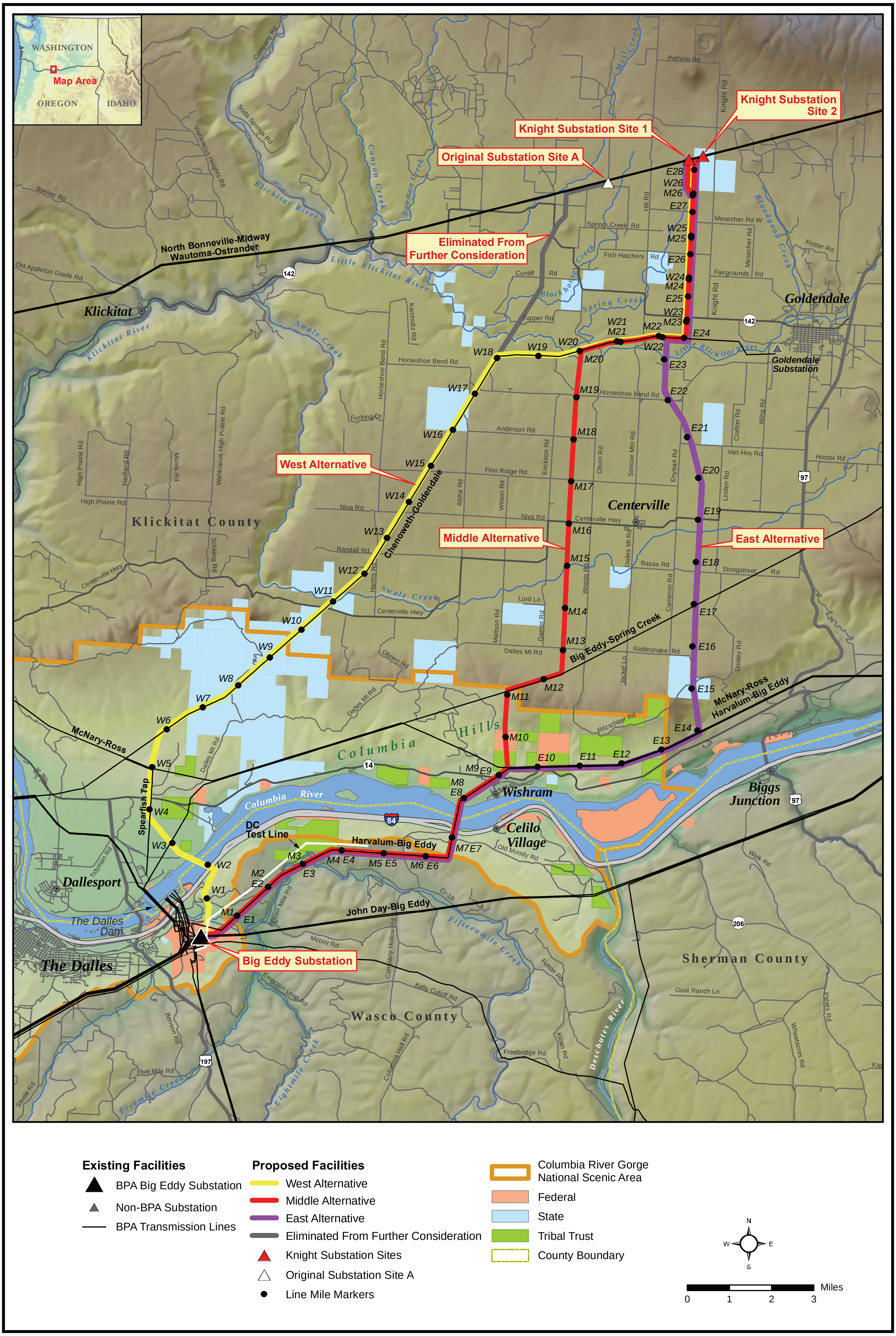
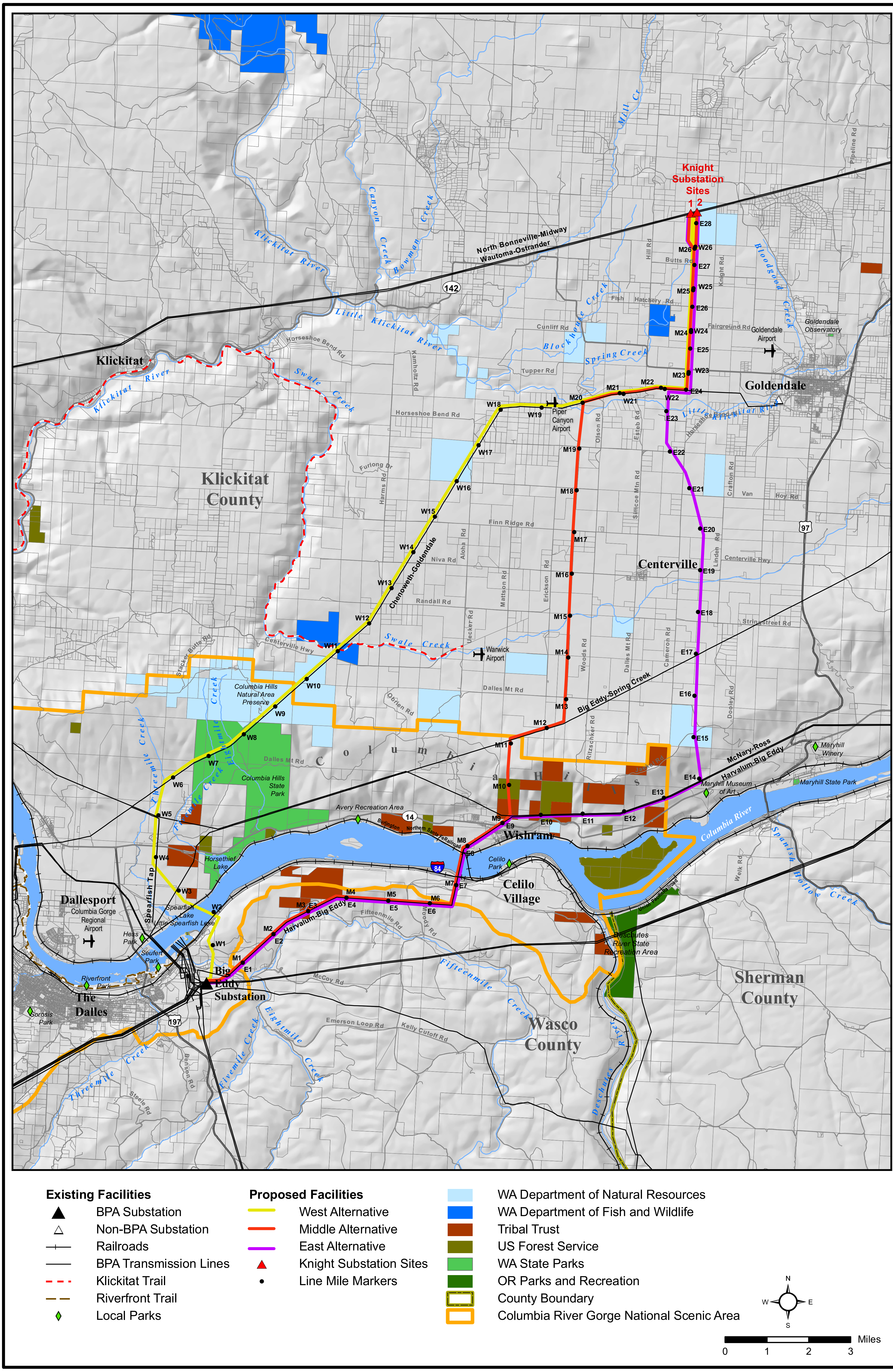


Map 1-1. Project Overview



Map 2-1. Project Overview of Proposed Action Alternatives



