



GEOLOGICAL CONDITIONS INVENTORY

EASTSIDE RAIL CORRIDOR REGIONAL TRAIL MASTER PLAN PROJECT

2015-05-12

The Eastside Rail Corridor Regional Trail Master Plan Project develops a baseline inventory and planning guidelines for portions of the Eastside Rail Corridor owned by King County and Sound Transit.

A variety of uses is possible for the corridor in the future, and various agencies and jurisdictions have ownership interests in the corridor. This document is an internal work product supporting a study for future development of a shared use trail in the corridor.

For more information please visit: Kingcounty.gov/parks/eastsiderailcorridor

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CONTENTS

1.	INTRODUCTION.....	1
1.1.	OVERVIEW	1
1.2.	A STRATEGIC CORRIDOR FOR THE EAST SIDE'S FUTURE.....	2
1.3.	THE ERC REGIONAL ADVISORY COUNCIL- A COLLABORATIVE VISION FOR THE FUTURE OF THE ERC	2
1.4.	PLANNING FOR A TRAIL ALONG THE EASTSIDE RAIL CORRIDOR	4
2.	PLANNING FOR GEOLOGICALLY HAZARDOUS AREAS WITHIN THE CORRIDOR.....	5
2.1.	METHODOLOGY	5
2.2.	CRITICAL AREAS DESCRIPTION	5
2.3.	GEOLOGIC SETTING.....	7
2.4.	SITE CONDITIONS.....	7
2.5.	CRITICAL AREAS CONCLUSION	10
2.6.	USE OF THIS REPORT.....	13

FIGURES

FIGURE 1—EASTSIDE RAIL CORRIDOR (ERC) OWNERSHIP	3
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GEOLOGIC CONDITIONS - MAPS AND PHOTOS

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GEOLOGICAL CONDITIONS INVENTORY

1. INTRODUCTION

1.1 OVERVIEW

“Our Puget Sound region is blessed with dramatic topography, majestic natural features, and large, picturesque water bodies. While adding immensely to the beauty and quality of life in our region, those same features also create challenges when developing transportation, recreation and utility connections. The Eastside Rail Corridor (ERC) provides a rare and unique chance to develop a major north-south corridor for a variety of important purposes: mobility, utility infrastructure, and recreation.”

-Excerpt from the Eastside Rail Corridor Regional Advisory Council report

The Eastside Rail Corridor (ERC) connects some of King County’s largest and fastest-growing communities. As part of the Woodinville Subdivision, a 42-mile rail corridor that stretches from Renton to Snohomish, the ERC passes through Renton, Bellevue, Kirkland, Woodinville,

Redmond, and portions of unincorporated King and Snohomish counties. Originally a rail line, known as the Lake Washington Belt Line, that supported development along the eastern shore of Lake Washington, the corridor has been brought into public ownership to provide a potential route for trail, transit, and utilities. The ERC Regional Trail Master Plan (Master Plan) will develop a strategy to build a non-motorized trail in the corridor without precluding potential future use for transit and utilities. Any future transit or utility uses of the corridor would be considered in separate planning processes.

The ERC includes approximately 42 miles of right-of-way. Currently, only a portion of the ERC is being planned for potential trail use—a segment of the former railroad main line between Renton and Woodinville and a spur line connecting Woodinville and Redmond. The cities of Kirkland and Redmond have completed their planning for a trail in the corridor. The Master Plan includes the

segments of the ERC between Renton and Kirkland, between Kirkland and Woodinville, and along the spur from Woodinville to Redmond. Throughout the Master Plan, the line between Renton and Woodinville is referred to as the “main line,” and the line between Woodinville and Redmond is referred to as the “spur.” See Figure 1 for an understanding of the ERC ownership interests considered in the Master Plan.

This document provides a preliminary Critical Areas evaluation of geologic conditions within the King County-owned segments of the ERC.

1.2 A STRATEGIC CORRIDOR FOR THE EAST SIDE’S FUTURE

After nearly a century of rail use, in 2003 Burlington Northern Sante Fe (BNSF) began conversations with local jurisdictions about abandoning the rail line. In 2009 a group of public partners, including King County and the Port of Seattle, signed a Memorandum of Understanding that envisioned a regional approach to preserve the corridor for multiple uses. Although no specific projects were in development at that time, the partners recognized the potential value of a continuous corridor linking the east side from north to south as the region continues to develop. To begin that regional effort, the Port of Seattle purchased the 42-mile corridor between Renton and Snohomish. The southern portion of the line between Woodinville and Renton was railbanked, a legal designation that allows certain uses of the corridor while preserving it for potential reinstatement of freight rail. The northern portion, between Woodinville and Snohomish, remained an active freight area.

The jurisdictions and public agencies involved in the acquisition of the corridor envisioned potential future needs for a non-motorized trail, water distribution, sewer, power transmission,

and transit in the corridor. Between 2010 and 2013 ownership interests were purchased from the Port of Seattle by the City of Redmond, Puget Sound Energy (utility easement), the City of Kirkland, Sound Transit (primarily transportation-related easements), and King County (see Figure 1). These five entities are now the owners of the corridor between Renton and Woodinville.

1.3 THE ERC REGIONAL ADVISORY COUNCIL—A COLLABORATIVE VISION FOR THE FUTURE OF THE ERC

Recognizing the value of collaboration for future development of the ERC, the owners of the corridor formed a Regional Advisory Council (RAC) as a forum to coordinate planning for the ERC. The RAC summarized the findings of their initial planning effort in the report entitled *Creating Connections – Recommendations on the Eastside Rail Corridor*, which provides a guide for the next steps in collaboratively planning, developing and using the ERC. The RAC vision for the corridor emphasizes its long-term value for the development of transit, utilities, and a trail:

“Development of the corridor will enhance the mobility of our region by creating a critical north-south transportation corridor that will allow for multimodal connections, including high-capacity transit (e.g. heavy rail, light rail, or other forms of fixed guideway transportation) and nonmotorized trail use. The corridor will help us integrate the pieces of our larger transportation networks. The corridor will enable key utility improvements to help meet the demands of a growing population. The corridor will expand the recreation network, creating equitable access for all residents, and benefiting generations of Puget Sound residents.”



CORRIDOR OWNERSHIP

- PORT OF SEATTLE
- KING COUNTY
- CITY OF KIRKLAND
- CITY OF REDMOND
- SOUND TRANSIT
- 1 MILE MARKER

Figure 1 - Eastside Rail Corridor (ERC) Ownership

A regional trail is a shared use path that serves as a component of an extensive network of off-road, non-motorized routes connecting all parts of King County. A regional trail accommodates a wider variety and higher volumes of trail users than local trails typically do. Regional trail design aims to safely accommodate non-motorized activities including walking, jogging, bicycling, rollerblading, skateboarding, and other uses.

1.4 PLANNING FOR A TRAIL ALONG THE EASTSIDE RAIL CORRIDOR

The Master Plan is focused on implementing the RAC vision for a non-motorized trail in the ERC. The ERC represents a critical link in King County's Regional Trail System, which includes a network of shared-use trails connecting county communities. King County is currently responsible for over 175 miles of regional trails throughout the county. These trails include both paved and soft-surface trails; however, they all share common features of providing a safe and enjoyable trail experience for a variety of users. The ERC provides a rare and unique opportunity to establish a major new component of the county's regional trail system—a component that provides a significant new north-south trail corridor, as well as creating the opportunity to introduce critical connectivity within the county's existing regional trail system and trail systems managed by neighboring communities.

The Master Plan will further several important goals from the RAC recommendations for the ERC and the county's vision for the regional trail system:

- Advance the understanding of opportunities and constraints for development in the corridor

- Engage jurisdictions, agencies, and the public in a planning process to implement a trail as part of the corridor's multi-use vision
- Connect communities and existing trails to expand access and connectivity to King County's Regional Trail System

Rail corridors are generally heavily modified landscapes, including extensive embankments, engineered drainage features, and managed vegetation. Typically, natural resource features within rail corridors have also been modified. Small streams have often been channelized and culverted, wet areas filled, extensive drainage ditches installed, and vegetated habitats cleared and managed. However, these features often still provide valuable habitat functions, especially in an urban context. This study documents the ecological features in the corridor to provide a basis for the overall planning process.

The ERC project will likely consider a wide range of potential modifications to the corridor which would require clearing, grading and potential placement of structures. Strategies for avoiding or mitigating steep slope (protected/sensitive steep slope for City of Renton), landslide (high landslide for Cities of Renton and Kirkland), and seismic and erosion hazard areas will be important components of the planning, permitting and design for improvements in the corridor. This document provides a preliminary evaluation of geological conditions within the county-owned portions of the corridor.

