

**Eastside 230 kV Project
Constraint and Opportunity Study
for Linear Site Selection**

Prepared for



Puget Sound Energy

Prepared by

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1. Executive Summary

PSE's System Planning evaluated a variety of options for addressing the Eastside's growing energy needs including conservation, local generation, and infrastructure improvements (e.g., transmission lines and substations). They found that even with aggressive conservation efforts, demand will outstrip supply in a few years. Additionally, local generation would be difficult to execute in a timely manner and ultimately would not meet long-term needs.

Based on PSE's technical evaluation of potential solutions, the most effective way to ensure the Eastside's power system will meet growing demand is to add a new 230 kV transmission line to connect PSE's Sammamish (Redmond) and Talbot Hill substations (Renton). With these endpoints in mind, PSE contracted with Tetra Tech, Inc. to employ a geographic information system (GIS)-based Linear Routing Tool (LRT) to conduct a broad evaluation of possible transmission line routes.

The LRT is a tool developed by Tetra Tech based on commercially available geospatial technology and Tetra Tech's linear routing experience (see Appendix A). It is a collaborative process that combines powerful analytical software with project experience, system planning, engineering, land use and local knowledge considerations. The LRT is an innovative geospatial tool that identifies the most suitable route alternatives based on modeled environmental and infrastructure factors. PSE and Tetra Tech began this process by identifying a study area of approximately 255 square miles that encompasses the Sammamish Substation in the north and the Talbot Hill Substation in the south. The study area is bounded on the west by the eastern shore of Lake Washington and extends eastward to include the BPA corridor near Soaring Eagle Regional Park (located northeast of the City of Sammamish). Any new transmission line route must connect to a new 230 kV to 115 kV transformation site within this area in order to solve the problem. Potential transformation sites within the study area include Lakeside, Westminster, and Vernell substations, which are all located in the City of Bellevue.

Tetra Tech staff collected existing available data and GIS files for land ownership, land use, public and private rights-of-way (ROW), wildlife, vegetation, threatened and endangered (T&E) species, environmentally critical areas, topography, historical resources, and other factors that would influence the location of the proposed transmission line, such as structure locations. The data collection process was designed to provide geospatial information on

criteria that could represent credible baseline opportunities and/or constraints for the location of an above-ground transmission line.

A team of LRT experts, system planners, engineers, land use planners and environmental professionals (Project Team) individually weighted various data layers of the model to reflect the varying degree of constraints or opportunities for each data set. The team assigned values to the data layers using a progressive scale of values ranging from the greatest constraint, such as endangered species, residences and safety hazards, to the greatest opportunity, such as existing PSE transmission lines.

The LRT combined these data layers and created an output file called the suitability grid, which represents a summation of all the constraints and opportunities for every point (grid cell) across the entire study area. The LRT modeled preferred corridors across the suitability grid that pass through the transformation site options within the study area. These preferred corridors were used to develop alternative routes. To provide for more flexibility in the route analysis, each route was partitioned at the crossing points of routes to create unique segments. Each unique LRT segment was validated using professional engineering judgment and available ancillary resources such as aerial photographs, to help assess whether they were feasible options. Once the segments were generated and validated, a composite score was calculated for each segment from the underlying suitability grid. A deterministic model was then used that considered more than 500 combinations of segments and transformation sites. If parallel segments (i.e., typically less than a block apart) were identified during the model evaluation, LRT scores were compared to determine which segment would be used to develop routes.

The LRT scores were used to eliminate from further consideration routes that were not considered viable options. Approximately the top five percent of the positive routes were then mapped to facilitate further discussion and evaluation.

The mapping exercise revealed that there are four general subareas, which when combined, formed a “ladder” of route alternatives. The “leg” components of the ladder comprised the north-south running routes connecting Sammamish, Talbot Hill, and one of the new transformation substations. Moving east to west between the “legs” could be accomplished by using one of the three cross-over segments or “rungs.” The only exception to this being an additional north-south segment situated in the central part of the study area, south of I-90. To simplify future discussion, each of the fourteen legs and rungs were given a unique identifier (Figure 1-1). All of the mapped segment combinations can be used to develop a route that meets the goal of connecting the Sammamish with the Talbot Hill substation,

while connecting to any one of the three intermediary substations. Further route refinement will continue during the on-the-ground data collection phase and public process, culminating in the selection of a preferred route.

Table 1-1. Route Segment Composition

Vernell 248	Vernell 249	Westminster 217	Lakeside 155	Lakeside 160	Lakeside 166
A	A	A	A	A	A
B	B	C	C	C	C
F	F	D	E	E	E
H	H	F	G2	G2	J
K1	L	H	G1	I	M
K2	N	L	H	K1	N
M		N	L	L	
N			N	N	

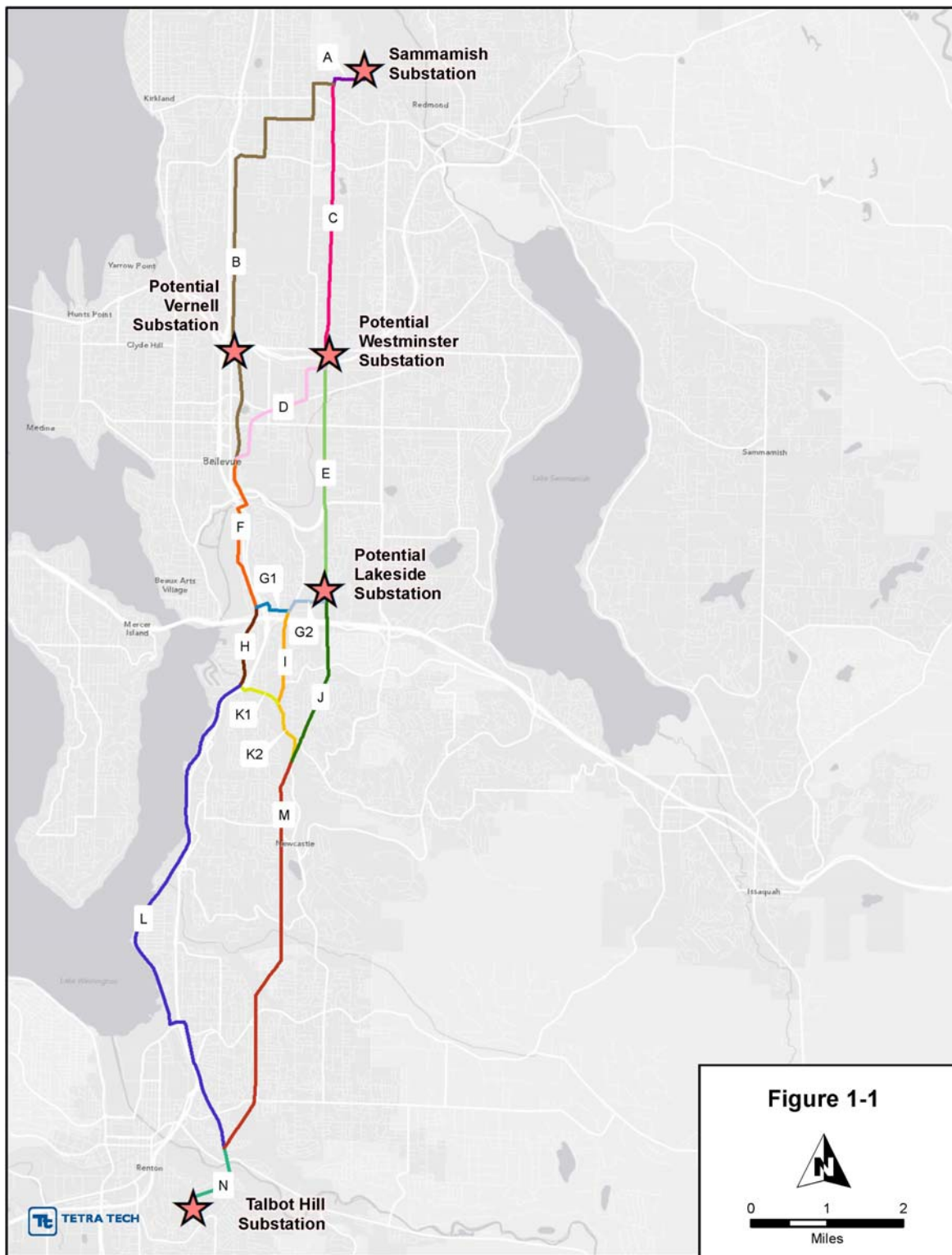


Figure 1-1. General Corridor for Eastside 230 kV Project

2. Overview

PSE System Planning conducted a needs assessment reviewing population trends, electric load growth, economic development patterns, conservation programs, energy efficiency improvements, and other key trends pertaining to power demand. Studies reveal that different parts of the transmission system will overload, or be close to overloading, within the 10-year study period (2012-2022) and more specifically, by 2017.

PSE's System Planning evaluated a variety of options for addressing the Eastside's growing energy needs including conservation, local generation, and infrastructure improvements (e.g., transmission lines and substations). They found that even with aggressive conservation efforts, demand will outstrip supply in a few years. Additionally, local generation would be difficult to execute in a timely manner and ultimately would not meet long-term needs.

System Planning's review determined that system infrastructure improvements must be made to resolve the deficiency issue. These system infrastructure improvements will address the following issues:

- Overload of PSE electrical facilities in the Eastside Area;
- Small margin of error to manage risks from inherent load forecast uncertainties;
- Increasing use and expansion of Corrective Action Plans;
- Emerging regional impacts identified by the ColumbiaGrid.

To meet the objectives above, PSE had to first identify 230 kV sources and then identify potential transformation sites (to convert 230 kV to 115 kV for distribution) between those sources. The new transformation site will be a 230 kV to 115 kV substation. The next step was to determine a study area between the source endpoints and evaluate the possible routes to make this connection using a 230 kV transmission line (Figure 2-1).

Seeking an objective fact-based evaluation, PSE contracted with Tetra Tech, Inc. to employ a geographic information system (GIS)-based Linear Routing Tool (LRT) to conduct a broad evaluation of possible transmission line routes. The LRT is a collaborative process that combines powerful analytical software with project experience, system planning, engineering, land use and local knowledge considerations. The LRT is an innovative geospatial tool that identifies the most suitable route alternatives based on modeled

environmental and infrastructure factors that are available in GIS format. The purpose of this study was to do a high-level review of significant and well known factors that affect route siting using available data in GIS format, to develop possible routes for further study.

The first steps of the LRT process were to define elements that were positive or negative for siting the proposed 230 kV transmission line and to collect the related data. These elements were defined as constraints and opportunities. GIS available data was collected for land ownership, land use, public and private rights-of-way (ROW), wildlife, vegetation, threatened and endangered (T&E) species, environmentally critical areas, topography, historical resources, and other factors that would influence the location of the proposed transmission line, such as structure locations.

With the GIS data compiled, a team of LRT experts, system planners, engineers, land use planners and environmental professionals (Project Team) individually weighted various data layers of the model to reflect the varying degree of constraints or opportunities for each data set. The LRT combined these data layers to create a suitability grid, summarizing all the constraints and opportunities for every point (grid cell) across the entire study area. This grid was used to develop suitable corridors and routes, and in turn those routes were broken down into segments. These segments were individually weighted so that more than 500 routes could be put together and mathematically considered.

The result of all this evaluation and modeling was that the top recommended segments could be combined to form five possible route options for further evaluation through public input, stakeholder review, further land use/zoning and environmental requirements review, and real estate review.



Figure 2-1. General Corridor for Eastside 230 kV Project

3. Process

The development of possible transmission line routes followed a six-step process that culminated in a set of alternatives that could be further evaluated. The steps included:

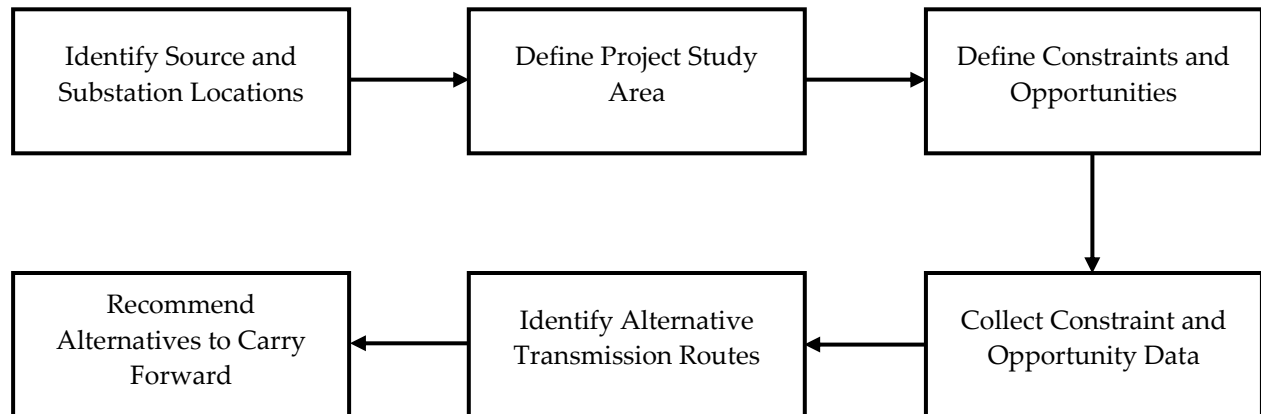


Figure 3-1. Route Development Process

3.1 IDENTIFY 230 KV SOURCE AND SUBSTATION LOCATIONS

At the beginning of the routing effort, the Sammamish and Talbot Hill Substations were defined as the 230 kV source for the project. Potential intermediate transformation (new 230 kV to 115 kV substation) sites between the Sammamish and Talbot Hill Substations were identified by PSE and used to help define the study area. The potential new transformation sites included PSE-owned property at the future Vernell and Westminster substations, and the existing Lakeside Substation. In addition, a new site referred to as Woodridge was considered based on its location. Ultimately the Lakeside, Westminster, and Vernell sites were selected as they meet the necessary minimum dimensions and are owned by PSE.