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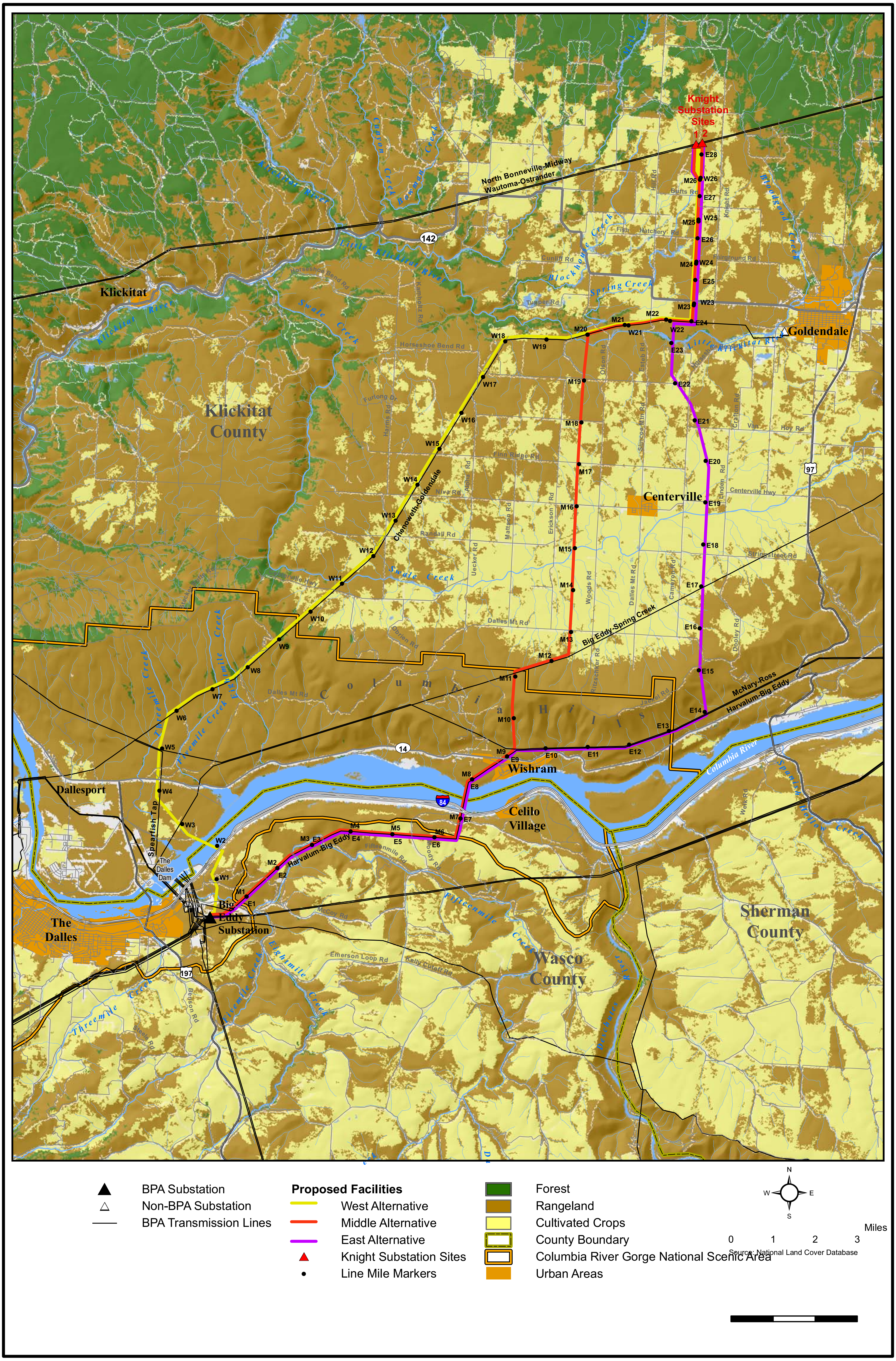
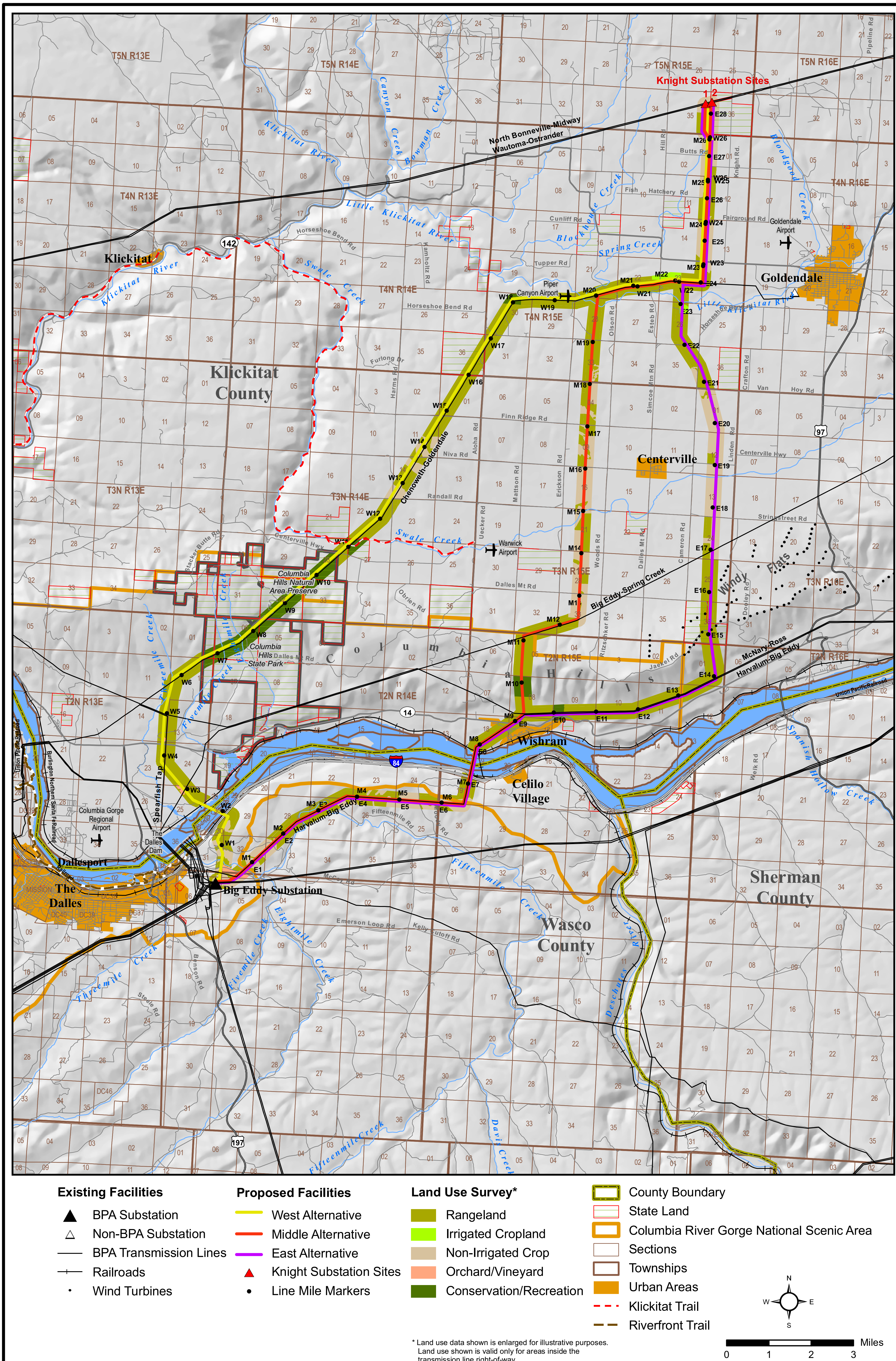
Map 3-1. Land Ownership