2. PLANNING FOR GEOLOGICALLY HAZARDOUS AREAS WITHIN THE CORRIDOR

2.1 METHODOLOGY

This report includes a Preliminary Critical Areas Evaluation and field reconnaissance review of the ERC targeted on the King County Ownership segments which pass through the cities of Renton (Milepost [MP] 4.8 to 6.8), Bellevue (MP 7.2 to 14.8), Kirkland (MP 20.4 to 21.7 [main line]; MP 2.4 to 3.3 [spur]), and Woodinville (MP 21.7 to 23.8 [main line]; MP 0.0 to 2.4 [spur]), and a short segment in unincorporated King County (MP 6.8 to 7.2).

The process included a review of topography and geology, aerial photographs and Light Detection and Ranging (LiDAR) imagery, soil and groundwater seepage conditions, and the condition of the existing vegetation along the ERC as a basis for evaluating the Critical Areas. The list below includes an overview of the information that was reviewed:

- Review of in house and web-based geologic mapping (maintained by the U.S. Geological Survey [USGS]) and subsurface exploration database (maintained by the Washington State Department of Natural Resources [DNR]) with respect to subsurface conditions (geologic and hydrogeologic) expected along the ERC.
- Review of in-house and web-based aerial photographs of the ERC dating back to 1936.
- Review of LiDAR imagery of the ERC.
- Geologic reconnaissance of the ERC at targeted areas where Critical Areas are identified.
- Preliminary and general recommendations for dealing with Critical Areas including buffer considerations, structural methods (retaining walls), and temporary and

permanent drainage and erosion and sediment control (best management practices).

2.2 CRITICAL AREAS DESCRIPTION

As previously described, the ERC crosses through five jurisdictions including the cities of Renton, Bellevue, Kirkland, and Woodinville, and King County. Each jurisdiction has regulations with respect to definitions of Critical Areas and work or modifications within Critical Areas. These regulations (definitions and development/performance standards) are described in each jurisdiction's municipal code (MC), land use code (LUC), zoning code (ZC) or county code (CC). The regulations also describe standards for exemptions and critical report requirements.

Critical Areas evaluated for this report are often referred to as geologically hazardous areas in the codes including steep slope, landslide, seismic, erosion, and coal mine hazard areas. No coal mine hazard areas are present within the ERC corridor.

Based on review of these codes, the definitions, development/performance standards and related exemptions and critical report requirements for geologically hazardous areas for each jurisdiction are similar in general context for each critical area. The following are on-line references for these code sections for each jurisdiction related to Critical Areas that are applicable to the ERC:

City of Renton

- Protected (Steep) Slope Area – MC Chapter 4.11.190 (S – Slope, Steep); MC Chapter 4.3.050 J.1.a
- Sensitive (Steep) Slope Area – MC Chapter 4.11.190 (S – Slope, Steep); MC Chapter 4.3.050 J.1.a
- High Landslide Hazards Area – MC Chapter 4.3.050 J.1.b

- Seismic Hazards Area – MC Chapter 4.3.050 J.1.d
- Erosion Hazards Area – MC Chapter 4.3.050 J.1.c
- Exceptions (Protected Slopes Area) – MC Chapter 4.3.050 J.5.b
- Critical Area Report Requirements – MC Chapter 4.3.050 J.2

City of Bellevue

- Steep Slope Hazard Areas – LUC 20.25H.120 A.2.; LUC 20.25H.120 B.; LUC Chapter 20.25H.125 (Development Standards).
- Landslide Hazards Area – LUC 20.25H.120 A.1.; LUC 20.25H.120 B.; LUC Chapter 20.25H.125 (Development Standards).
- Seismic/Liquefaction Prone Hazard Area – not codified*
- Erosion Hazard Area – not codified*
- Modification Approval – LUC Chapter 20.25H.145
- Critical Area Report Requirements – LUC Chapter 20.25H.140

*The City of Bellevue does not specifically include seismic/liquefaction prone or erosion hazard areas in their LUC although these areas have been regionally mapped by other agencies (King County and eCityGov Alliance - <http://www.nwmaps.net/>). These sensitive areas are regulated on a case-by-case basis. Proposed development in areas mapped for these hazards should include coordination with the city to review potential best practices or regulatory considerations.

City of Kirkland

- Steep Slope Hazard Areas – contained within the definition of a Landslide Hazard

- High Landslide Hazard Areas – ZConing Code Title 23 Chapter 85.13 (4)
- Seismic Hazard Areas – ZConing Code Title 23 Chapter 85.13 (5)
- Erosion Hazard Areas – ZConing Code Title 23 Chapters 85.13 (2) and 85.14
- Exemptions – Evaluated on a case-by-case basis
- Critical Area Report Requirements – Landslide and Seismic Hazards, Municipal Code Chapter 85.15

City of Woodinville

- Steep Slope Hazard Area – contained within the definition of a Landslide Hazard
- Landslide Hazard Area – MC Chapter 21.24.290 (2b)
- Seismic Hazard Area – MC Chapter 21.24.290 (2c)
- Erosion Hazard Area – MC Chapter 21.24.290 (2a)
- Exemptions – MC Chapter 21.24.060
- Critical Area Report Requirements – MC Chapter 21.24.120

King County

- Steep Slope Hazard Area – CC Chapter 21A.06.1230
- Landslide Hazard Area – CC Chapter 21A.06.680
- Seismic Hazard Area – CC Chapter 21A.06.1045
- Erosion Hazard Area – CC Chapter 21A.06.415
- Exemptions – CC Chapter 21A.24.070
- Critical Area Report Requirements – CC Chapter 21A.24.110

2.3 GEOLOGIC SETTING

The regional geology of the study area has been mapped by the USGS, referenced as the DNR Geologic Information Portal website (<https://fortress.wa.gov/dnr/geology/?Theme=subsurf>). Geotechnical test pit and test boring data were reviewed as available via the DNR Geologic Information Portal website (<https://fortress.wa.gov/dnr/geology/?Theme=subsurf>).

Geomorphic (landform) evaluation was based on historical aerial photographs and LiDAR imagery, referenced as follows:

- King County iMAP, 2010, LiDAR imagery
- King County iMAP, 1936 and 2009, aerial photographs

The ERC is within the Puget Sound Lowlands and is underlain by post-glacial, glacial and pre-glacial soil deposits referred to as peat, alluvium, recessional outwash, glacial till, advance outwash, advance outwash/transitional beds, pre-Fraser glacial drift and non-glacial deposits, and undifferentiated glacial drift. The following is a brief description of these Geologic Units as shown on the Regional Geologic Maps, Figures 2, 3 and 4:

- Peat – Very soft partially decayed organic material
- Alluvium – Stratified (layered) soft peat, clay and silt, and loose sand and gravel
- Recessional outwash – Stratified loose to medium dense sand and gravel with variable amounts of silt
- Glacial till – Unstratified and unsorted mixture of dense silt, sand, gravel, cobbles and boulders
- Advance outwash – Stratified dense sand with variable amounts of silt and gravel

- Advance outwash/transitional beds – Stratified hard silt and dense fine sand
- Pre-Fraser age glacial drift and non-glacial deposits – Stratified or massive silt, sand and gravel
- Glacial drift (Undifferentiated) – Undifferentiated glacial deposits; silt, sand and gravel

It is important to note that for the level of detail completed for this preliminary evaluation of Critical Areas, and related geology, cuts and fills (often referred to as “modified land”) were not mapped. Based on site observations, modified land occurs frequently, if not for the full length of the ERC. Fill is a primary concern for the project as the quality and quantity of the fill is not known until adequate subsurface exploration is completed. Cuts and fills also create steep slopes (slopes more than 40 percent grade), although these are typically exempt from regulation if created through previous legal grading.

2.4 SITE CONDITIONS

2.4.1 Topography

The project area is located within a glacially-sculpted landscape that forms a series of north-northwest trending valley and upland areas. The ERC typically follows the lakeshore of Lake Washington south of Interstate 90 (I-90) then along valleys north of I-90, crossing to the east in the Totem Lake area before heading north again to Woodinville.

Elevation along the corridor varies from about elevation 30 feet along the Lake Washington shoreline to about elevation 160 feet in the Overlake area of Bellevue (I-405/State Route [SR] 520 interchange area). The ground surface ranges from about elevation 20 feet at the Sammamish River – Bothell crossing to about elevation 500 feet along the east end of the NE 145th Street segment in King County.

Steep slopes (slopes inclined more than 40 percent grade) occur locally as natural or artificial (cut and fill) slopes at each of the upland hillsides paralleling the primary and secondary valleys. In the upland areas, the ERC crosses gently undulating to nearly level terrain.