3.2 DEFINE PROJECT STUDY AREA

The next step was to establish a study area that was defined as a boundary that generally encompassed the 230 kV source substations locations and the potential routes to connect them. Therefore, the study area encompasses the Sammamish Substation in the north, the Talbot Hill Substation in the south, the eastern shore of Lake Washington in the west, and eastward to near Soaring Eagle Regional Park in King County, east of the City of Sammamish. Figure 3-2 shows the extent of the study area used during the constraint and opportunity analysis.

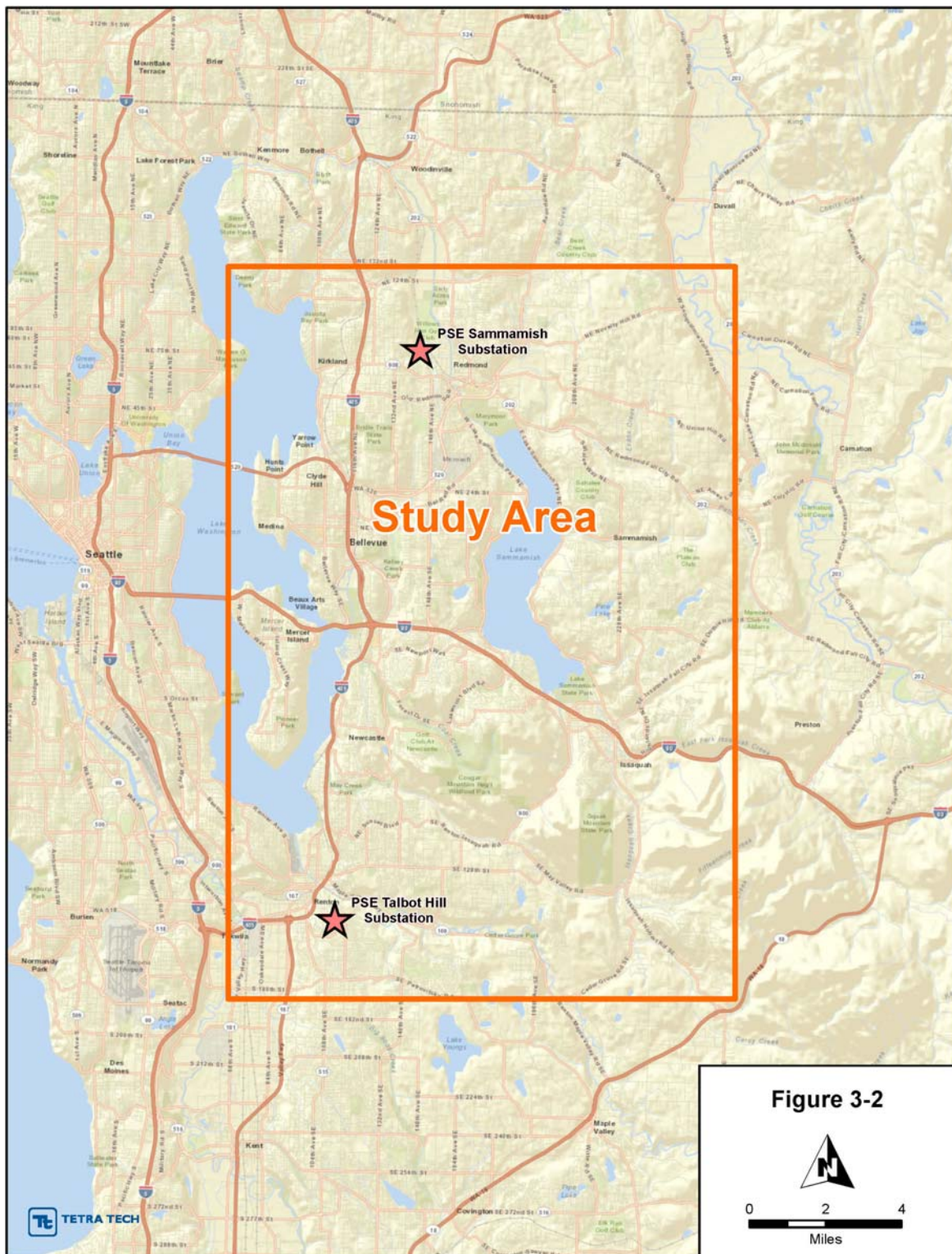


Figure 3-2. Study Area

Once the boundaries of the study area were established, the Project Team identified and delineated constraints and opportunities to siting the transmission line. Constraints are defined as resources or conditions that potentially limit project siting because of regulations or engineering requirements associated with facility construction and operation.

Opportunities are defined as resources or conditions that can accommodate facility permitting, construction, or operation. The following sections describe the GIS data sets that were collected to analyze these constraints and opportunities, describe the key categories of constraint and opportunity factors in the study area based on GIS data sets, and summarize how the GIS data were processed in preparation for route development.

3.3 AVAILABLE GIS DATA BASES USED FOR CONSTRAINTS AND OPPORTUNITY ANALYSIS

Based on the defined study area, Tetra Tech collected readily available GIS data sets to use in the LRT model. Data collection was based on the constraint and opportunity factors used in the analysis. The data used in routing were subjected to a defined process of preparation and analysis before being used in the LRT as described below. Preparation of data began with the compilation of multiple layers into a geodatabase. Data layers were then quality checked and evaluated for project usefulness, including reliability and accuracy based on available maps. If the data passed the quality check, the data then went through several additional geoprocessing steps in order to be ready to input into the LRT. Where appropriate, buffer areas were added to the data based on how the feature would impact the transmission line route. These buffers were necessary to ensure line routes would not go over the top of structures, down the center of vehicular travel lanes, as well as allowing for adequate area to physically accommodate a 230 kV line. Buffers added to specific data layers are described in Section 3.6 Existing Conditions and in Table 3-1, below.

Data for the constraint and opportunity analysis were obtained from a variety of county, state, and federal GIS database sources (see Table 3-1). These GIS databases included the Washington Department of Natural Resources (WDNR), Department of Fish and Wildlife (WDFW), Department of Transportation (WSDOT), and State Parks and Recreation Commission (WSPRC); the US Fish and Wildlife Service (USFWS); the King County Assessor's Office, Department of Development and Environmental Services (DDES), and Department of Natural Resources (DNR); and Tetra Tech. This information was supplemented by the review of aerial photography and local knowledge. The following discussion outlines specific data sets collected for this project and their sources.

Table 3-1. Analysis Attributes and Data Sources

Attribute	Data Source
Existing and Proposed Linear Corridors	
PSE transmission corridors	PSE
PSE 55 kV corridor	PSE
BPA transmission corridors	PSE
Natural gas pipeline	Photo interp. and King County
Highways and roads	King County
Arterial road corridors	Interp. of King County roads
Railroads	ESRI Streetmap, King County, Sound Transit
Abandoned rail corridor	Photo interp. and King County parcels
Land Ownership, Land Use and Special Designated Uses	
Land Ownership	
Rights-of-way	King County
Parcels	King County Assessor
Transfer of development rights	King County Assessor
BNSF Railroad parcel boundaries (active)	King County
Land Use/Future Land Use	
Structures	King County
Coal mine	King County
Renton municipal airport	Photo interp. and King County parcels
Airports clear zone	Photo interp. and analysis
Residential	King County
Special Land Use Designation	
Parks	King County
Recreational trails	King County
Scenic byways	WSDOT
Soils, Topography, and Geology	
Unspanable slope 20 to < 40%	King County LiDAR and analysis
Unspanable slope \geq 40%	King County LiDAR and analysis
Slopes 20%+	King County LiDAR and analysis
Slopes 40%+	King County LiDAR and analysis
Landslide potential	WDNR
Elevation – LiDAR	King County
Water Resources	
Lakes	King County
Floodways and floodplains	King County
Wetland Resources	
Wetlands – large	USFWS, National Wetlands Inventory

Attribute	Data Source
Wetlands – SAO	King County
Wildlife	
Chinook salmon streams	USFWS
Waterfowl areas	WDFW
Great blue heron rookeries	WDFW
Bald eagle management areas	WDFW
Natural Heritage locations	WADNR
Historic Resources	
Historic register and districts	WADAHP
Historic property inventory - named	WADAHP
Heritage barns	WADAHP

Various King County agencies maintain extensive GIS databases on natural and built environment conditions within the county. Tetra Tech purchased several King County GIS data sets on DVD for use in the analysis. Many of these GIS data sets were used directly in the analysis, or processed to derive new data to represent constraints and opportunities, including the following:

- Airpark
- Airport clear zone
- Arterial road corridors
- Water pipeline corridors
- BPA substation
- Railroads and railroad corridors
- Public right-of-way
- Parcels
- Structures (based on address points)
- Residential areas
- Coal mine
- Parks
- Recreational trails
- Streams and rivers
- Lakes
- Floodways and floodplains

- Wetlands – SAO
- Historic points
- Contours
- Unspanable slope 20 to < 40%
- Unspanable slope \geq 40%
- Slopes 20%+

For the purpose of this process, only data sets that were readily available and in GIS form were used. Constraints of opportunities that were not easily identified in an available GIS data set (such as cultural resources, real estate issues, electric distribution lines, or non-high pressure natural gas pipelines) were not considered for the purposes of this study, but will be evaluated in future steps.

3.4 PRIMARY GIS CATEGORIES CONSIDERED FOR CONSTRAINTS AND OPPORTUNITIES

Study area conditions applicable to the key categories of constraints and opportunities are described below, along with a description of how the data were preprocessed for analysis.

3.4.1 Utilities

3.4.1.1 Transmission

The existing PSE 115 kV corridor runs between the Sammamish substation, the Lakeside substation, and the Talbot Hill substation (Figure 3-3). Transmission line corridors owned by BPA run along the north, east and south boundaries of the study area.