Map 3-2. Land Cover



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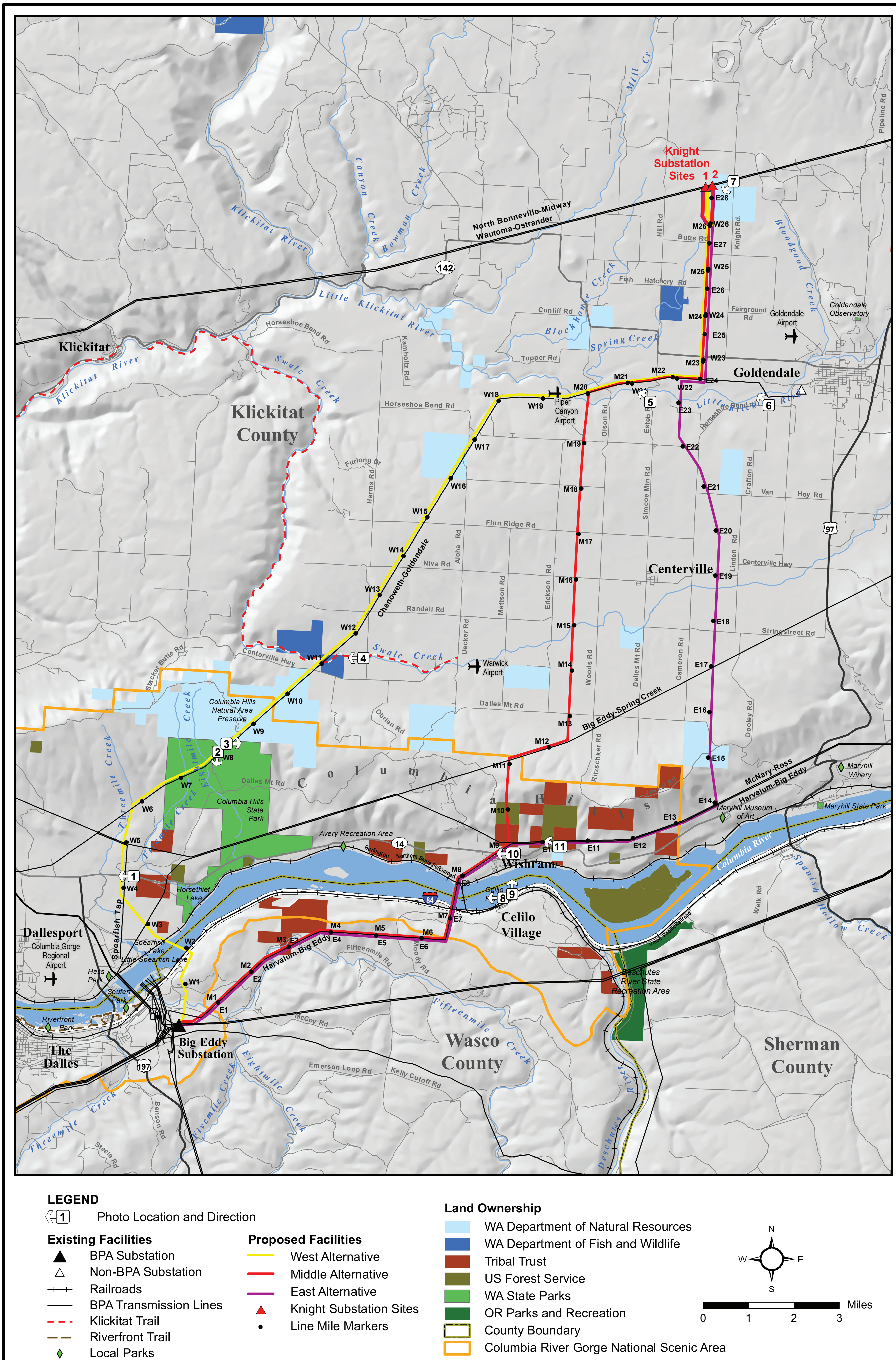
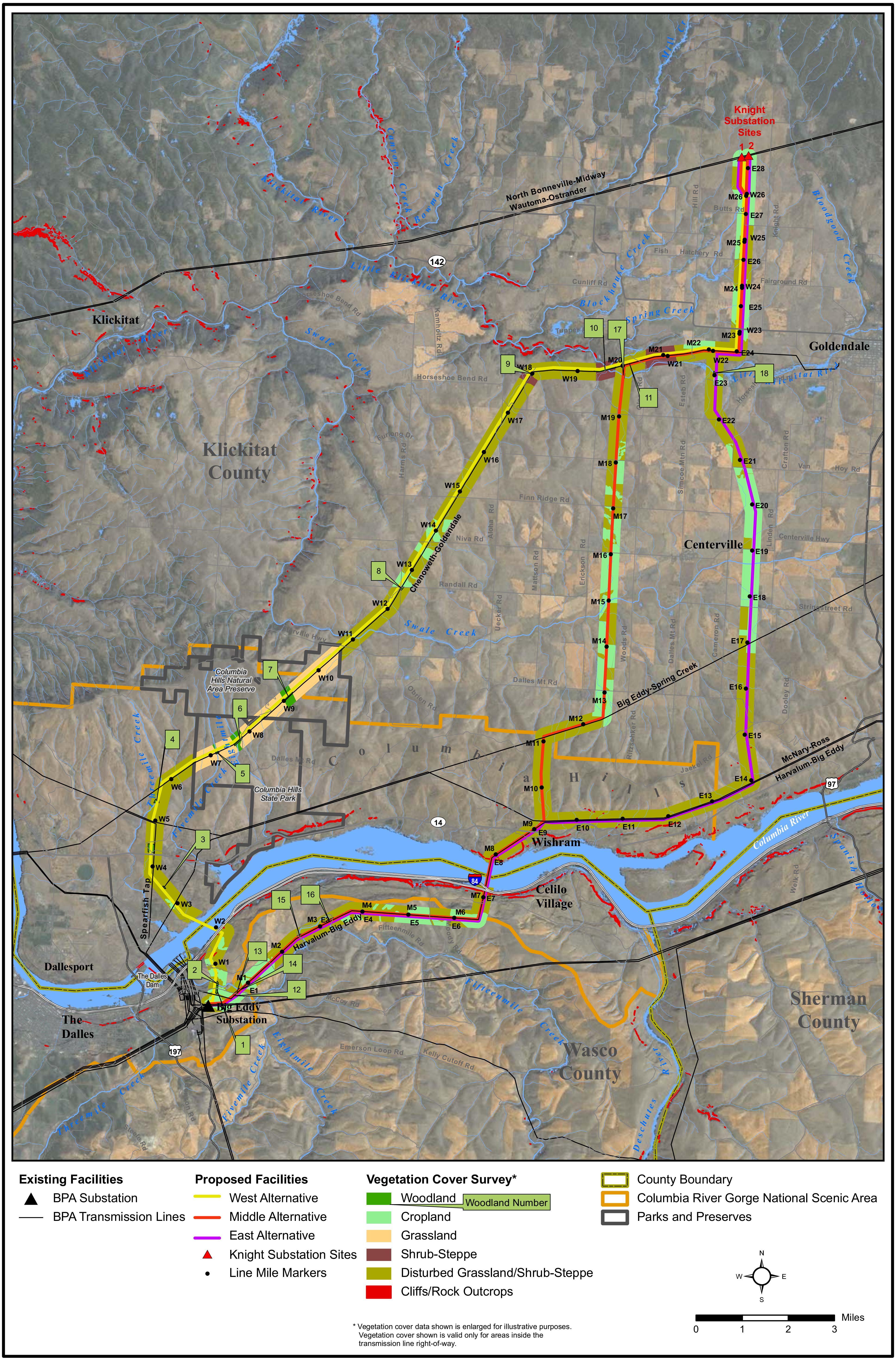