Topography along the ERC is locally altered by cuts and fills (modified land) where the rail line traverses hillsides or crosses low/high areas where cuts and fill were made to maintain grade. Many road crossings are by overpass (elevated structure/trestle), including a large overpass at the I-90 crossing and a former crossing by embankment at the “Wilburton Tunnel” site (removed in 2008). Other larger overpass crossings occur at the Lake Hills Connector and the Wilburton Trestle over SE 8th Street, both in Bellevue.

2.4.2 Surface Conditions

ERC main line:

MP 4.9 to 9.0 – This segment of the ERC parallels Lake Washington by traversing a moderately sloped, west-facing hillside at about elevations 30 to 70 feet.

The rail line parallels Lake Washington Boulevard North to about MP 6.3 (I-405/NE 44th Street interchange) then continues to parallel I-405 to the north along the fully developed (residential waterfront) Lake Washington shoreline to about MP 8.6. Along this area the rail line is relatively narrow with Lake Washington Boulevard North to the west (steep cut/fill embankment). The adjacent residential properties and paved access include non-structural landscape walls and cuts into the rail line embankment which appear to have been completed to provide more private access and parking.

At about MP 6.1, the rail line enters a nearly level area (May Creek crossing) then parallels

the west side of the former Barbie Mill site (current location of the Seattle Seahawks Virginia Mason Athletic Center) from about MP 6.5 to 6.7.

From about MP 6.7, the rail line continues north in an area where the east side parallels I-405 and the west side borders residential waterfront development to about MP 8.5. The ERC right-of-way within this segment appears to be encroached upon by residential development and paved access, and, to a lesser extent, the I-405 embankment.

From about MP 8.5 to 9.0, the rail line parallels I-405 as it curves to the northeast in the east side of Newcastle Beach Park.

MP 9.0 to 14.75 – From about MP 9.0 to 9.8, the ERC turns to the north-northeast, rising from about elevation 70 feet to elevation 100 feet by an upward hillside traverse bordered by residential properties and 118th Avenue SE to the west and an undeveloped (forested) hillside to the east.

From about MP 9.8 to 10.1, the rail line crosses I-90 on an elevated structure (overpass).

From about MP 10.1 to 11.0, the rail line parallels I-405 to the east and industrial/commercial properties to the west in a nearly level area at about elevation 100 feet.

From about MP 11.0 to 11.5, the rail line turns to the north-northeast where it formerly crossed I-405 (known as the Wilburton Tunnel on I-405). The Wilburton Tunnel was removed in 2008, though much of the fill embankments that carried the rail line on either side and in between the northbound and southbound lanes of I-405 remain from about MP 11.0 to 11.4 (modified land). From about MP 11.4 to 11.6 the rail line continues on a fill embankment through a residential area (modified land), then crosses SE 8th Street on the Wilburton Trestle which is a

historic wooden trestle 975 feet long and over 100 feet high at about MP 11.5 to 11.7. A short embankment section leads to a second overpass at the Lake Hills Connector Road at about MP 11.7.

From the Lake Hills Connector Road overpass at MP 11.7 to 12.2, the rail line occupies a relatively wide cut into a hillside (modified land) in an area bordered by commercial and retail land use. From about MP 12.2 to 12.5 the rail line is at or near existing grade and is bordered to the west by an approximately 10- to 20-foot high hillside which becomes at-grade north of MP 12.5.

From about MP 12.5 to 14.7, the rail line is at or near natural grade bordered by commercial and retail land use, crossing by Lake Bellevue at about MP 12.8. The rail line crosses under I-405/SR 520 from about MP 13.6 to 13.9 then continues north and northeast to about MP 14.75 which is the end of this portion of the King County owned segment.

MP 14.75 to 20.35 – This segment of the ERC crosses through the City of Kirkland and is being evaluated by others.

MP 20.35 to 23.8 – The ERC goes east in a nearly level area following the Totem Lake/NE 124th Street corridor at about elevation 135 feet then turns to the north and north-northeast along the base of the hillside paralleling 141st Avenue NE, then 140th Avenue NE, generally at about elevation 110 feet. The rail line continues to the north within a bench constructed into the lower part of an undeveloped (forested) hillside area (modified land). Some commercial/industrial development borders the rail line to the east.

The ERC main line ends at MP 23.8 at about Elevation 50 feet.

ERC spur:

MP 0.0 to 3.3 – The spur segment goes south-southeast from MP 23.8 paralleling and in between the Woodinville-Redmond Road and the Sammamish River at about elevation 50 feet. At about MP 2.1 on the spur, this segment turns to the south within the Sammamish River Valley at about elevation 40 feet to the end of the King County ownership at about MP 3.3. This entire segment is bordered by mixed land use including residential (single-family and multi-family), commercial, retail, and pasture (farming).

2.4.3 Subsurface Conditions

Based on regional geologic mapping and our site observations, the ERC is underlain by recent deposits (alluvium in local areas) and post-glacial, glacial and pre-glacial soil deposits. However, local fill has been placed in some areas several feet or tens of feet thick (modified land). The fill is likely to closely resemble some of the more granular native soils and is likely in a medium dense or better condition as it was placed, generally speaking, as structural fill to support a rail line. The following is a summary of the subsurface geologic conditions along the ERC.

ERC main line:

MP 4.9 to 9.2 – The ERC parallels Lake Washington by traversing a moderately sloped west-facing hillside underlain by recessional outwash and glacial till. This segment crosses two primary stream valleys including the May Creek Valley from about MP 6.1 to 6.7 and the Coal Creek Valley from about MP 9.1 to 9.2. The May Creek Valley and Coal Creek Valley crossings are underlain by alluvium. The rail line is likely supported by several feet of fill where alluvium is present.

MP 9.2 to 14.75 – The ERC turns to the north-northeast, then north crossing an upland area primarily underlain by glacial till with local areas of advance outwash and pre-Fraser age glacial drift and non-glacial deposits. A wide former glacial meltwater channel mantled with recessional outwash occurs from about MP 13.2 to 14.0 (I-405/SR 520 area).

MP 20.35 to 23.8 – The ERC follows a former glacial meltwater channel mantled with recessional outwash, then turns to the north along the base of a hillside area which is underlain by advance outwash and advance outwash/transitional beds.

ERC spur:

MP 0.0 to 3.3 – The ERC spur parallels the main line (MP 20.35 to 23.8) to the east, is within the Sammamish River Valley, and underlain by alluvium.

2.4.4 Critical Areas

Critical Areas, including steep slope, landslide, seismic, and erosion hazard areas, along the ERC were initially mapped using on-line mapping resources from each of the jurisdictions. This mapping was then modified, usually slightly, for this report based on site observations, which included detailing of geologic mapping and better topographic information. Steep slope hazard areas and protected/sensitive steep slope hazard areas (slopes inclined more than 40 percent grade) were mapped using 5-foot contour mapping available on King County iMAP. At a regional scale, Critical Areas along the ERC are shown on the regional critical areas maps (Maps 4 through 32). Selected photos obtained during geologic reconnaissance of the ERC are attached (photo pages 1 through 3).

During the design phase of this project, it is likely that the regional mapping of Critical Areas will change based on more detailed survey, with consideration of certain

exemptions such as slopes created by previous legal grading (fill slopes).

2.5. CRITICAL AREAS CONCLUSIONS

2.5.1 General

Based on corridor geologic, topographic, surface, and subsurface conditions, it is likely that the redevelopment of the ERC can be completed without adverse impacts to Critical Areas and the buffers. Potential adverse impacts may be mitigated based on detailed Critical Area evaluation and identification along with recommendations to mitigate by special design measures, buffering, or avoidance, as appropriate.

2.5.2 Steep Slope Hazard Areas (Including Protected/Sensitive Steep Slope Hazard Areas for Renton)

Probably the most common Critical Area will be steep slope hazard areas. Based on site observations, it is apparent that subsequent improvements adjacent to the rail line in local areas have encroached into the ERC by the construction of road embankments or cutting into the toe of the rail line area to widen/level adjacent areas. Cuts and fills for the original rail line were also made at steeper inclinations than what would be considered as currently accepted engineering practices. It is also probable that subsequent cuts or construction



Homes and other adjacent land uses are frequently at the toe of steep slopes located within the ERC right-of-way.

of landscape walls (non-structural walls) into these slopes were done by others to create more usable space for vehicle access, parking, etc. However, based on limited observation of the ERC, these slopes are performing reasonably well in the current condition.