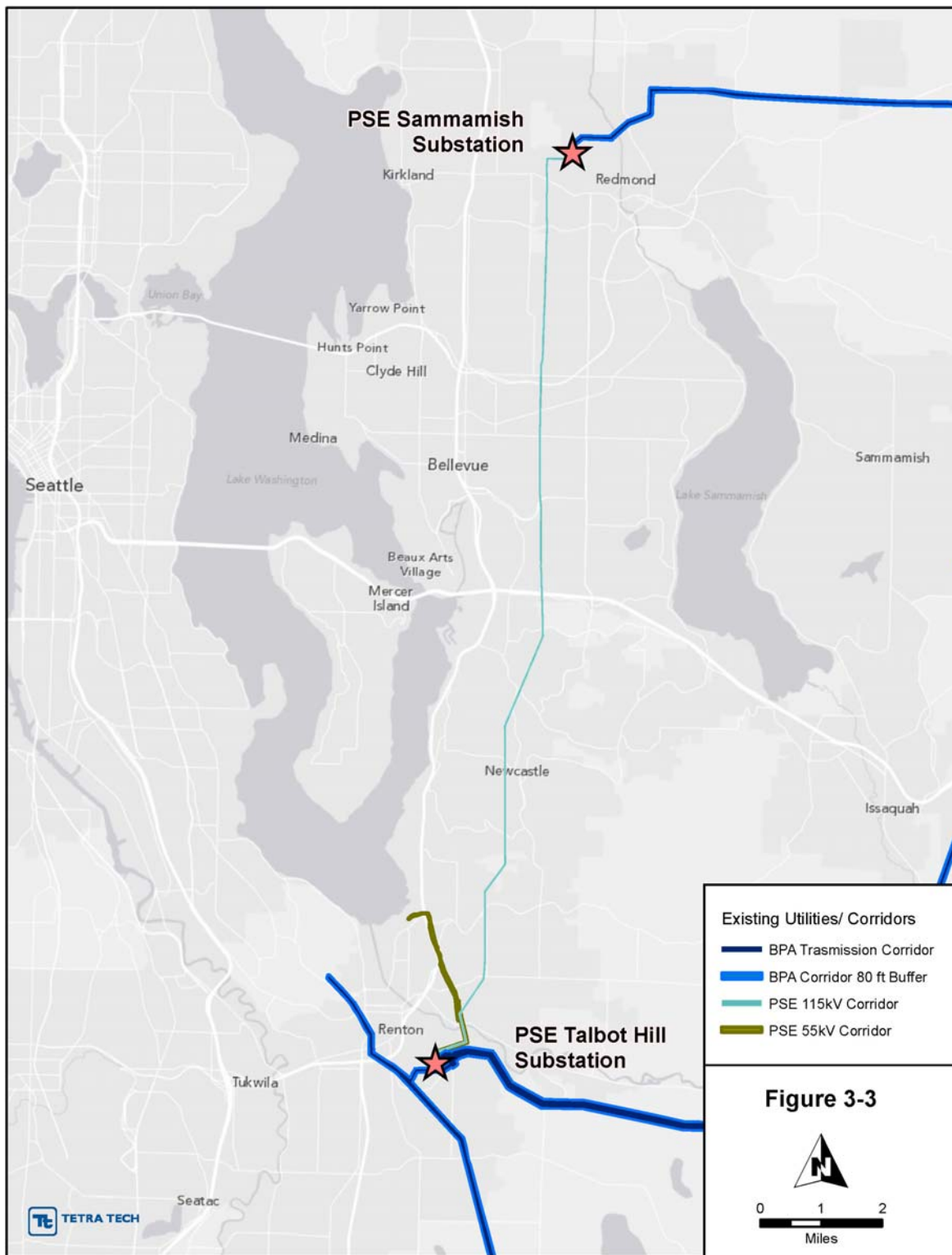


Figure 3-3. Utilities

PSE provided the locations of existing transmission corridors between the Sammamish and Talbot Hill Substations. PSE 115 kV and 55 kV transmission corridor systems were considered opportunities in the analysis. PSE's transmission system is primarily operated at 115 kV; however, a remnant 55 kV corridor still exists in the southern portion of the study area. This corridor can be upgraded to a higher voltage without a change in land use, so it was considered an opportunity. In order to accommodate the space requirements for the proposed 230 kV line, a buffer was applied to the 55 kV line corridor before including it in the analysis.

Based on past experience, BPA does not allow additional third party transmission lines within their corridors; therefore, existing BPA transmission corridors were considered a constraint. However, an 80 ft corridor (minimal area required for a transmission line) was created adjacent to BPA corridors and used in the analysis as an opportunity, since paralleling existing corridors is typically considered favorable during the permitting process.

3.4.1.2 High Pressure Natural Gas Pipeline (Northwest Pipeline)

High-pressure natural gas pipelines run along some arterial roads in the study area. The north-south trending sections potentially provide the most benefit, such as along 148th Ave. NE between NE 70th St. and Bel-Red Rd.; however, these sections are only small opportunities and do not contribute significantly to the siting analysis.

3.4.1.3 Fuel Pipeline (Olympic)

The Olympic Pipeline (fuel products) corridor is co-located with PSE's existing 115 kV corridor (between Sammamish and Talbot Hill) for most of its length in the study area. As a result, it was not included in the analysis so that the existing 115 kV corridor would not be double counted as an opportunity.

3.4.2 Transportation

3.4.2.1 Roads

The major vehicular routes through the study area are Interstate Highway 405 (I-405), I-90 and Washington State Route (SR) 520. Nineteen miles of I-405 runs north-south through the west side of the study area; I-90 runs east-west through roughly the center of the study area; and SR 520 meanders roughly east-west through the northern third of the study area (Figure 3-4). I-405 runs through the study area from Kirkland, through Bellevue, along the east side of Lake Washington, and finally through Renton in the south. I-90 runs across the north end of Mercer Island in the west, through Eastgate (Bellevue), past the southern tip of Lake Sammamish and finally through Issaquah and High Point in the east. SR 520 starts in Hunts

Point alongside Lake Washington, passes through Clyde Hill and Bellevue, and then terminates in Redmond along the northern edge of Marymoor Park. Based on past experience, the Interstate travel routes are considered impedances, as installation of transmission lines within those corridors has not been allowed. Additionally, in some locations spanning of such travel routes is restricted by WSDOT. Throughout the study area, there are several smaller state highways with similar restrictions. However, the study area is dominated with arterial roads, which are typically considered opportunities for transmission line routing. Arterial roads are often paralleled by existing transmission lines or distribution lines that can be overbuilt with transmission line, thereby affording a viable passage route through areas that have existing development.

To prepare arterial road corridors for analysis, King County's Transportation Network layer was buffered by 45 ft on either side of the road centerline. This provided the area necessary to place a 230 kV line along the roadways. A second buffer of 20 ft on both sides of the road centerline was then removed from the 45 ft buffer to create the polygons that roughly represent the buildable opportunity while excluding the paved surface. This approach was used to create an opportunity for routing along paved roadways.

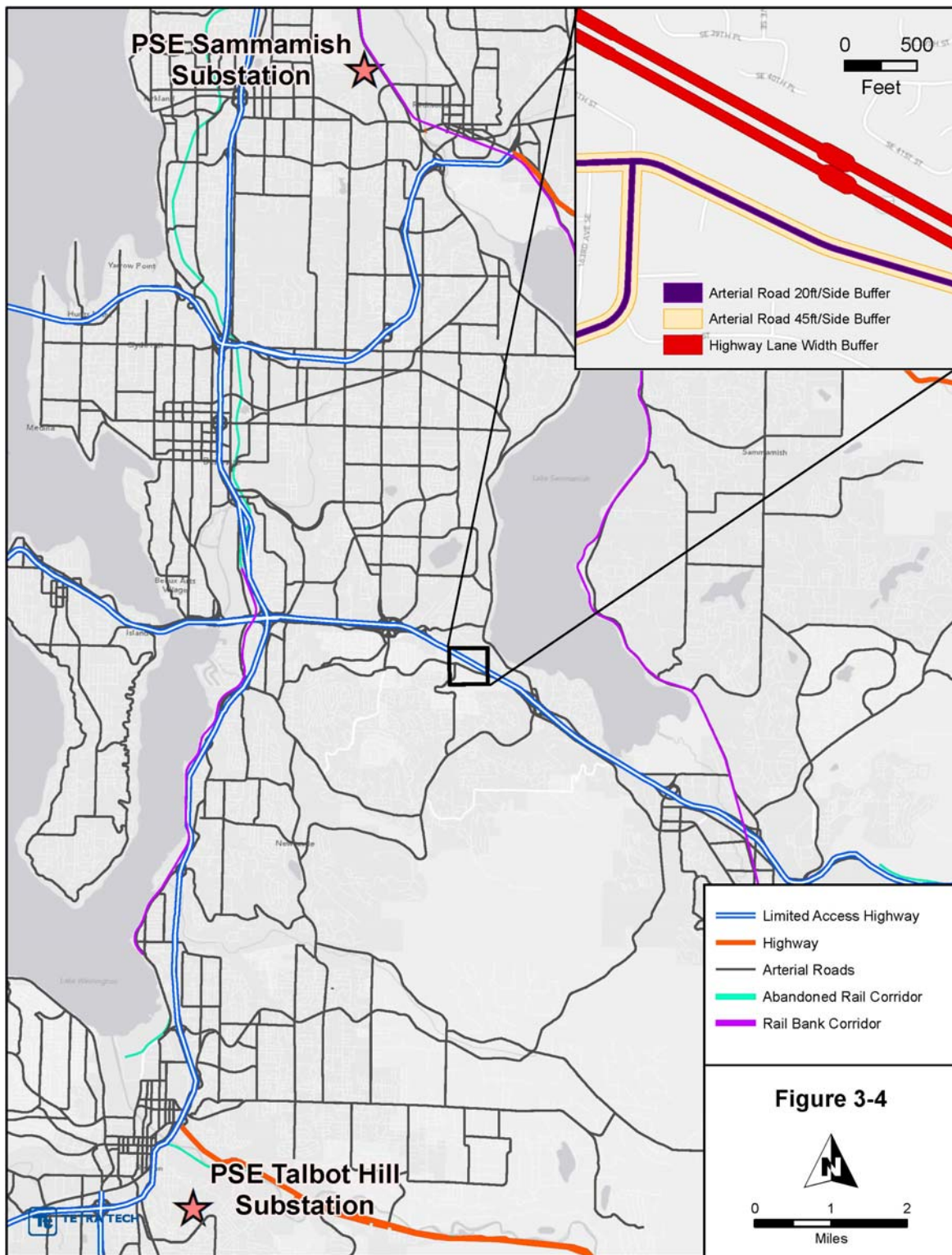


Figure 3-4. Transportation

3.4.2.2 Railroads

The Eastside Rail Corridor, which was formerly the BNSF railroad line, runs parallel to I-405 and Lake Washington in the western part of the study area. Although portions of this corridor have been mapped as “parks” lands, PSE has purchased easement rights along the majority of the corridor. This corridor offers routing opportunities for the proposed line because it is considered abandoned throughout the study area, and it runs in a north-south direction. There are some segments, such as along the southeastern edge of Lake Washington, that are also considered “rail banked,” however, since this was considered only a minor impedance, the combined values of abandoned plus rail banked still leave this corridor as a relatively strong opportunity. Rail banks constitute rail corridors that can be converted to trails and other uses, while still preserving the ability to revert back to rail use under certain conditions.

Where active rail corridors existed, a 50-foot buffer was applied to provide an adjacent area of opportunity that would parallel them. For abandoned rail corridors, no buffer was applied because the corridor itself provided the opportunity.

3.4.3 Slope and Slope Stability

3.4.3.1 Slope

The topography of the study area is composed of mostly flat terrain and rolling hills separated by small valleys. The most significant topographic features running east-west are the incised drainages created by the rivers draining into Lake Washington. These include the Cedar River, May Creek, Coal Creek, and Richards Creek.

PSE design standards and experience indicate that transmission line construction on slopes greater than 20 percent is difficult, requiring special engineering measures, while slopes greater than 40 percent should be avoided. Areas with slopes greater than or equal to 20 percent were calculated from the elevation model. All slope areas greater than or equal to 20 percent were not included in the steep slope layer if at least 200 ft per slope was not present to site the transmission line. The remaining high-slope areas are wider than the standard structure span for the project, and were therefore considered “unspanable.” The same process was done for slopes greater than or equal to 40 percent (Figure 3-5). If an area with a steep slope can be spanned within standard design limitations, then the slope is not considered an impediment to a specific route. Figure 3-6 explains graphically how the final result was attained.