Map 3-3. Land Use



Map 3-4. Photo Locations



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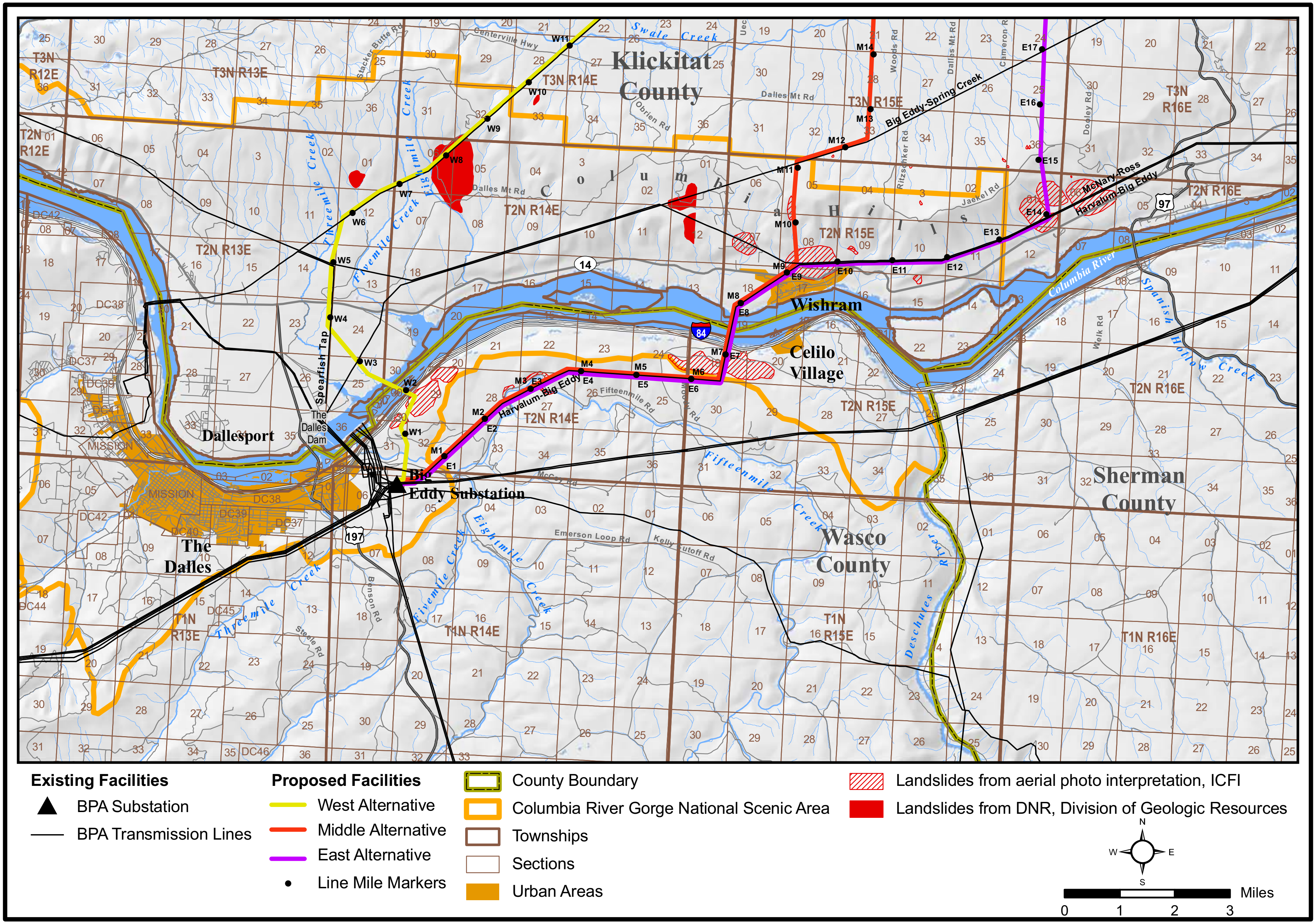
Map 3-5. Vegetation Types