Many of the steep slope hazard areas may end up as exempt because of slope height (10 or 20 feet depending on the jurisdiction) or are “created” slopes as a result of previous legal grading. Evaluation of these exemptions will be completed during the design planning phase on a case-by-case (site specific) basis as better topographic information becomes available.

In some areas where the trail is narrow and bordered by road embankments on one side (usually uphill) and accessory residential improvements (landscape walls/toe cuts) on the downhill side, a zero buffer may be needed. For this purpose, structural walls can be used to replace the lateral support of cuts on the uphill side and structural earth walls (SEWs) can be used on the downhill (fill) side.

2.5.3 Landslide Hazard Areas (Including High Landslide Hazard Areas for Renton and Kirkland)

Based on site observations, landslide hazard areas will be a primary concern at the north end of the ERC where the rail line traverses



Steep embankments, as seen to the right in this photo, are common within the ERC right-of-way.

an undeveloped hillside and crosses several ravines. Some of these ravine crossings by the rail line may need the culverts replaced for a variety of reasons.

The primary mitigation methods will be to maintain as much existing vegetation as possible, minimize cuts and fills, and to enhance drainage along the rail line corridor. Other mitigation includes the use of structural walls and SEWs as previously described.

2.5.4 Seismic Hazards Areas

Seismic hazard areas or liquefaction zones (City of Bellevue) areas occur in the lower nearly-level areas underlain by alluvium (vicinity of May Creek, Coal Creek, and the Sammamish River valley). Trail construction is not particularly sensitive to seismic hazard areas/liquefaction zones, though differential settlement, retaining wall settlement, and pavement damage by liquefaction can be expected and are typically not mitigated in design and construction.

Usually the cost of repair of trail facilities caused by a seismic event is less than mitigation to reduce damage. Structural additions such as structural walls and SEWs could be damaged by an earthquake, but are somewhat flexible and can be more easily repaired as compared to reinforced concrete walls.

2.5.5 Erosion Hazard Areas

Erosion hazard areas occur depending on the surficial soil type and slope inclination. Best construction practices including a temporary erosion and sediment control (TESC) plan can be implemented within erosion hazard areas for the ERC project to reduce the potential for erosion, and to reduce environmental impacts to wetland areas and their buffers.

2.5.6 Geotechnical Considerations

Recessional outwash, glacial till, advance outwash, transitional beds, and glacial drift typically will provide adequate support for the proposed trail, as demonstrated by the existing, more demanding requirement of the previous use as a rail line. The alluvium should also provide adequate support for a trail, but may vary considerably in compressibility (especially if organic soil, such as peat, is present) which could require design mitigation such as overexcavation of compressible soil for new fills, or SEWs or other structures. Shallow (less than 5 feet deep) groundwater is expected in areas underlain by alluvium.

Hillside areas underlain by glacial outwash/transitional beds (MP 21.0 to 23.8) may be the most sensitive to landslides, but can usually be mitigated by analyzing new fills or walls during the design phase and implementing drainage measures and/or cut/fill geometry to mitigate slope stability concerns.

There is a higher risk of liquefaction (seismic hazard areas) in the areas underlain by alluvium (May Creek, Coal Creek, and Sammamish River Valley [spur]). Liquefaction may result in loss of support of fill pads, SEWs,



Railroad construction often included steeper cuts and fills than are typical in contemporary construction practices, as seen in the steep cut slope on the left of this photo.

or other structures. If liquefaction occurs, then localized settlement of the ground surface can be expected.

Erosion hazard areas exist throughout most of the ERC, especially during construction when larger areas of bare soil and soil stockpiles are exposed. Managing erosion and sediment should be a primary goal for the project as minimizing erosion will also mitigate steep slope and landslide hazard area concerns.

2.5.7 Recommendations For Planning and Design

Detailed topographic mapping (survey) and geotechnical exploration should be completed as part of the design phase of this project, especially in Critical Areas and their buffers. The survey and geotechnical information would be used to better understand the soil and groundwater conditions and slope stability. This information would be used as a basis for evaluating site preparation, cuts and fills, excavations, fill placement, SEWs or other structures, and overall stability of cuts, fills, and walls in slope areas.

Impact avoidance measures for steep slope, landslide, and erosion hazard areas are directly inter-related. Often, a landslide problem begins as a drainage or erosion problem on or near a steep slope. Focusing on reducing erosion has the benefit of controlling drainage and/or reducing landslide potential. For this reason, recommendations are directed primarily at reducing erosion potential with respect to trail construction methods. Erosion control is important in wetland areas and their buffers.

The following construction practices should be implemented for the ERC project while working in or near Critical Areas to reduce the potential for erosion and landsliding, and to reduce environmental impact to wetland areas:

- The drier season (typically late June

through early October) is preferred for construction to reduce erosion potential. However, construction may occur during the wetter season (typically late October through early June), but increased costs should be expected because of construction delays during wet weather, and the cost of additional materials and labor for erosion control installation and monitoring.

- In areas where no access road is present, construction equipment should cross over vegetation to the extent that this is practical. In some areas, such as wetland or soft ground, Terra Mats (or equivalent) should be used to support construction equipment to reduce rutting.
- Grading (cuts or fills) may occur in steep slope or landslide hazard areas provided that site specific geotechnical evaluation and recommendations for mitigation are completed.
- Wetland boundaries and buffers should be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete.
- Cut tree stumps should be left in place, where practical.
- Tree removal in steep slope and landslide hazard areas should be completed by hand-carrying out small pieces or using full/partial suspension cable systems, such that dragging of the cut tree across the natural ground surface is reduced.
- Limbs and tree trunks may be left in steep slope and landslide hazard areas provided they are cut into pieces (no more than 10 feet long) and scattered on the ground surface.

- Excessive disturbance to the ground surface outside of the improved trail corridor, such as rutting caused by tree removal, should be repaired using hand tools and covered with an appropriate ground cover (e.g., straw mulch or other appropriate erosion control products).
- Within steep slope and landslide hazard areas, tree cutting and removal, and the installation of erosion control measures should be observed by a qualified engineering geologist to evaluate the effectiveness of erosion control measures, and to provide additional recommendations, if needed.
- Development/performance standards described in the codes should be followed to the extent that this is practical. Modifications to steep slope and landslide hazard areas need to be considered on a case-by-case and site-specific basis, appropriate at the time of design for the project.

Mitigation of seismic hazard areas or liquefaction zones may include design and construction of a trail on a structural fill pad, which provides separation and some additional support. In most areas along the ERC, this “fill pad” already occurs (the rail bed).

2.6 USE OF THIS REPORT

This preliminary Critical Areas report presents the results of Icicle Creek Engineers' (ICE's) geotechnical engineering services for the King County Ownership segments of the Eastside Rail Corridor.

ICE's services were requested by Jenny Bailey, Senior Planner with Parametrix and were completed in general accordance with Parametrix's Subconsultant Agreement for Professional Services dated May 1, 2014. This

report was submitted in draft form for review and comment on September 26, 2014.

ICE prepared this report for use by Parametrix. The report was completed as a preliminary review for planning purposes and does not address site-specific conditions; as such the report, conclusions, and interpretations should not be construed as a warranty of the site conditions.

Within the limitations of scope, schedule and budget, ICE's services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, express or implied, should be understood.