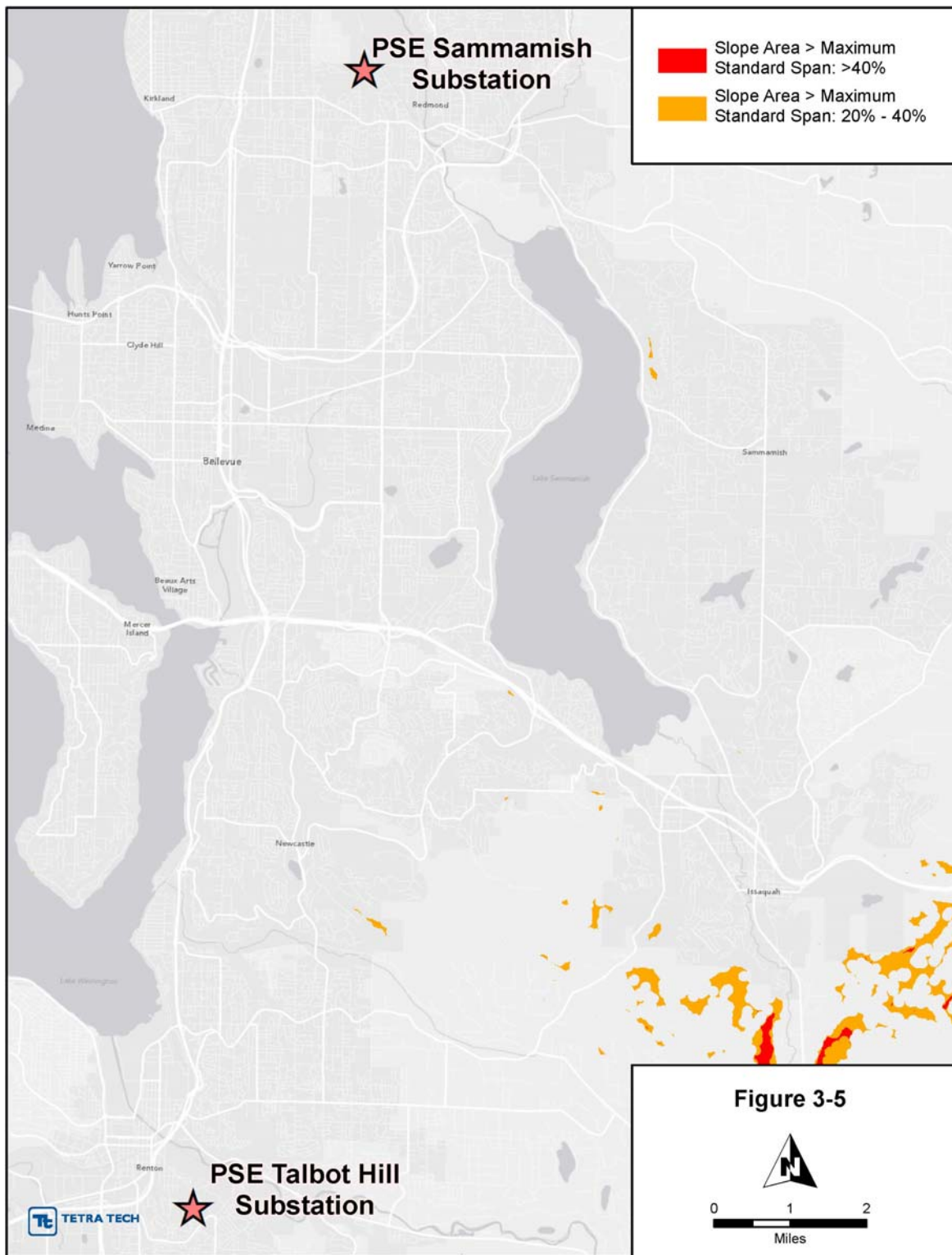
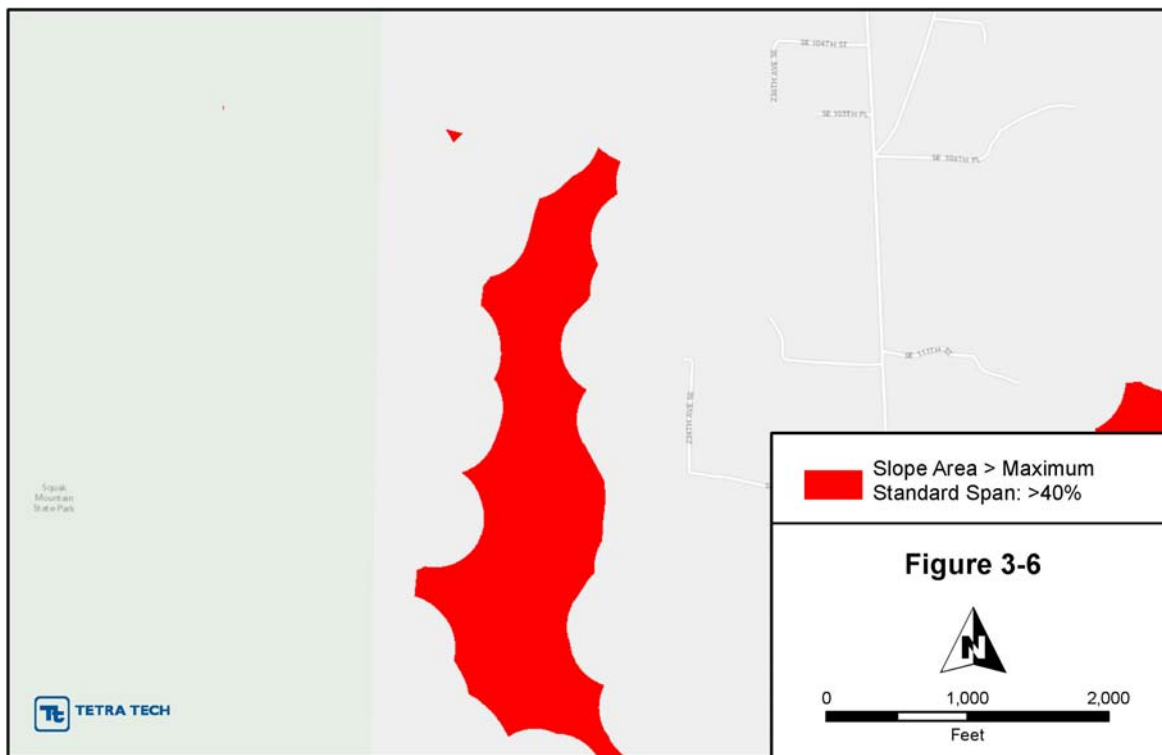
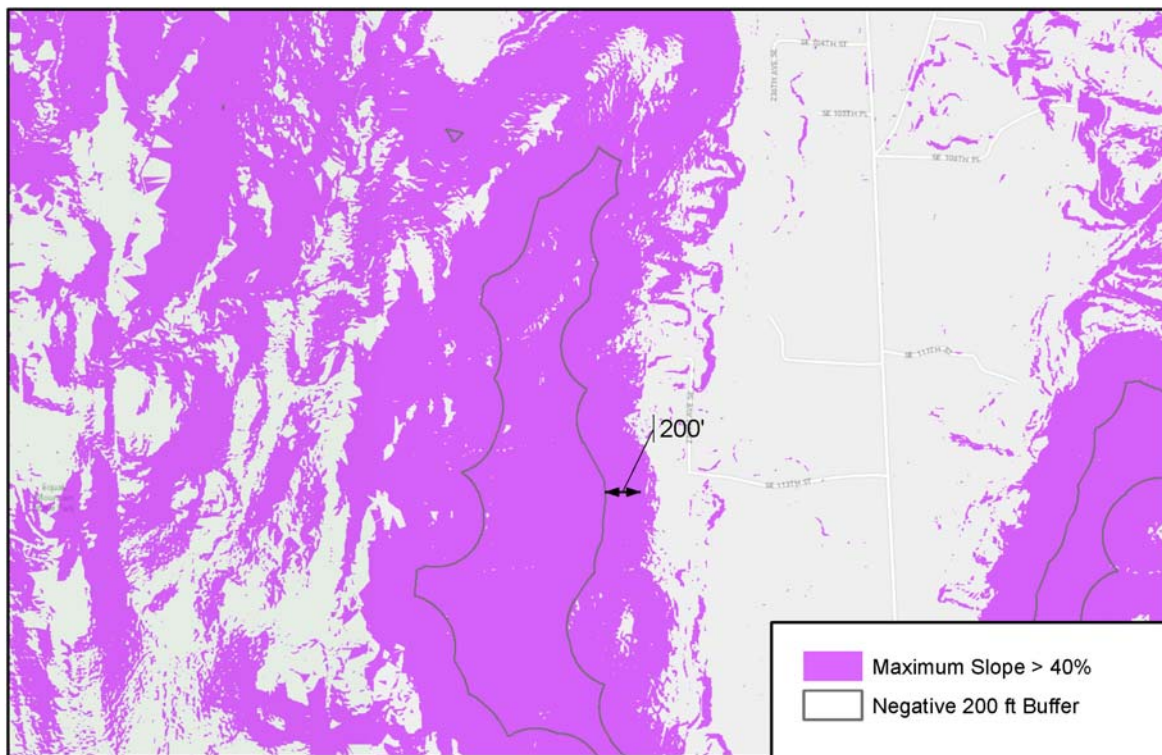


Figure 3-5. Unspanable Slope



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Figure 3-6. How Unspanable Slope Is Derived

3.4.3.2 Slope Stability

Figure 3-7 shows the various levels of slope stability. As shown, the large majority of land has stable slopes, including the existing PSE corridor. Areas of high instability occur mostly along valley walls. To reduce potential impacts, GIS mapped unstable slopes were avoided to the extent possible. This factor is important, especially during construction.

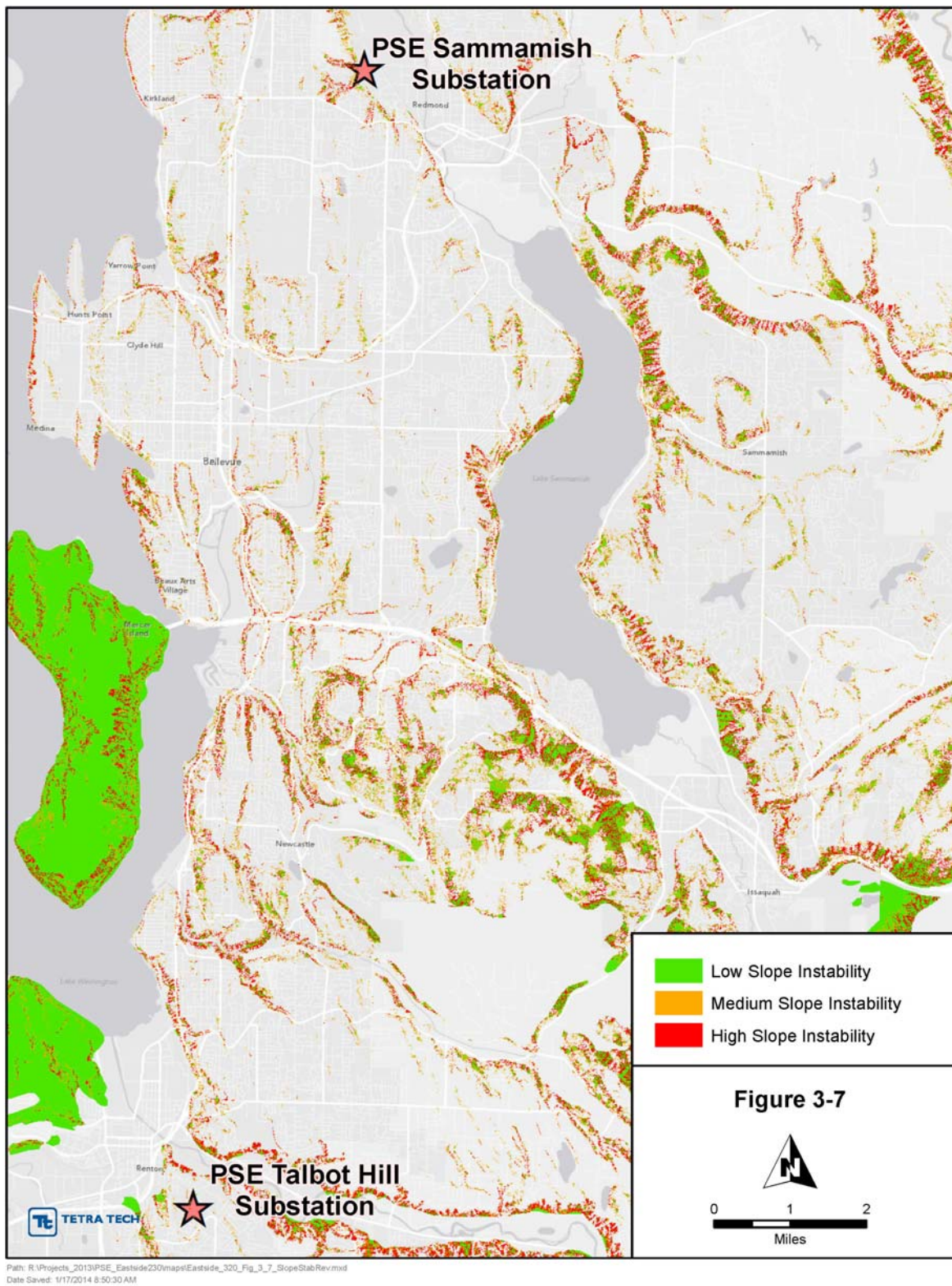


Figure 3-7. Slope Stability

3.4.4 Habitat

3.4.4.1 Waterfowl, Heron Rookeries and Bald Eagle Management Zones

Locations of priority habitat features were acquired from the WDFW GIS database. The identified priority habitat features in the study area are waterfowl areas, great blue heron rookeries, and bald eagle management zones. WDFW has identified priority waterfowl areas at the north and south ends of Lake Sammamish, Phantom Lake, Juanita Bay (part of Lake Washington), and several smaller lakes in the region that are classified as “Lakes With Waterfowl Use.” The transmission line alternatives under consideration do not cross any of these GIS features.

Great blue heron rookeries are scarce within the study area. The nearest GIS mapped rookery to any alternative is 0.3 miles away in the Mercer Slough Nature Park.

Bald eagle management zones are designated by WDFW according to current conservation guidelines, and their locations were used unaltered in the analysis. Development of any transmission line within a bald eagle management zone will be subject to review and regulation by WDFW.

3.4.4.2 Fish and Wildlife Species

Streams in the Puget Sound region that provide Chinook salmon habitat are protected under the federal Endangered Species Act (ESA) and are considered a constraint to be avoided or spanned (Figure 3-8). Data for streams with known Chinook salmon use were acquired from the U.S. Fish and Wildlife Service (USFWS) GIS database. These mapped streams can be typically be avoided or spanned.