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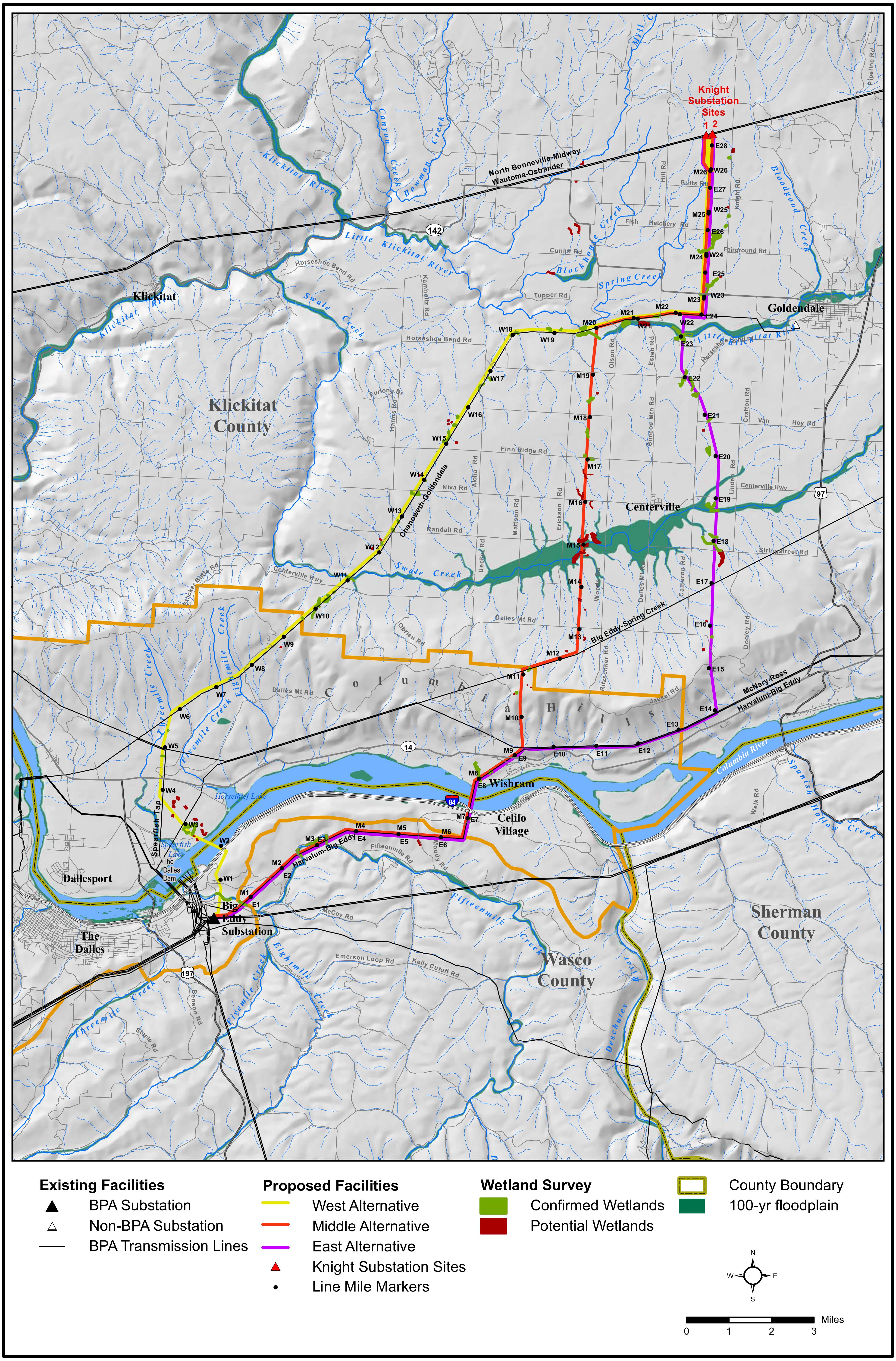
Map 3-6. Landslide Areas



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