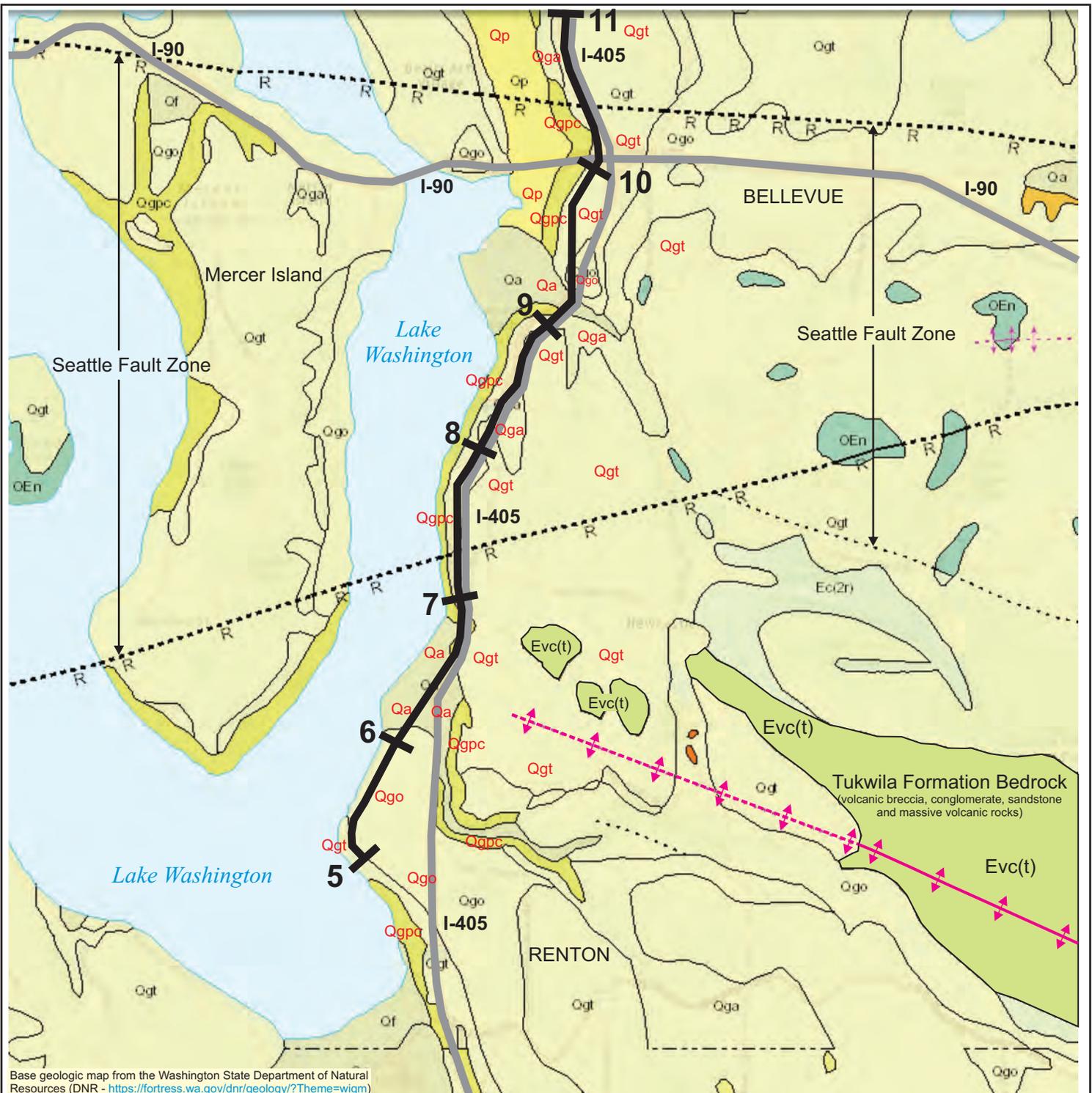


GEOLOGICAL CONDITIONS-MAPS AND PHOTOS

MAPS 1-3 : REGIONAL GEOLOGICAL MAPS

MAPS 4-32 : REGIONAL CRITICAL AREAS MAPS

PHOTOS



Base geologic map from the Washington State Department of Natural Resources (DNR - <https://fortress.wa.gov/dnr/geology/?Theme=wigm>)

GEOLOGIC UNITS/EXPLANATION

	Peat - very soft partially decayed organic material
	Alluvium - stratified (layered) soft peat, clay and silt, and loose sand and gravel
	Recessional Outwash - stratified loose to medium dense sand and gravel with variable amounts of silt
	Glacial Till - unstratified and unsorted mixture of hard/dense silt, sand, gravel, cobbles, and boulders
	Advance Outwash - stratified dense sand with variable amounts of silt and gravel
	Advance Outwash/Transitional Beds - stratified hard silt and dense fine sand
	Pre-Fraser Age Glacial Drift and Non-Glacial Deposits - stratified or massive silt, sand, and gravel
	Glacial Drift - undifferentiated glacial deposits; silt, sand, and gravel
	Eastside Rail Corridor - milepost (STUDY AREA)
	Eastside Rail Corridor - milepost (evaluation by others)

Notes: Geologic units that occur within or near the Eastside Rail Corridor are labeled in red typeface



REGIONAL GEOLOGIC MAP



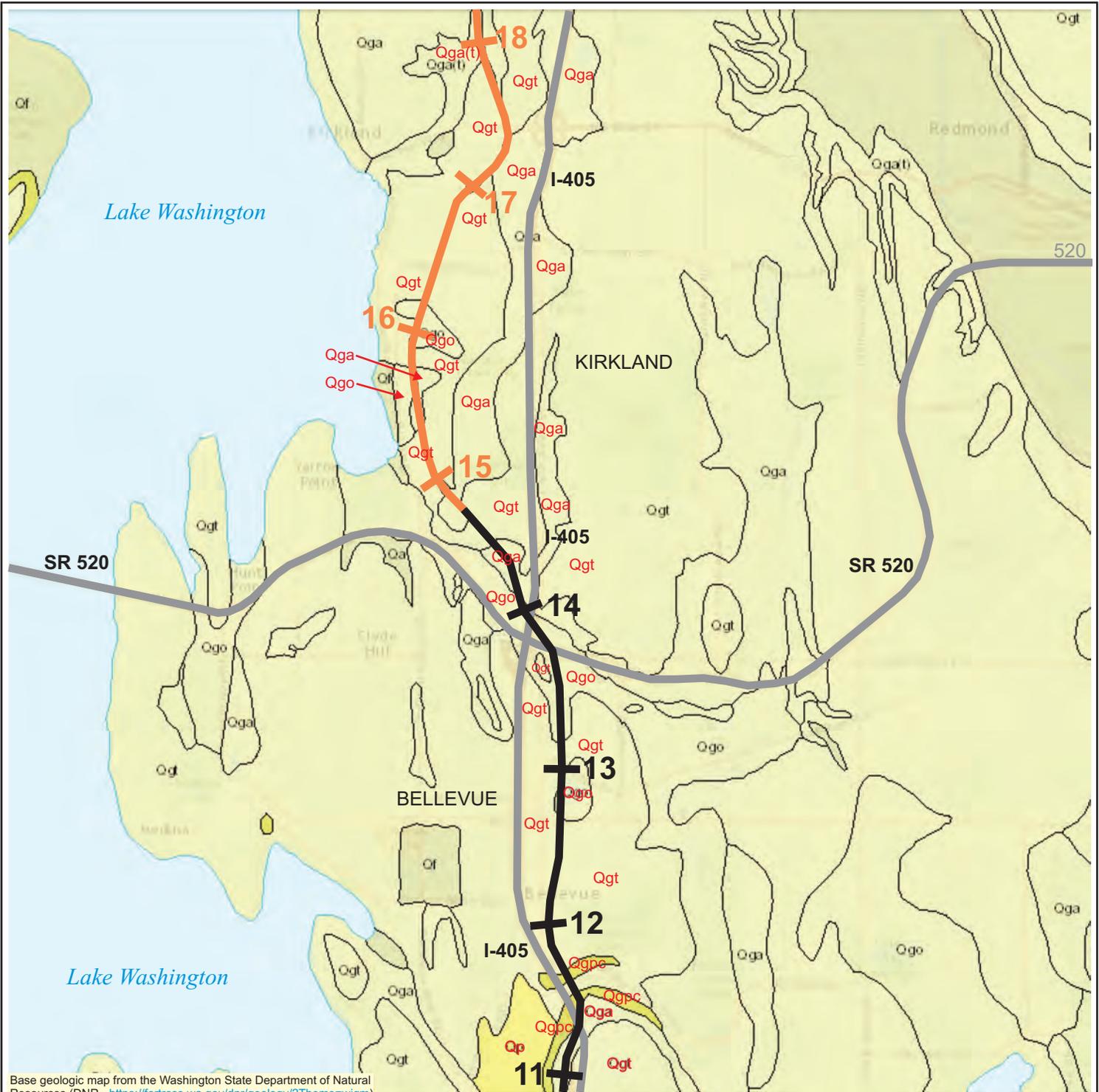
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