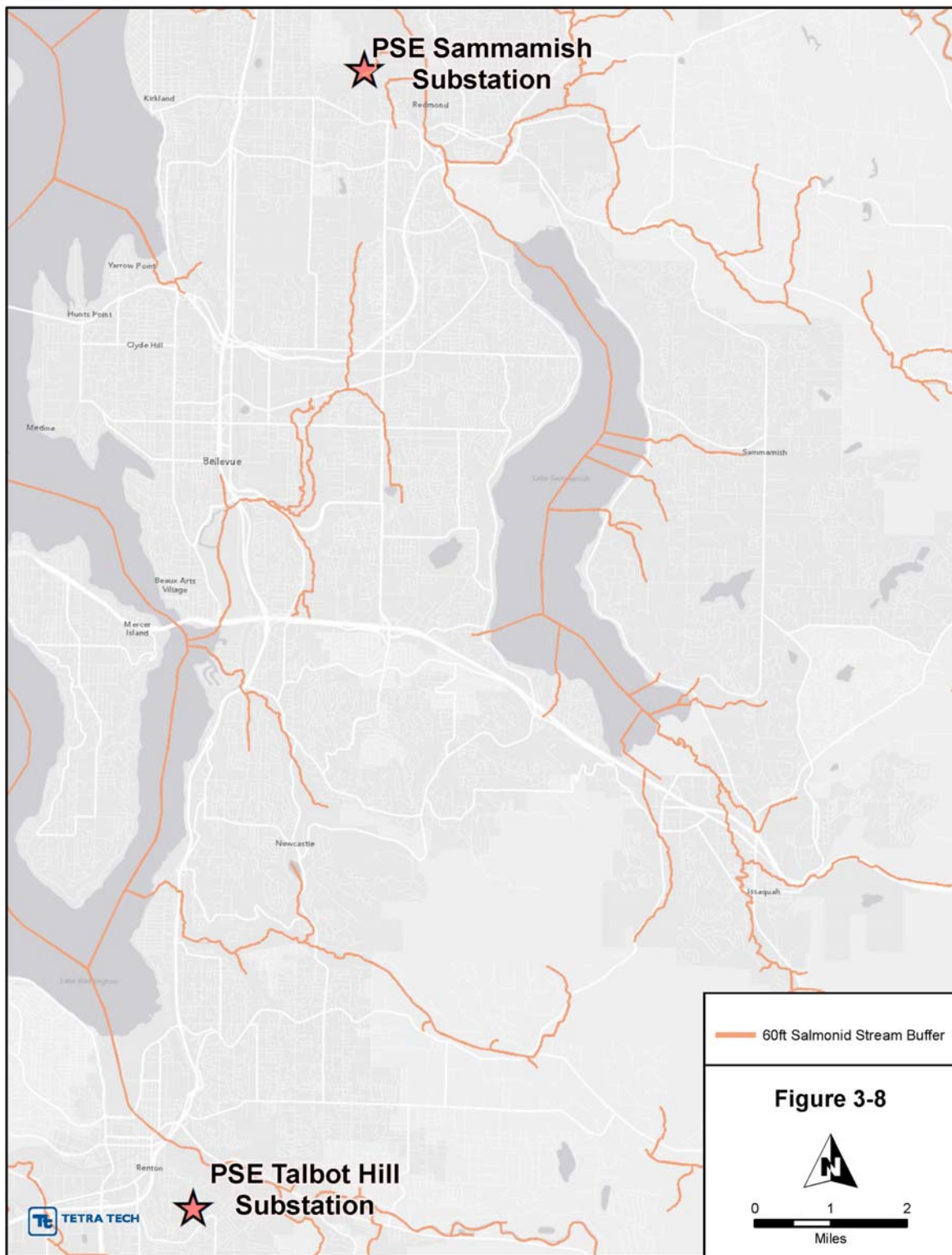


Figure 3-8. Salmonid Streams

3.4.5 Land Ownership

The optimum location of the transmission line is across land that allows for sufficient access, such as an easement owned by PSE, as this facilitates performance of maintenance and vegetation management in accordance with applicable clearance and safety requirements. As shown on Figure 3-9, private ownership is the predominant land owner type in the study area and would be a constraint if the transmission line had to traverse it. However, it is expected that most of the line can be constructed along existing road/utility corridors or overbuilt at existing overhead electrical line structure locations on PSE easement where the setting already includes both vertical and horizontal linear transmission facilities.

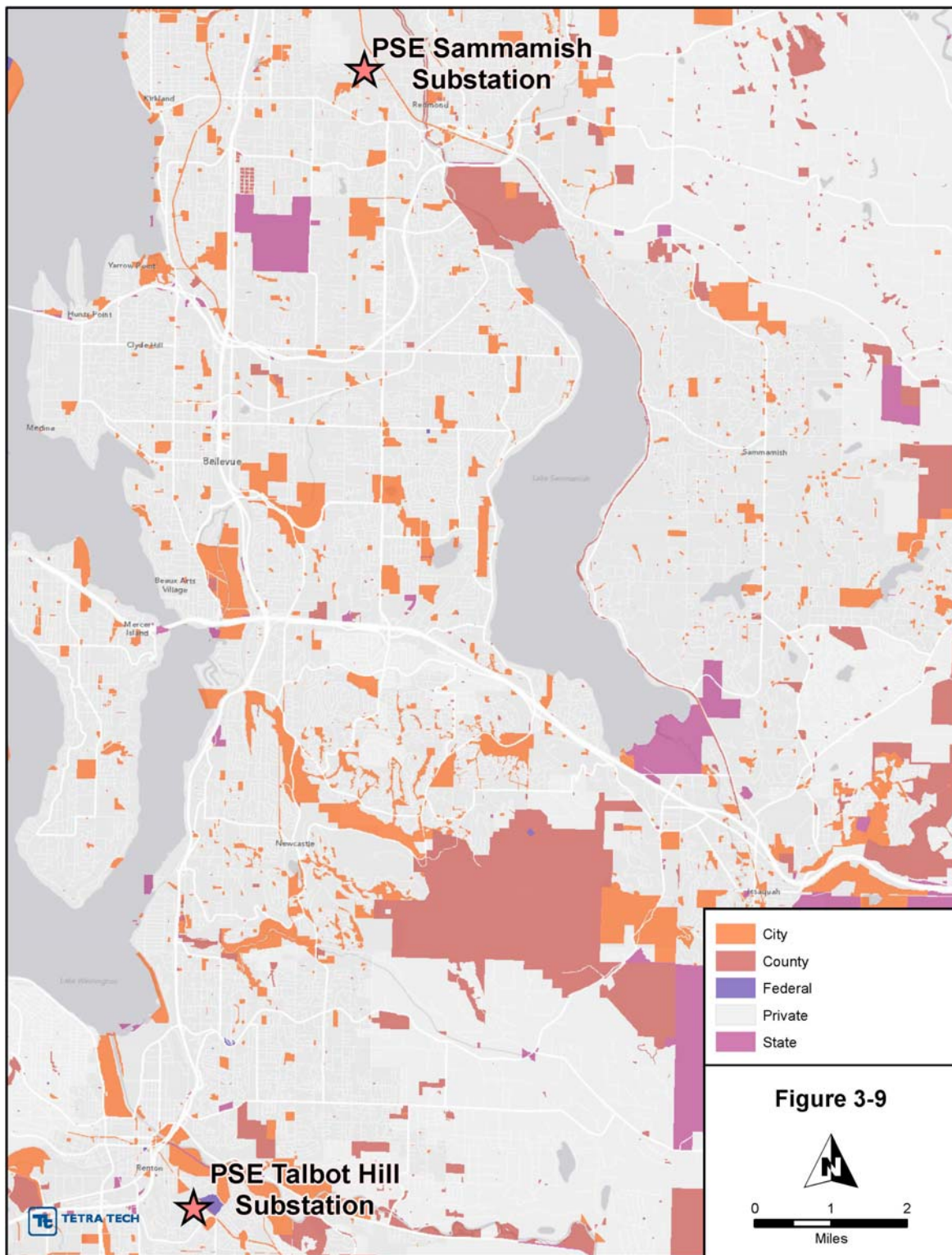


Figure 3-9. Land Ownership

3.4.6 Zoning/Land Use

Zoning and land use patterns were considered for purposes of this study based on two available GIS databases, a GIS database on current zoning (setting forth envisioned land use patterns such as agricultural, residential, commercial, etc.), and the tax assessors database based on current type of land use (commercial, residential, etc.). According to the zoning database, most of the land in the study area is zoned residential (Figure 3-10). More specific zoning and land use patterns and land use policy considerations will be evaluated in the next step of the process.

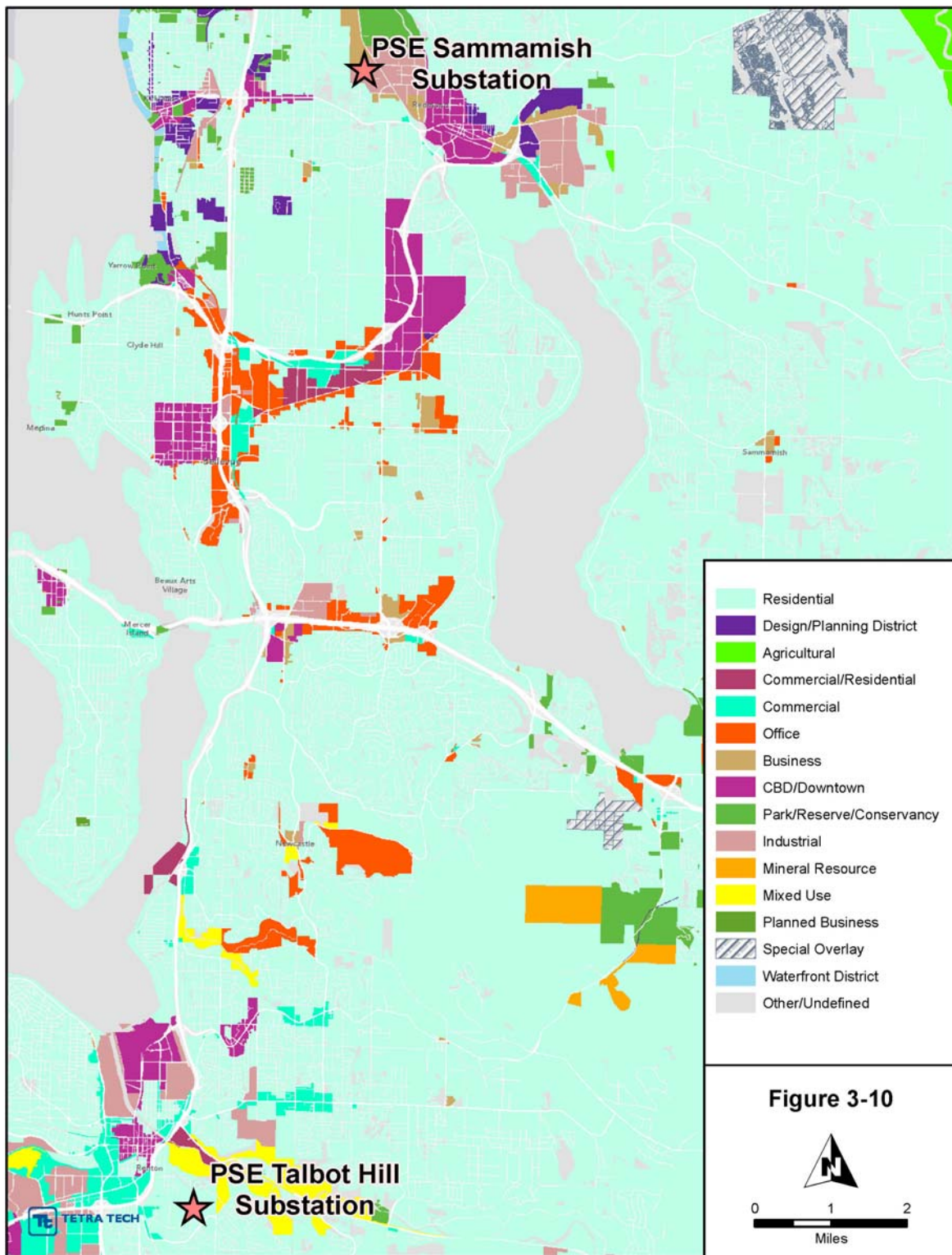


Figure 3-10. Zoning

3.4.7 Structures

Address point locations obtained from the tax assessor's GIS database were used as a proxy for occupied structure locations. In order to provide adequate avoidance, residential points were buffered by 100 feet, commercial locations were buffered by 160 feet, and trailers were buffered by 60 feet (Figure 3-11). Structure buffer density is high in the study area; therefore, buffers that overlapped onto roadways and existing corridors were removed as the structures would not be located in those areas (Figure 3-12). Additionally, without this modification, the address point layer density was too great to facilitate creation of viable routes.