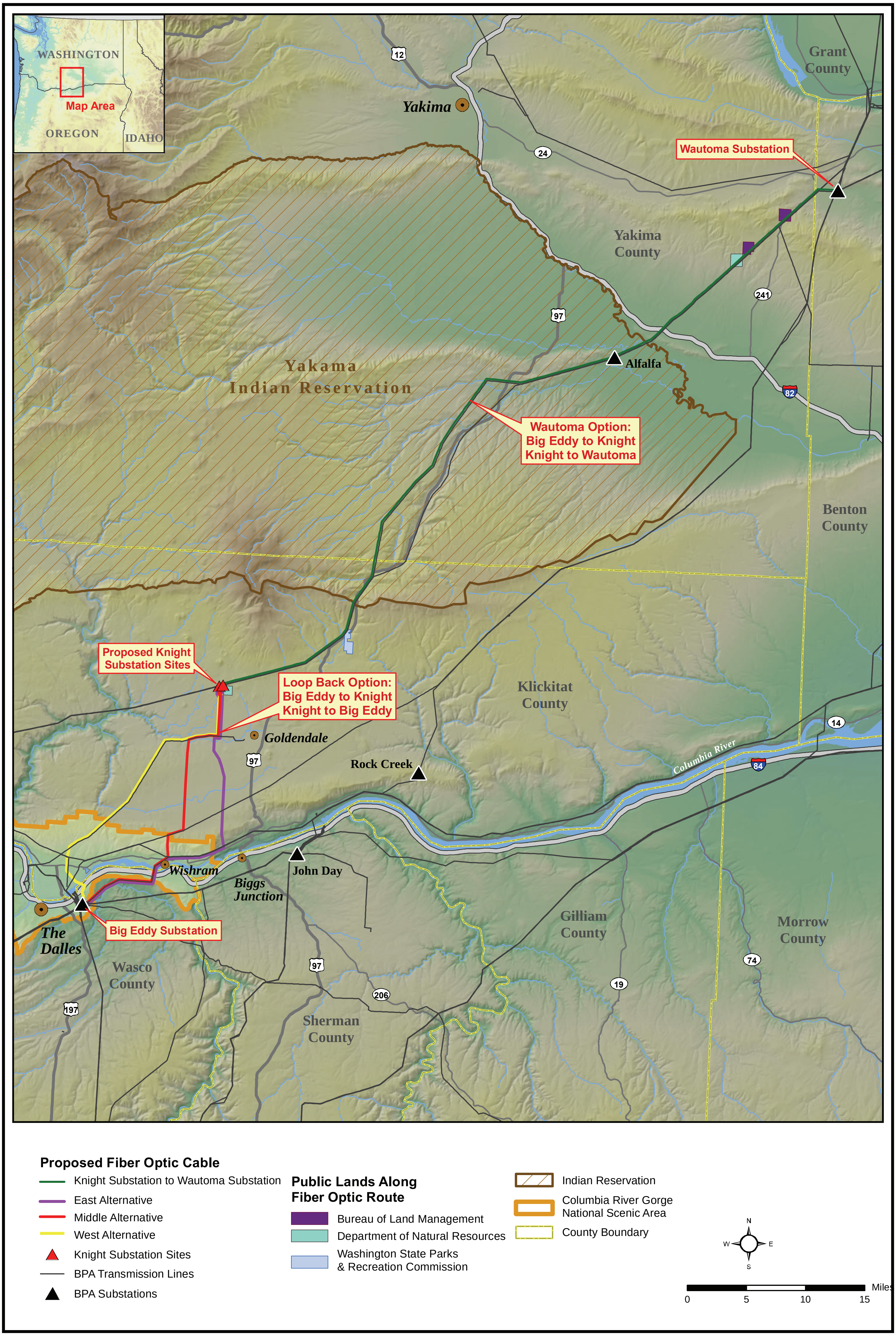
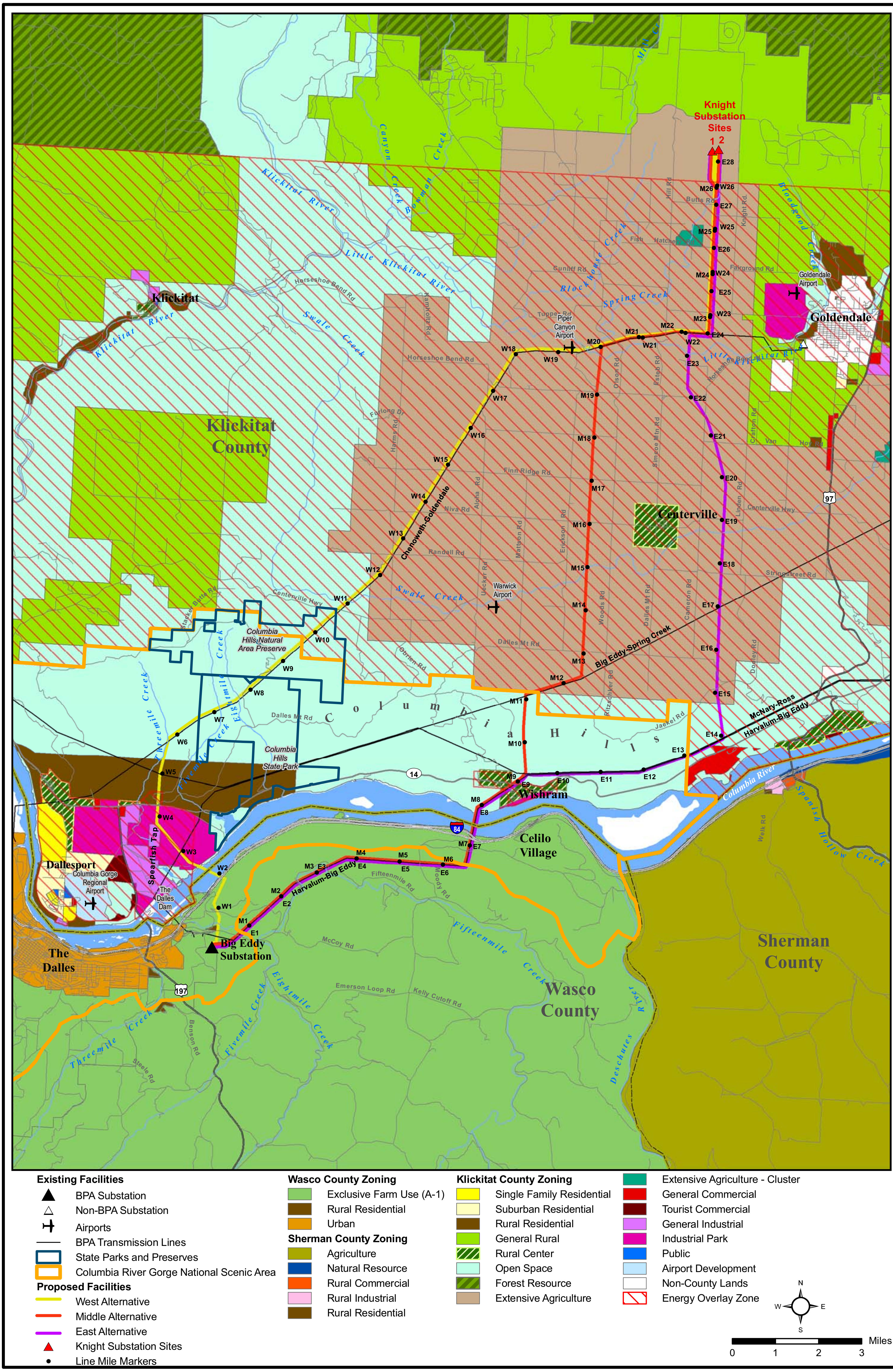
Map 3-7. Water Resources and Wetlands



Map 3-8. Fiber Optic Cable Overview