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EASTSIDE RAIL CORRIDOR



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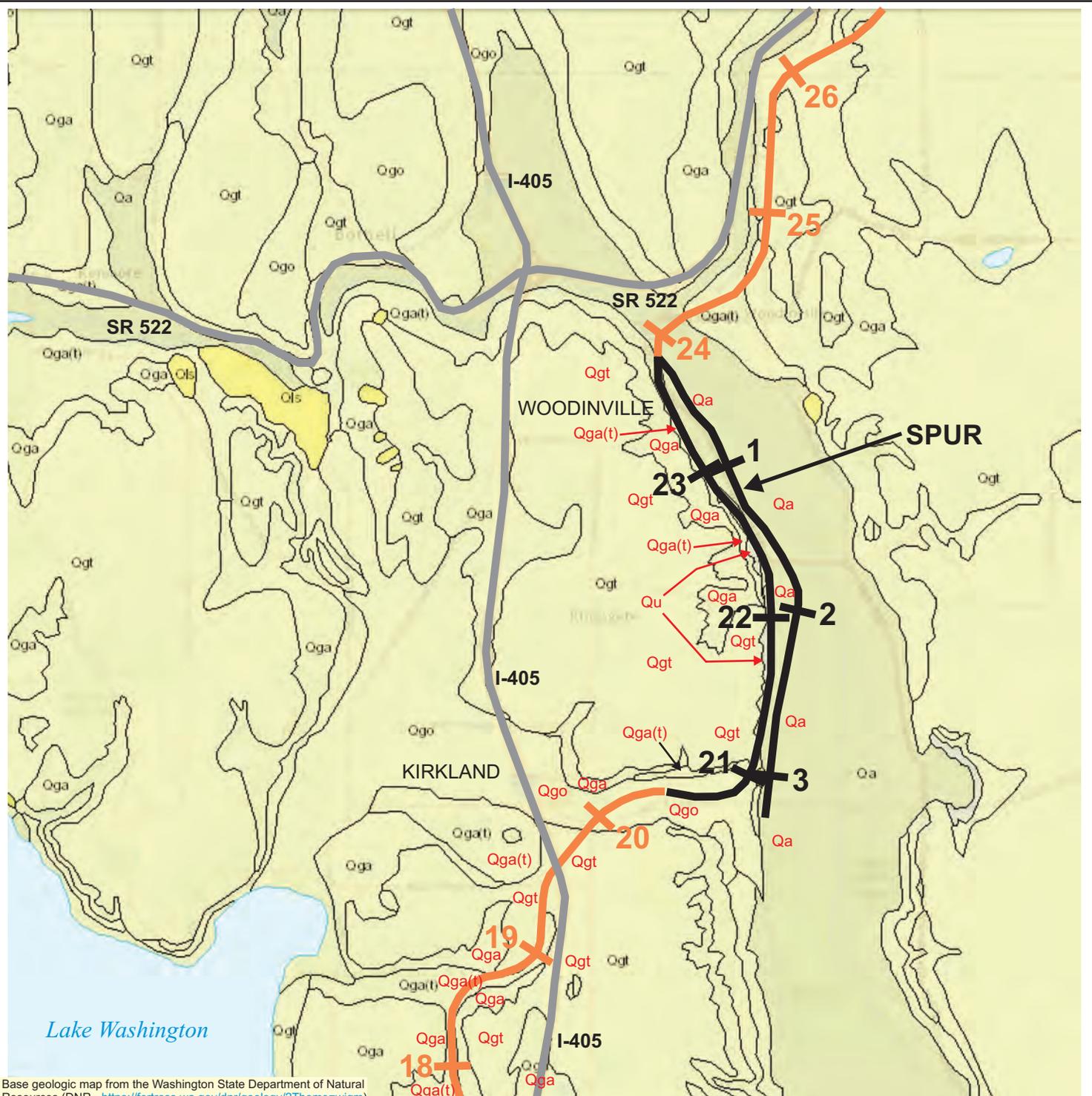
REGIONAL GEOLOGIC MAP

EASTSIDE RAIL CORRIDOR



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 (425) 333-0093

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REGIONAL GEOLOGIC MAP

EASTSIDE RAIL CORRIDOR

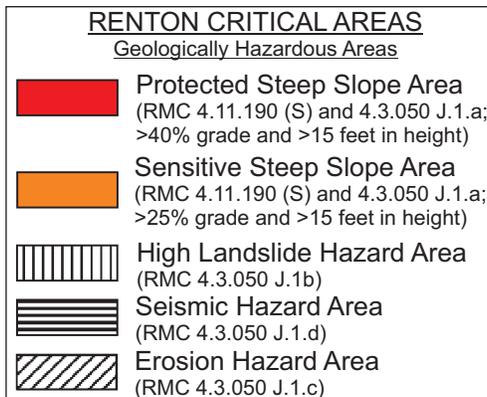


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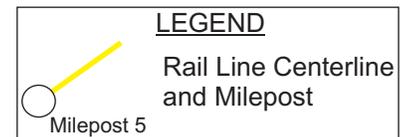
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DATE: 01/21/15	



Notes
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RMC = Renton Municipal Code



REGIONAL CRITICAL AREAS MAP



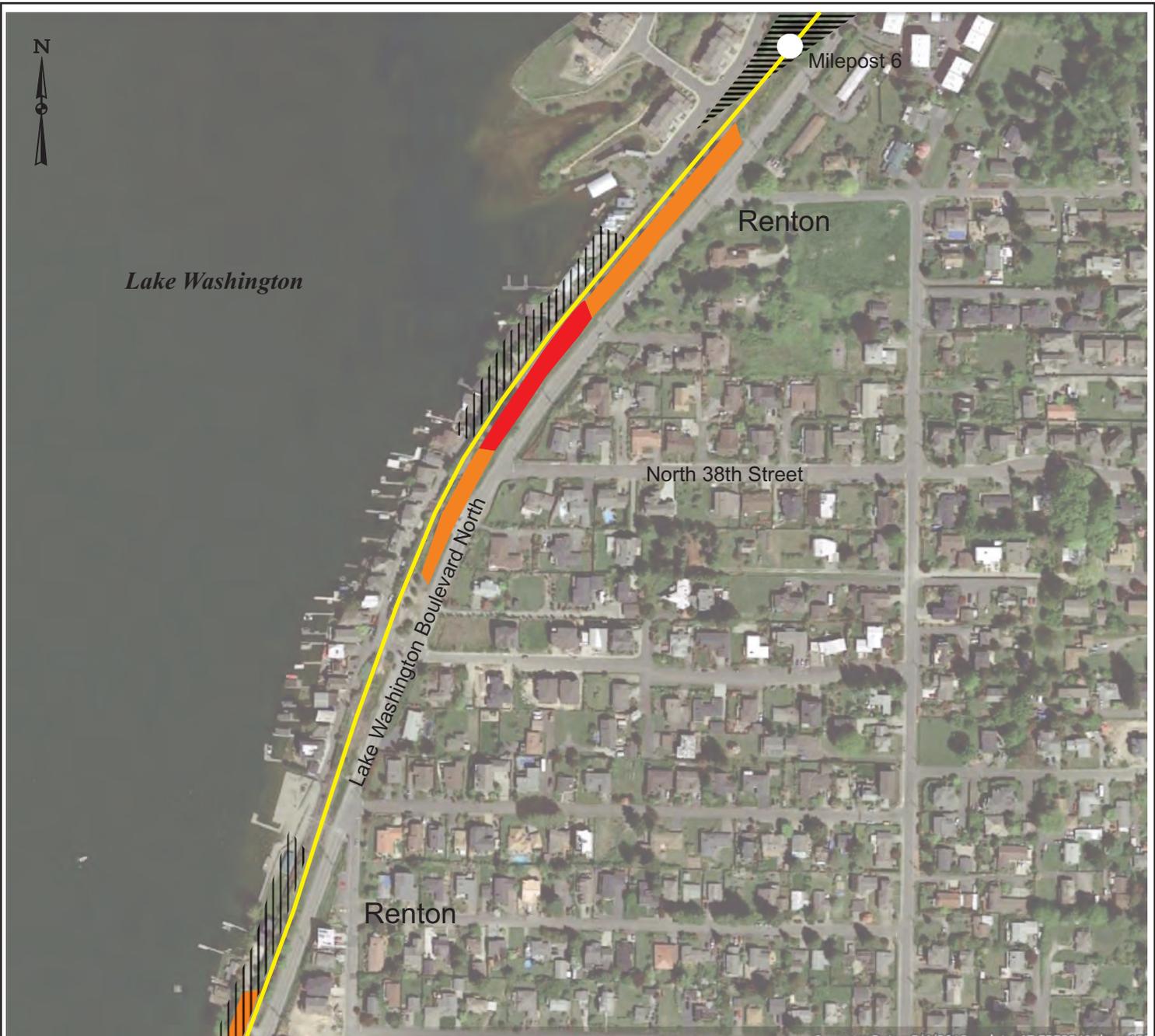
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Map	4



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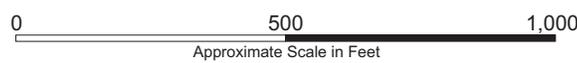
RENTON CRITICAL AREAS
 Geologically Hazardous Areas