Figure 3-11. Structure Buffer Process

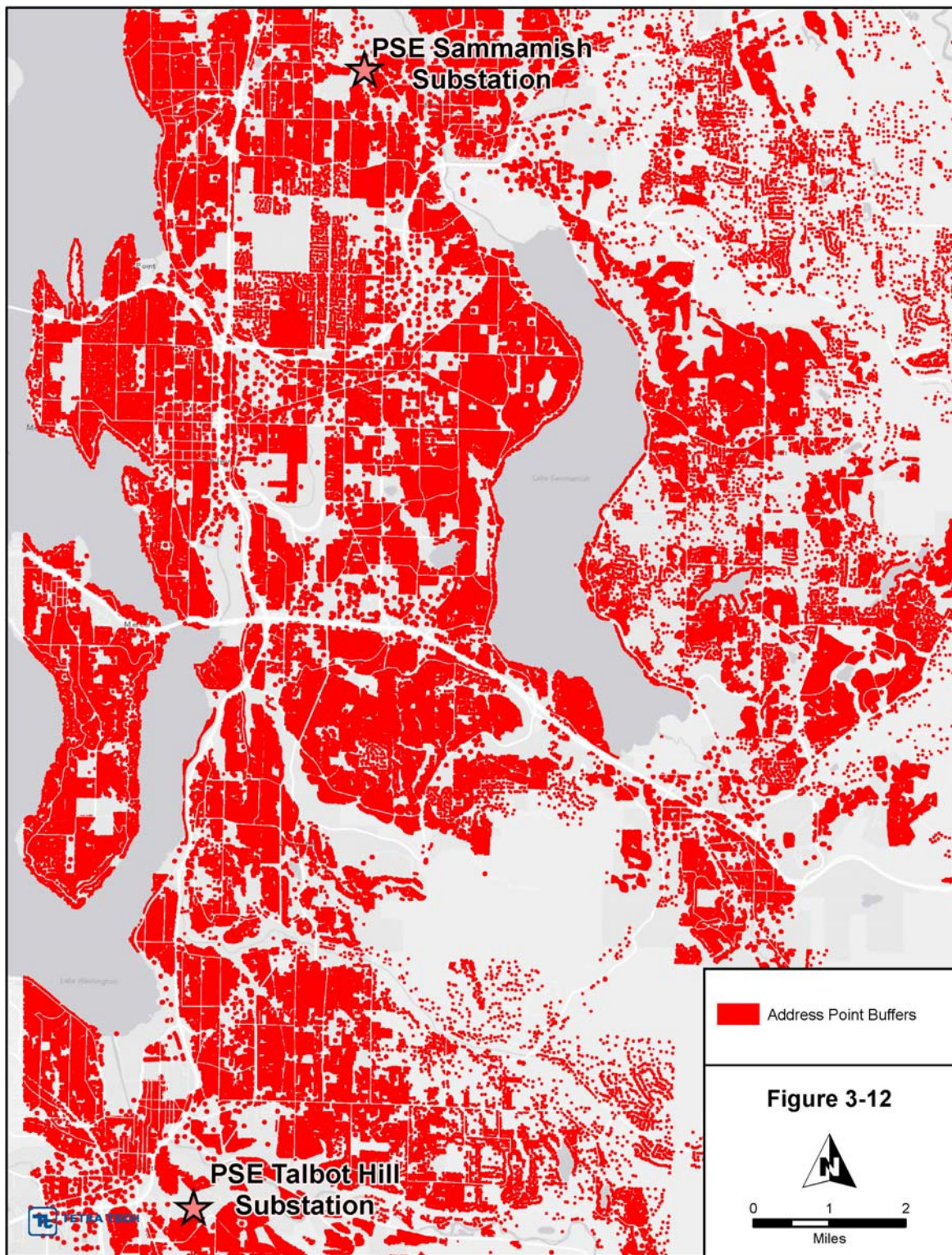


Figure 3-12. Buffered Address Locations

3.4.8 Parks and Recreation

The study area includes public lands designated as parks and recreational trails (Figure 3-13) using a GIS database from King County. While these lands can sometimes represent constraints for transmission line routing (with exception to the Eastside Rail Corridor, as described in section 3.5.2.2 above), they are relatively scarce and widely distributed, and therefore easily avoided.

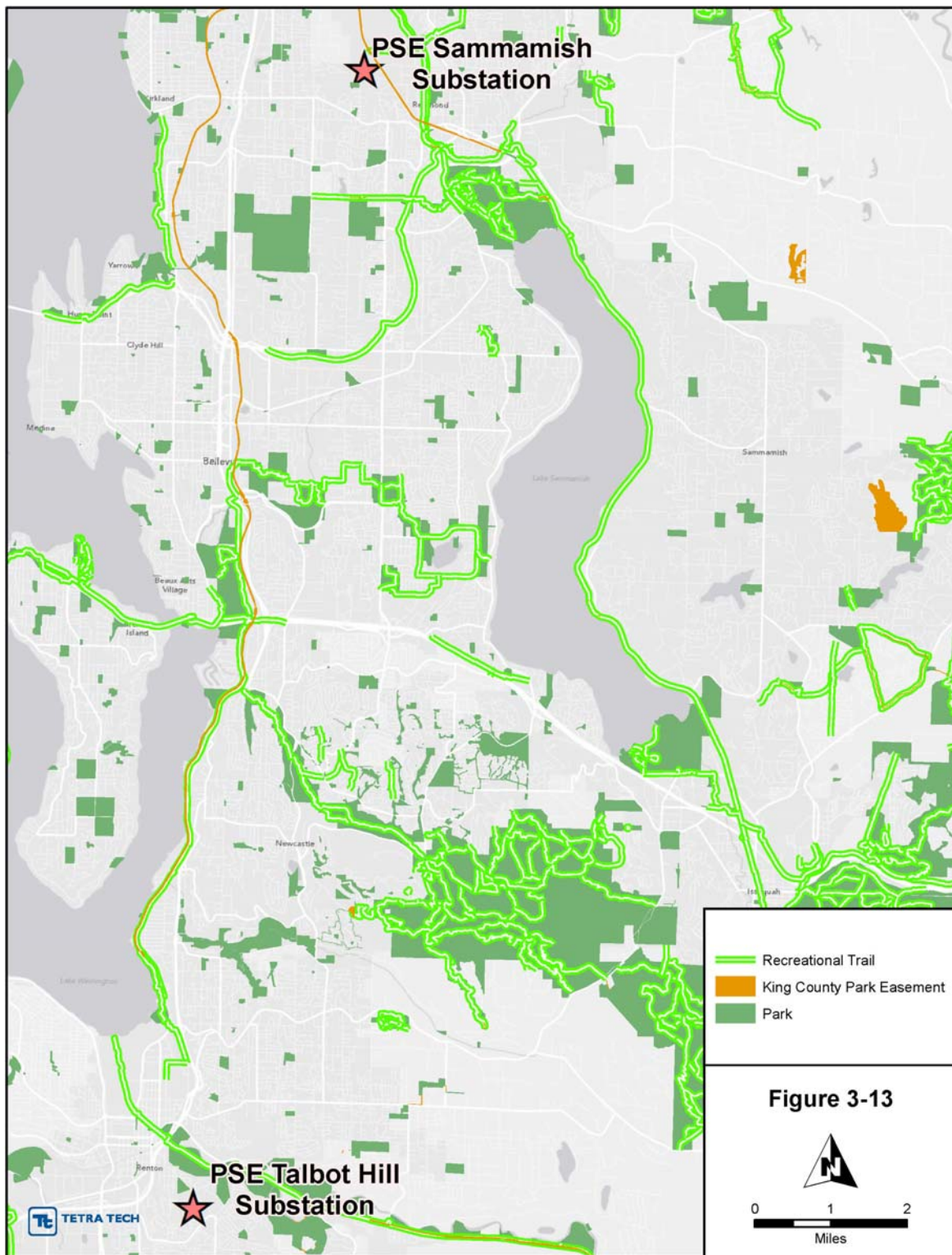


Figure 3-13. Special Land Use Designations

3.4.9 Historic Sites

Historic sites represent constraints, but also tend to be spaced well apart and can be easily avoided (Figure 3-14). For purposes of this analysis, data for Historic Parcels and Points were acquired from the King County GIS database. Cultural site data are classified as sensitive by the Department of Archaeology and Historic Preservation and therefore, were not included in the analysis. A review of cultural and historic sites will be undertaken during further route development, which is the next step of the process.

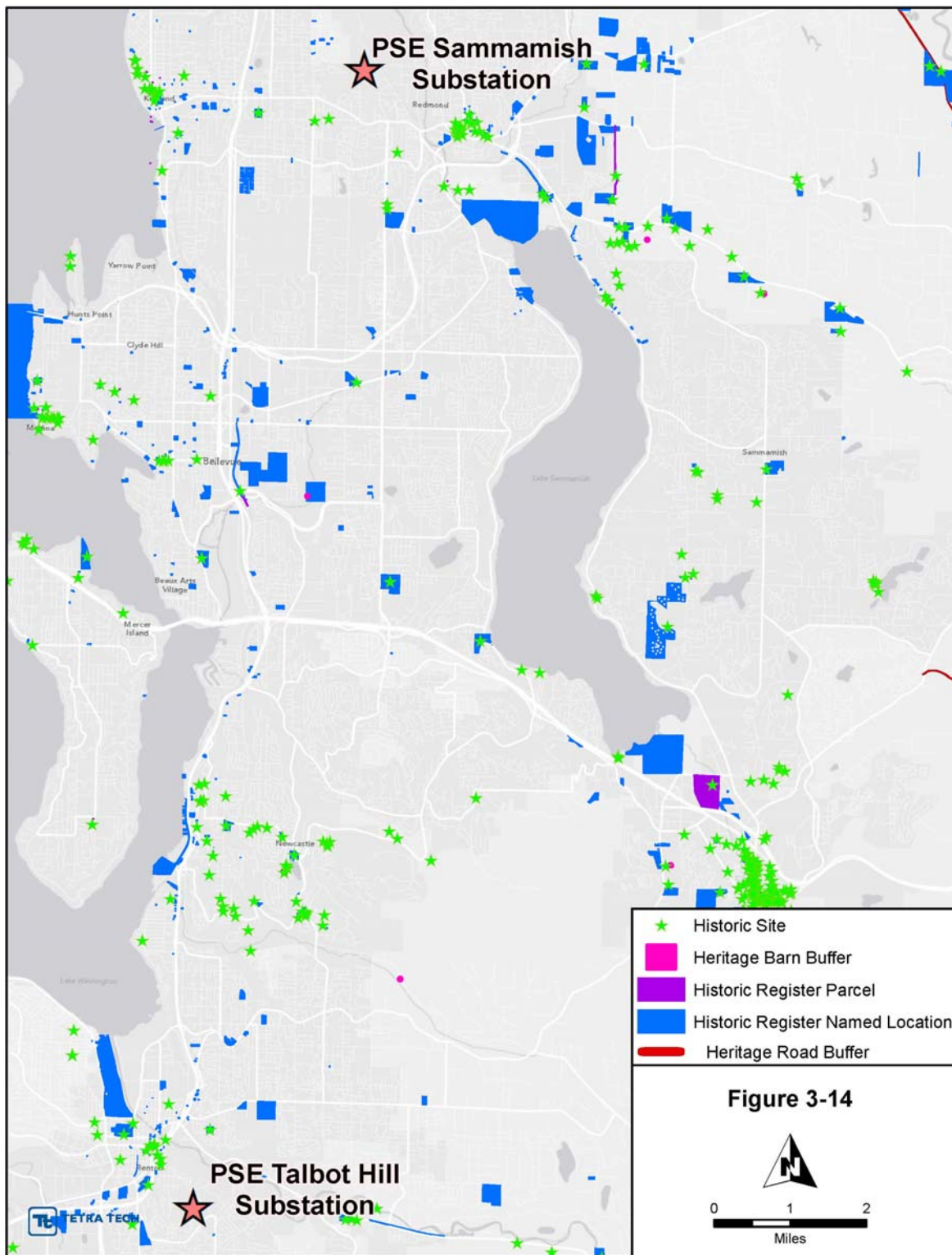


Figure 3-14. Historic Parcels and Points

3.4.10 Visual Resources

There is no GIS data available to effectively represent visual resource considerations in the routing analysis. Nonetheless, using existing corridors or ROW already occupied by existing lines can help minimize new visual impacts.

3.4.11 Waterbodies and Wetlands

There are a number of existing wetlands in the study area that could present constraints to routing a transmission line (Figure 3-15). Large wetlands can be routed around and therefore do not pose a serious problem. The wetlands in the project area occur mostly in river/stream floodways and floodplains, and around shallow lakes. Wetland locations were collected from the National Wetlands Inventory and King County.

Locations of water bodies, such as rivers, streams and lakes were collected from King County, as were the floodways and floodplains. These features can be spanned, except for Lake Sammamish, Lake Washington, Phantom Lake, Larson Lake, and Lake Boren, which can be routed around.