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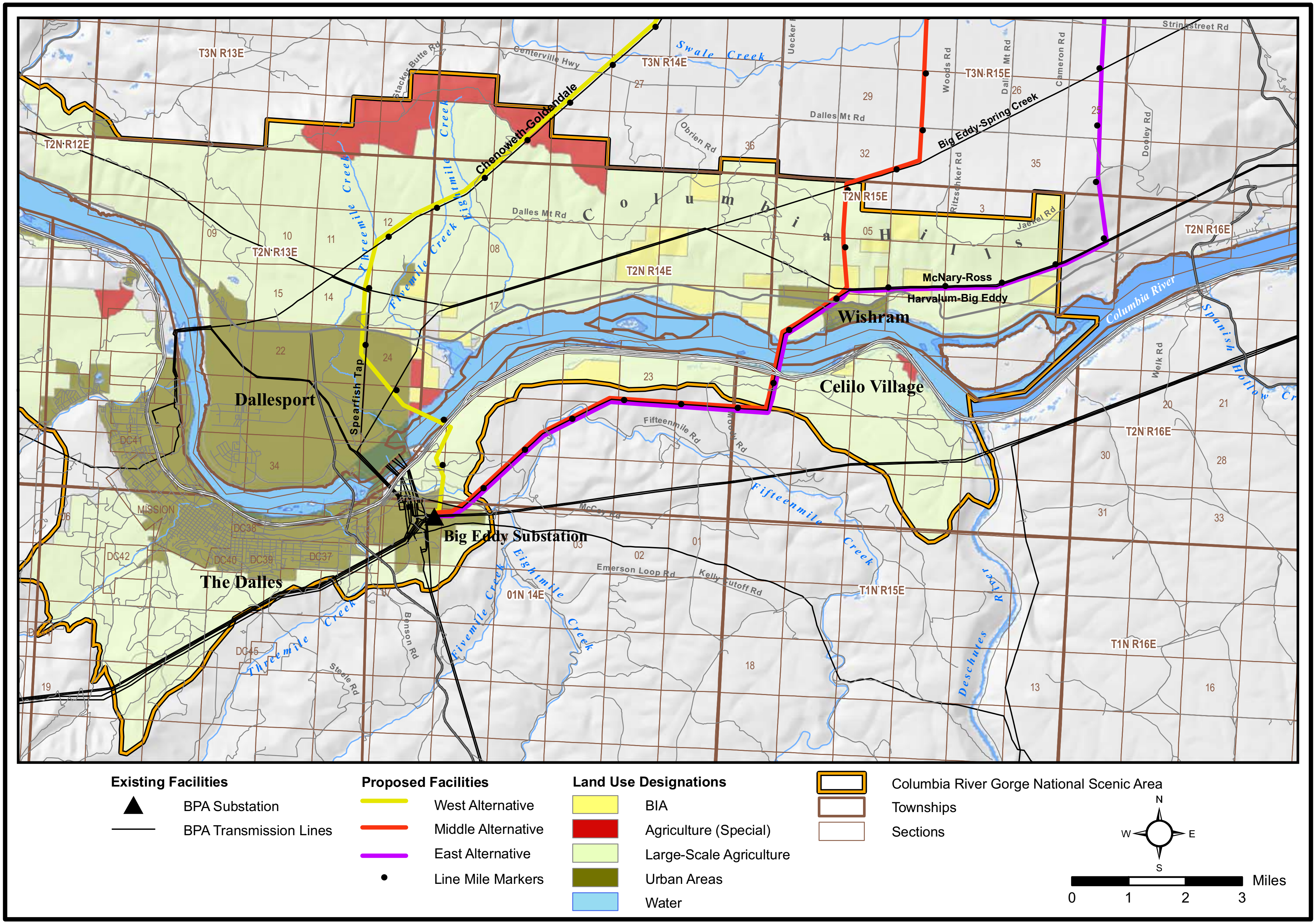
Map 5-1. County Zoning



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