	Protected Steep Slope Area (RMC 4.11.190 (S) and 4.3.050 J.1.a; >40% grade and >15 feet in height)
	Sensitive Steep Slope Area (RMC 4.11.190 (S) and 4.3.050 J.1.a; >25% grade and >15 feet in height)
	High Landslide Hazard Area (RMC 4.3.050 J.1.b)
	Seismic Hazard Area (RMC 4.3.050 J.1.d)
	Erosion Hazard Area (RMC 4.3.050 J.1.c)

RMC = Renton Municipal Code

LEGEND

 Rail Line Centerline and Milepost
 Milepost 5





Lake Washington

Renton

I-405

NE 44th Street

Renton

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LEGEND



REGIONAL CRITICAL AREAS MAP



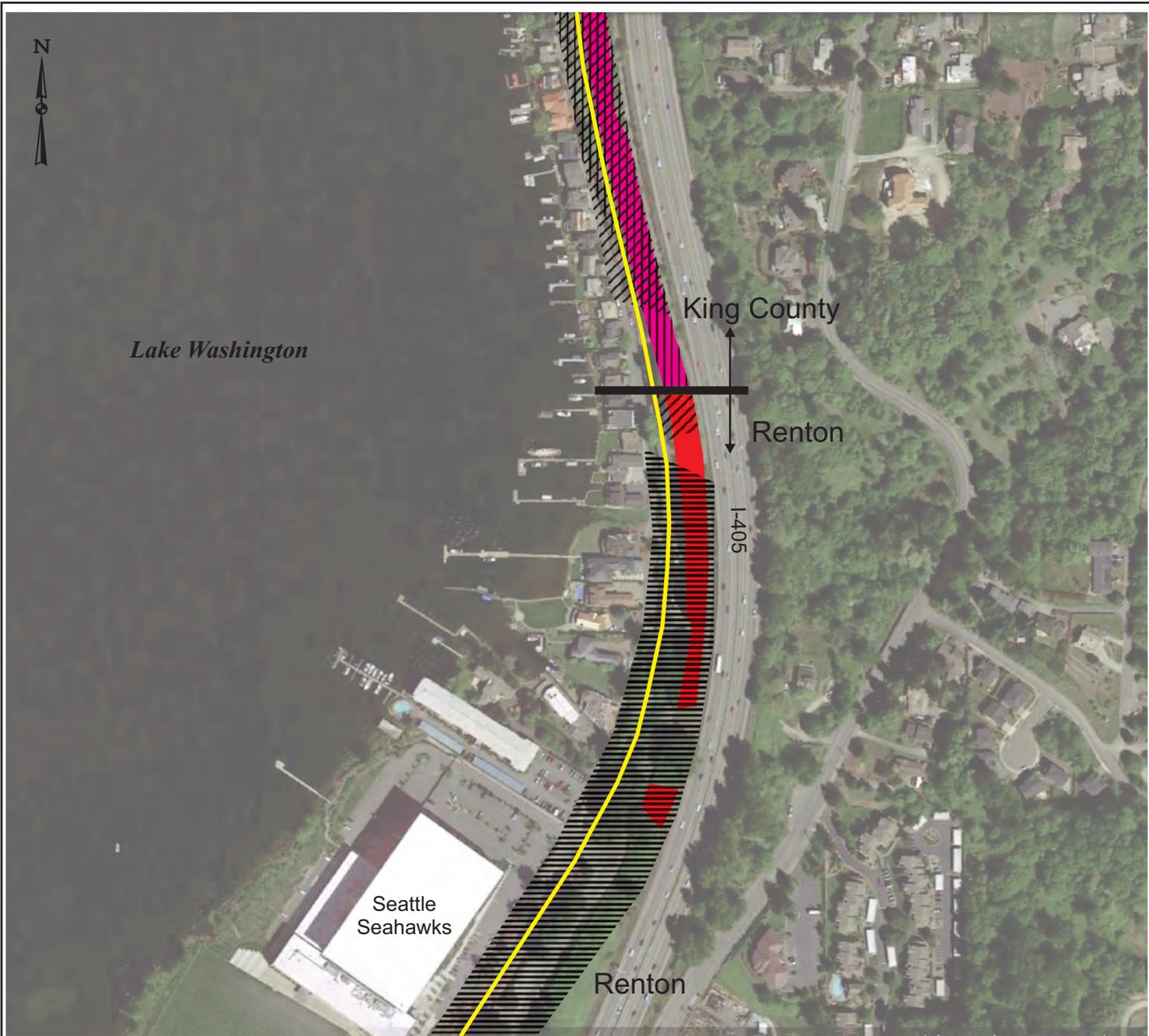
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KING COUNTY CRITICAL AREAS
Geologically Hazardous Areas

- Steep Slope Hazard Area (King County Zoning Code 21A.06.1230; >40% grade and >10 feet in height)
- Landslide Hazard Area (King County Zoning Code 21A.06.680)
- Seismic Hazard Area (King County Zoning Code 21A.06.1045)
- Erosion Hazard Area (King County Zoning Code 21A.06.415)





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KING COUNTY CRITICAL AREAS
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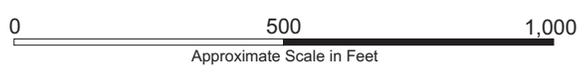
BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

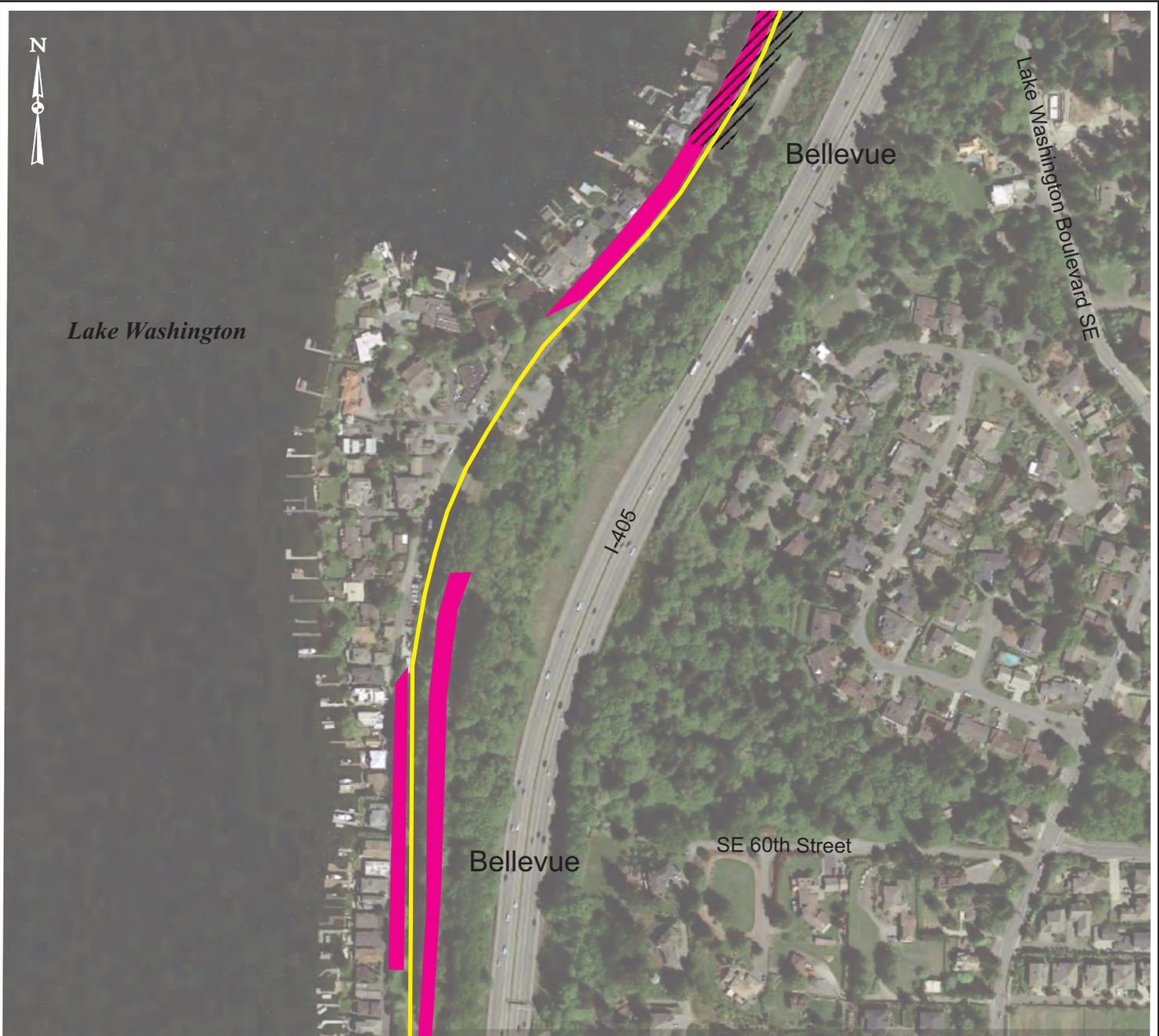
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LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
	Milepost 5