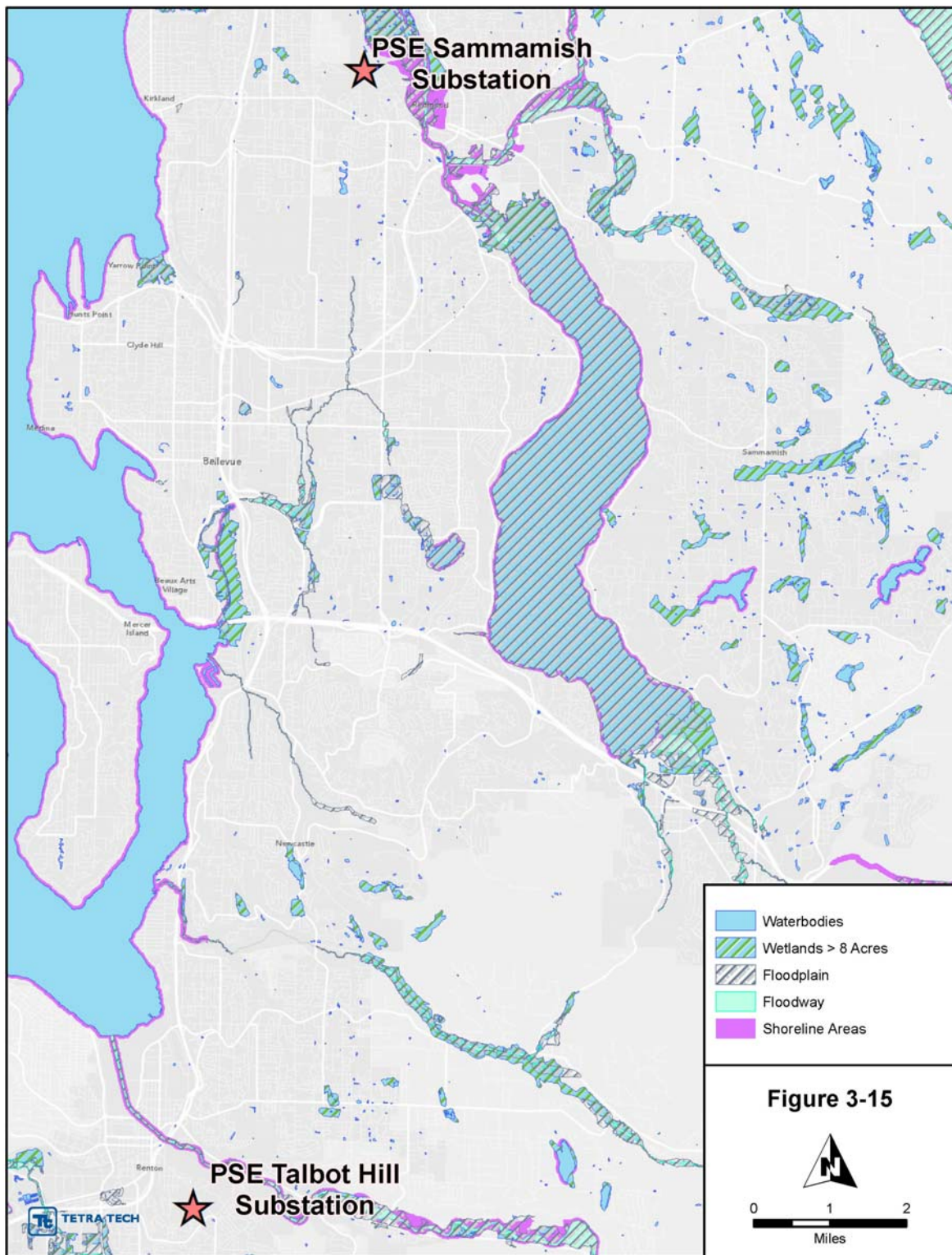


Figure 3-15. Water and Wetlands

3.4.12 Plants and Vegetation

The selected route must be compatible with PSE's vegetation management obligations, as well as applicable local, state, and federal species designated for enhanced protection. However, for the purposes of this study, only GIS mapped special habitat areas were considered. Washington Natural Heritage Program (WNHP) GIS data indicate that several rare, endangered or sensitive plant species occur in the study area. There is *Boschniakia hookeri* (S3) in Bridle Trails State Park, a *Pseudotsuga menziesii* - *Arbutus menziesii* / *Gaultheria Shalloon* Forest (S2) between Squak Mountain and Tiger Mountain, and a Forested Sphagnum Bog PTN (S1). S1 is the most sensitive of these categories, and the bog is over 4 miles east southeast of the Talbot Hill substation, and therefore does not influence the analysis. The S2 forest is over 8 miles east of the Talbot Hill substation, and not pertinent to the analysis. The S3 *Boschniakia hookeri* is 0.6 mile from a route segment; however, it is a small patch and easily avoided. In addition, King County and the local municipalities all have regulations regarding wildlife habitat conservation areas, as well as plant, significant tree, and vegetation disturbance in their jurisdictions that will be evaluated in the next step.

3.5 LRT ANALYSIS OF GIS MAPPED CONSTRAINTS AND OPPORTUNITIES

Following definition of the project study area, collection and processing of GIS data, and assessment constraints and opportunities, the LRT was used to identify transmission corridor options for further evaluation. Refinements to the corridors identified by the LRT were made after considering electric system feasibility and reviewing aerial photography, street maps, U.S. Geological Survey (USGS) topographic maps, and readily available knowledge of local conditions. Other criteria, such as engineering and construction feasibility, were also considered to a certain extent. Route distance minimization is built into the LRT as a standard parameter for route development. The respective steps in the transmission line route selection process are discussed below.

To select the best route options from the large number of possible routes, relevant attributes were evaluated simultaneously. Each of the environmental and engineering data sets identified in Table 3-1 were used to determine preliminary routes. Other criteria, such as total distance, engineering, and construction feasibility were also incorporated.

To enable this process, all of the datasets had to be normalized according to anticipated or potential constraints or opportunities associated with construction or operation of the proposed substation and transmission line(s). For that reason, the Project Team assigned values to each resource according to its relative contribution as an opportunity or constraint.

Tetra Tech staff collected existing available GIS files for land ownership, existing and future land use, public and private ROW, wildlife, vegetation, threatened and endangered (T&E) species, wetlands, topography, historical resources, and other factors that would influence the location of the proposed transmission line. The data collection process was designed to provide geospatial information on criteria that could represent either opportunities or constraints for the location of a transmission line.

Using the team's professional, multi-discipline expertise, the various data layers were individually weighted to reflect the varying degree of constraint or opportunity for each data set. The team's resource and LRT experts assigned values to the data layers (resources) using a progressive scale of values ranging from the most negative or adverse constraint, such as endangered species and residences, to the most positive or greatest opportunity, such as existing PSE ROW. Certain features were considered exclusion areas that could not be crossed under any circumstances because of regulatory, environmental, or engineering limitations. A matrix populated with these resources and their associated values was used as input to the LRT to identify potential transmission line routes. The GIS constraints and opportunities are listed in Appendix B.

The LRT combined these resource layer values and created an output file called the suitability grid, which represents a summation of all the constraints and opportunities for every point (grid cell) across the entire study area. Each grid cell was 10 feet by 10 feet in size, allowing for the model to look at the study area in relative detail. For each grid cell, the scores for each of the attribute layers were summed. The suitability grid can be likened to a landscape of opportunities and constraints that the corridor must traverse. The areas of greatest opportunity are the easiest to cross (valleys), while the areas of highest constraint (hills) are more difficult. The LRT generated multiple corridors across the suitability grid from PSE's Sammamish substation to PSE's Talbot Hill substation connecting via the potential transformation sites. An example of this output is shown in Figure 3-16. This figure depicts the optimal feasible route from the Sammamish to the Vernell substation, and from the Vernell to the Talbot Hill substation. Because all feasible routes include a transformation site between the Sammamish and Talbot Hill substations, all routes were modeled from the Sammamish substation to a potential intermediate transformation site, and then from that site to the Talbot Hill substation.

Multiple corridors, with varying degrees of opportunities and constraints were generated and used to develop alternative routes. To simplify analysis, each route was partitioned at the crossing points of routes to create unique segments. Each LRT segment was validated using professional judgment and ancillary resources such as aerial photographs, to help ensure they were realistic options. Once the segments were generated and validated, a composite score was calculated for each segment from the underlying suitability grid. The composite score for each segment was put into a deterministic model that considered over five hundred combinations of segments and substation sites. If parallel segments (i.e., typically less than a block apart) were identified during the model evaluation, LRT scores were compared to determine which segment would be used to develop routes.

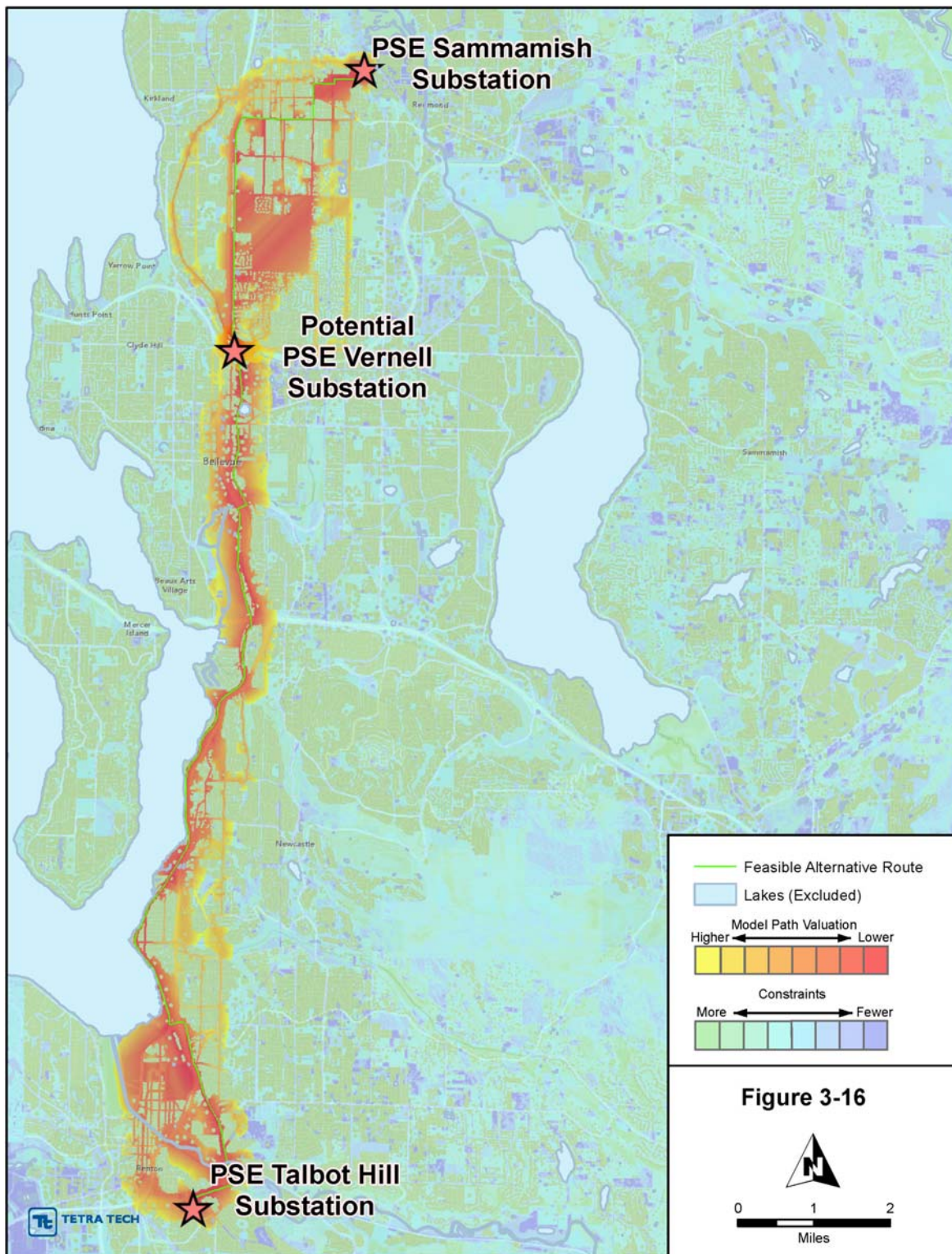


Figure 3-16. LRT Constraints and Opportunities, Corridor Grid and Route Alternatives

3.6 SELECTION OF ALTERNATIVES TO CARRY FORWARD

Because the Corridor Grid shows variations in the degree of opportunity and constraint, it is used to define route alternatives. Multiple corridors, with varying degrees of opportunities and constraints, were generated and used to develop alternative routes. To simplify analysis, each route was partitioned at the crossing points of routes to create unique segments. Each segment was then analyzed by the Project Team. This process has been used to help identify route options on many linear projects, further refining the professional judgment of the analysts over time. The analysis process also includes review of ancillary resources, such as aerial photographs, that add new and objectively verifiable information to the data sets that generated the corridor grid and route segments. By applying professional judgment to the data sets and ancillary resources, each LRT segment was validated to help ensure that they were feasible options. Once the segments had been identified, the constraint value score was calculated for each one. A constraint value model was developed that considered over 500 segment/route/substation site combinations. If parallel segments (i.e., typically less than a block apart) were identified during the model evaluation, LRT constraint values were used to compare and determine which segment would be used to develop routes.