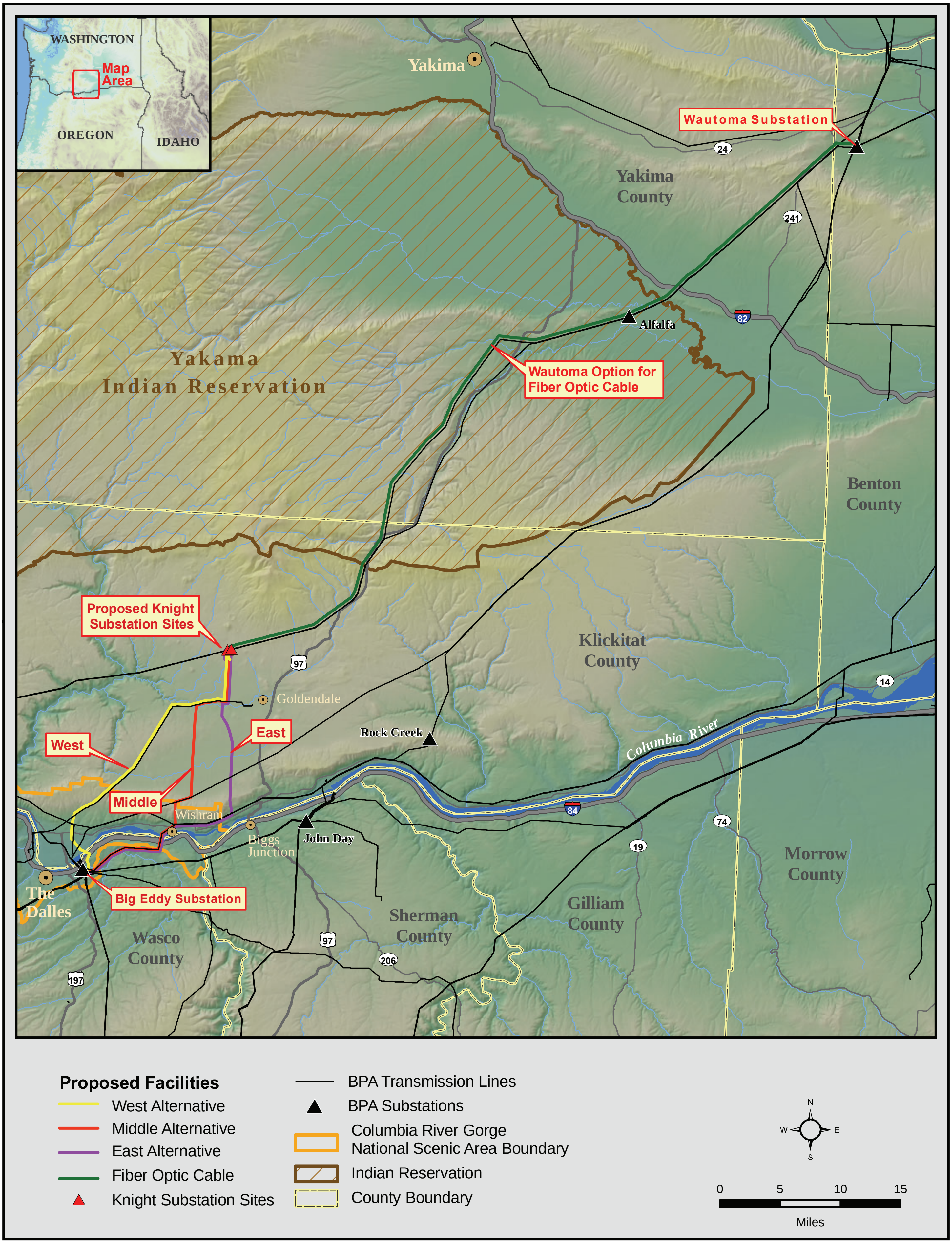
Map 7-1. Columbia River Gorge National Scenic Area Land Use Designations



Map S-1. Project Overview