A deterministic model was used to evaluate the LRT scores for each of the segment/route/site combinations. Negatively scored routes were eliminated from further consideration as they were not considered viable options. The top five percent of the positive routes were then mapped to assist further discussion and evaluation, with the segment combinations for these routes provided in Table 3-2, below. The mapping exercise revealed that there were four general subareas, which when combined, formed a “ladder” of route alternatives. The “leg” components of the ladder comprised the north-south running routes connecting the Sammamish, Talbot Hill, and one of the new transformation substations. Moving east to west between the “legs” could be accomplished by using one of the three cross-over segments or “rungs.” The only exception to this being an additional north-south segment situated in the central part of the study area, south of I-90. To simplify future discussion, each of the fourteen legs and rungs were given a unique identifier (Figure 3-17).

Table 3-2. Route Segment Composition

Vernell 248	Vernell 249	Westminster 217	Lakeside 155	Lakeside 160	Lakeside 166
A	A	A	A	A	A
B	B	C	C	C	C
F	F	D	E	E	E
H	H	F	G2	G2	J
K1	L	H	G1	I	M
K2	N	L	H	K1	N
M		N	L	L	
N			N	N	

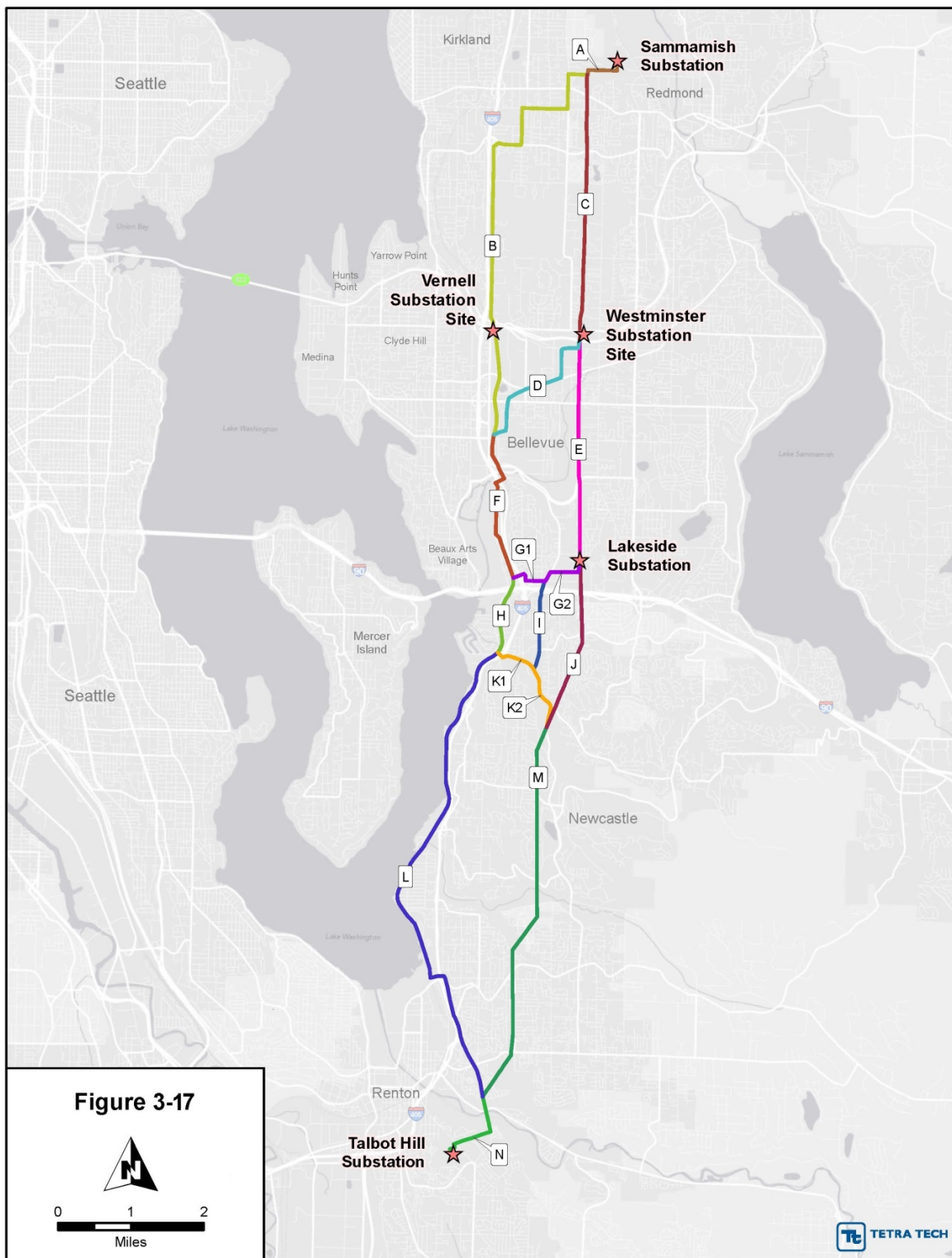


Figure 3-17. Route Alternatives with Unique Identifiers

4. Conclusion and Next Step: Viable Segments and Recommended Routes

Collection and synthesis of the GIS data sets identified throughout this report, analyzed by linear route selection professionals using the processes discussed above, supports the determination that all of the mapped segment combinations shown in Figure 3-17 can be used to develop a route capable of connecting the Sammamish Substation with the Talbot Hill Substation, while connecting to any one of the three new 230 kV intermediary substations.

Additional data collection and evaluation will be conducted in order to further refine the assessment of route segments, which will support a determination that the most viable route is one that is technically feasible and practicable for permitting, construction, and maintenance over time. Following a public review and input process, PSE will select the preferred route, which will then be subjected to project-specific land use and environmental review in support of permits to construct the new transmission facility.

5. Report Limitations

This assessment was developed in conjunction with Puget Sound Energy in an effort to assist in the selection of a feasible 230 kV transmission line route from the Sammamish Substation to the Talbot Hill Substation. The report was developed to describe the evaluation and selection processes. The need for future analysis may also be warranted if specific issues are identified that were outside the intended scope of this assessment.

As with any project that involves an evaluation of environmental and permitting factors, there is a certain degree of dependence upon available information that may not be readily verifiable without the implementation of thorough field programs. Data collected and used within this report were derived primarily from examination of records in the public domain and input from the project team's knowledge about the project area. The passage of time, manifestation of latent conditions, or occurrence of future events may require further study, as well as reevaluation of the findings, observations, and conclusions in the report.

APPENDIX A- Tetra Tech Routing Experience

Tetra Tech, founded in 1966, has provided siting and permitting services for AC and DC electric transmission lines for approximately 40 years in locations from California to Maine, including our current work on the longest contiguous electric transmission project in the nation, the Gateway West Transmission Project.

Listed below is a table of transmission siting projects in the West that Tetra Tech is currently supporting or has supported recently.

Client	Project	Location
Puget Sound Energy	Berrydale to Lake Holm (Krain Corner)	King County
Puget Sound Energy	Eastside 230 kV Project	King County
Idaho Power/ PacifiCorp	Gateway West 230 kV and 500 kV Lines	Wyoming and Idaho
Idaho Power	Boardman to Hemingway 500 kV Line	Oregon and Idaho
NV Energy	Falcon-Gender 345 kV Line	Nevada

APPENDIX B- GIS Constraints and Opportunities

Constrain/Opportunity	Value	Value Definition
Address point buffers (buildings); BPA substation; Large lakes	barrier	Exclusion areas that cannot be crossed under any circumstances due to regulatory, environmental or engineering requirements.
Highway polygons created using lane widths; WSDOT Utility Restrictions – restricted; WA Natural Heritage Project Critically Imperiled Species of Special Concern (S1); Water bodies, Airport; Transfer of development rights – receiving; Convenience Store with Gas; Service Station; Marina; Resort/Lodge/Retreat; 4-Plex; Air Terminal and Hangers; Apartment; Apartment (Co-op); Apartment(Mixed Use); Apartment (Subsidized); Campground; Condominium (Residential); Condominium (Mobile Home Park); Duplex; Fraternity/Sorority House; Retirement Facility; Townhouse Plat; Triplex; Gas Station; Mobile Home Park; Daycare Center; Golf Course; Historic Prop (Misc); Historic Prop (Office); Mobile Home; Reserve/Wilderness Area; Residence Hall/Dorm; Rooming House; School (Private); School (Public); Single Family (C/I Use); Single Family (C/I Zone); Single Family (Res Use/Zone)	-5	Very high impact (duration, regulation). Very difficult or impossible to mitigate (due to technology, sensitivity of resource or cost of mitigation).
Arterial Roads buffered by 20 feet; Landslide potential (class 3); Wetlands, large; Parks; Art Gallery/Museum/Social Service; Auditorium/Assembly Building; Church/Welfare/Religious Service; Club; Condominium Office); Park-Private (Amuse Center); Park- Public (Zoo/Arbor); Condominium (Mixed Use); Group Home; Health Club; Hospital; Hotel/Motel; Medical/Dental Office; Mini Lube; Movie Theater; Nursing Home; Office Building;	-4	High impact. Mitigation would be successful, but would be difficult to implement, very costly, and/or require a long time to complete.

Post Office/Post Service; Rehabilitation Center; Restaurant (Fast Food); Restaurant/Lounge; Skating Rink (Ice/Roller); Tavern/Lounge; Vet/Animal Control Service		
WSDOT Utility Restrictions – with exceptions; WA Historical Register; WA Historical Register Districts; Historic Property Inventory – named; WA Natural Heritage Project Imperiled Species of Special Concern (S2); Slope 20% or greater, unspanable; Slope 40% or greater, unspanable (combined with slope >20% results in a total of -6); Shorelines (200' Buffer); Waterfowl habitat; Heron rookeries; Bald eagle nest buffers; Native growth protection easement; River/Creek/Stream; Water Body- Fresh	-3	Moderate impact. Would not likely result in significant adverse impact. Mitigation, if necessary, would be fairly easy to implement.
WA Natural Heritage Project Rare or Uncommon Species of Special Concern (S3); Floodway; Floodplain; Coal mine hazards; Airport approach notification zone; Landslide potential (class 2); Utility, Private (Radio/T.V.); Retail Store; Shopping Center (Community); Shopping Center (Major Retail); Shopping Center (Neighborhood); Shopping Center (Regional); Shopping Center (Specialty); Retail(Discount); Retail(Line/Strip); Open Space Timber Land/Greenbelt; Open Space (Agriculture-RCW 84.34); Open Space (Current Use-RCW 84.34)	-2	Low impact. Mitigation, if necessary, would be easy to implement.
Scenic Byways buffered by 50 feet; Railroads (rail bank) buffered by 50 feet; BPA transmission corridor; Heritage Barns buffered by 100 feet; Landslide potential (class1); Salmonid streams buffered by 60 feet; Park easements, King County; Tideland, 1st Class; Auto Showroom and Lot, Bank; Bowling Alley; Car Wash; Convenience Store without Gas; Grocery Store; Service Building; Sport Facility	-1	Very low impact. No mitigation required.
Transfer of development rights – sending; Governmental Service;	0	No impact or impact not a concern.

Greenhouse/Nursery/Horticulture Service; High Tech/High Flex; Mining/Quarry/Ore Processing; Office Park; Retail(Big Box); Terminal (Auto/Bus/Other)		
High Pressure Gas Lines buffered by 75 feet; Farm; Mortuary/Cemetery/Crematory	1	Reduces impacts and mitigation requirements, and would facilitate permitting to a very minor extent.
Recreational Trails buffered by 10 feet; BPA transmission corridor buffered by 80 feet; Vacant (Commercial); Vacant (Multi-family); Vacant (Single-family)	2	Reduces impacts and mitigation requirements, and would facilitate permitting to a fairly minor extent.
Industrial Park; Industrial (Gen Purpose); Industrial (Heavy); Industrial (Light); Mini Warehouse; Terminal (Rail); Vacant (Industrial); Warehouse	3	Reduces impacts and mitigation requirements, and would facilitate permitting to a moderate extent.
Arterial Roads buffered by 45 feet; Railroads (abandoned) buffered by 50 feet; PSE 55kV corridor; Easement; Parking (Assoc); Parking (Commercial Lot); Parking (Garage); Right-of-Way/Utility-Road; Utility-Public	4	Reduces impacts and mitigation requirements, and would facilitate permitting to a large extent.
PSE transmission ROW buffered by 50 feet	5	Reduces impacts and mitigation requirements, and would facilitate permitting to a very large extent.