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LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
Carnation, Washington 98014
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Map

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Rail Line Centerline and Milepost



REGIONAL CRITICAL AREAS MAP



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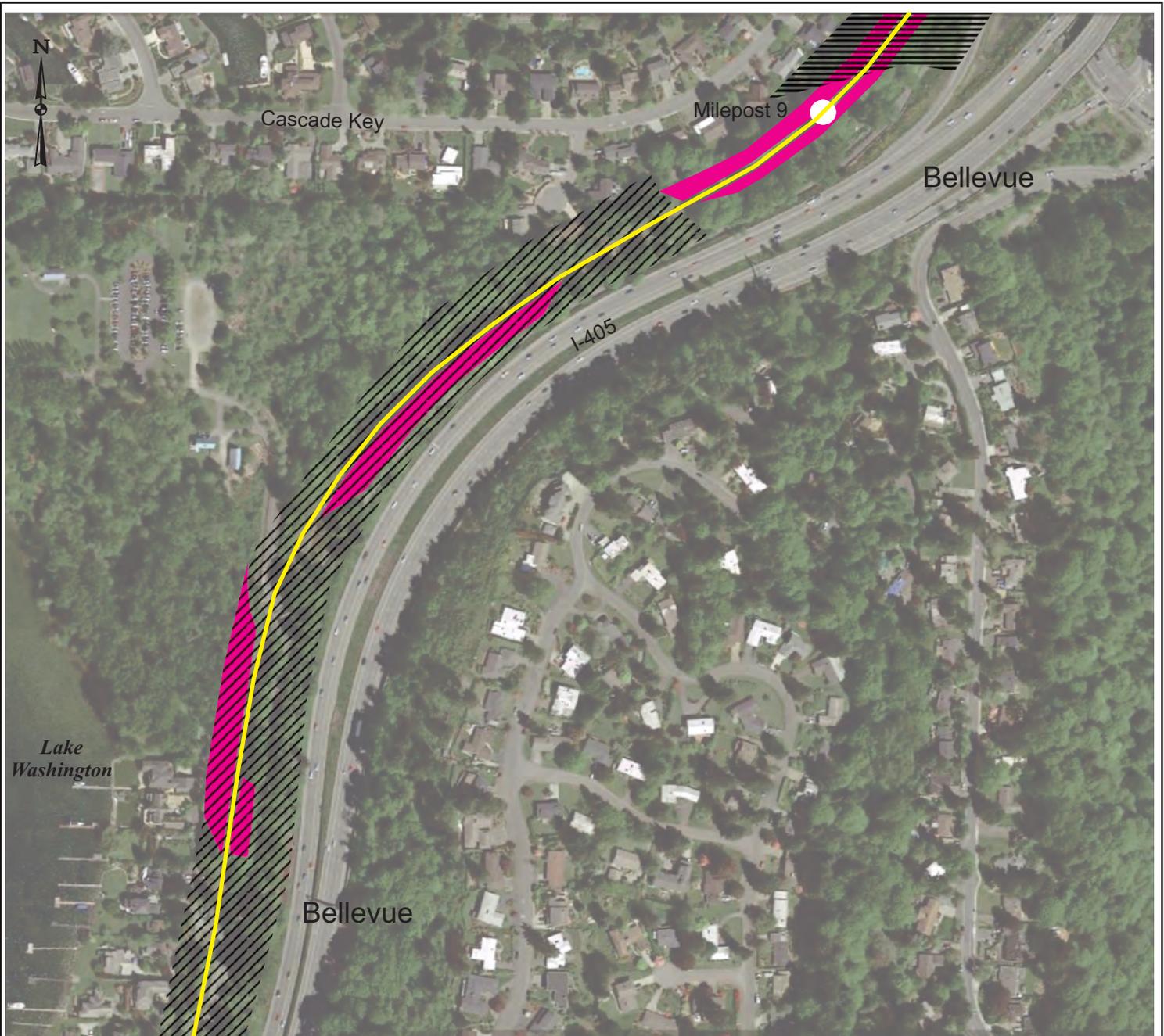
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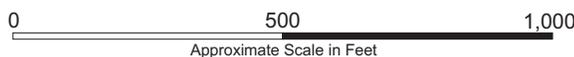
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Geologically Hazardous Areas

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	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
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11



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LEGEND

Rail Line Centerline and Milepost

Milepost 5



REGIONAL CRITICAL AREAS MAP



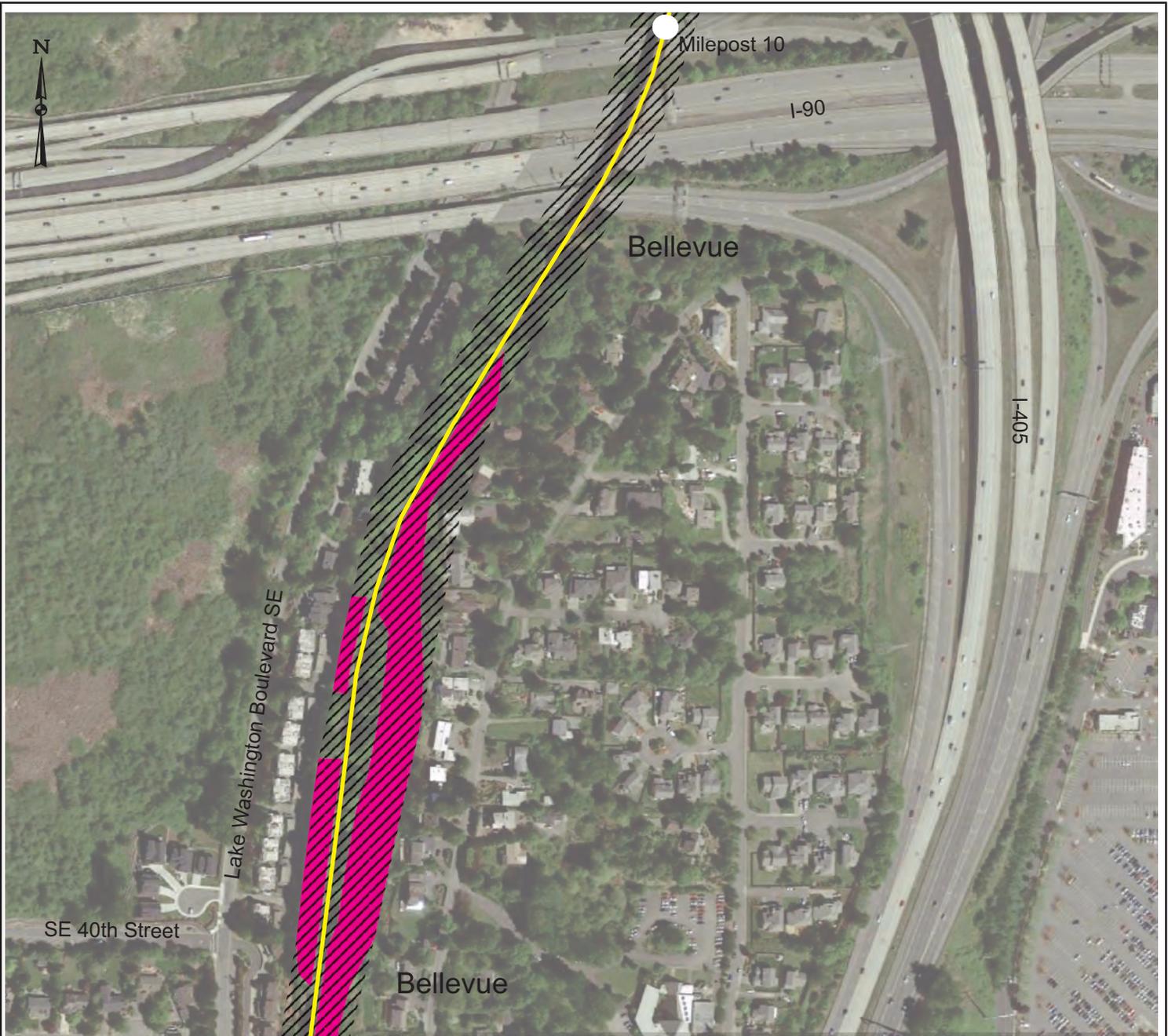
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LEGEND

	Rail Line Centerline and Milepost
○	Milepost 5



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



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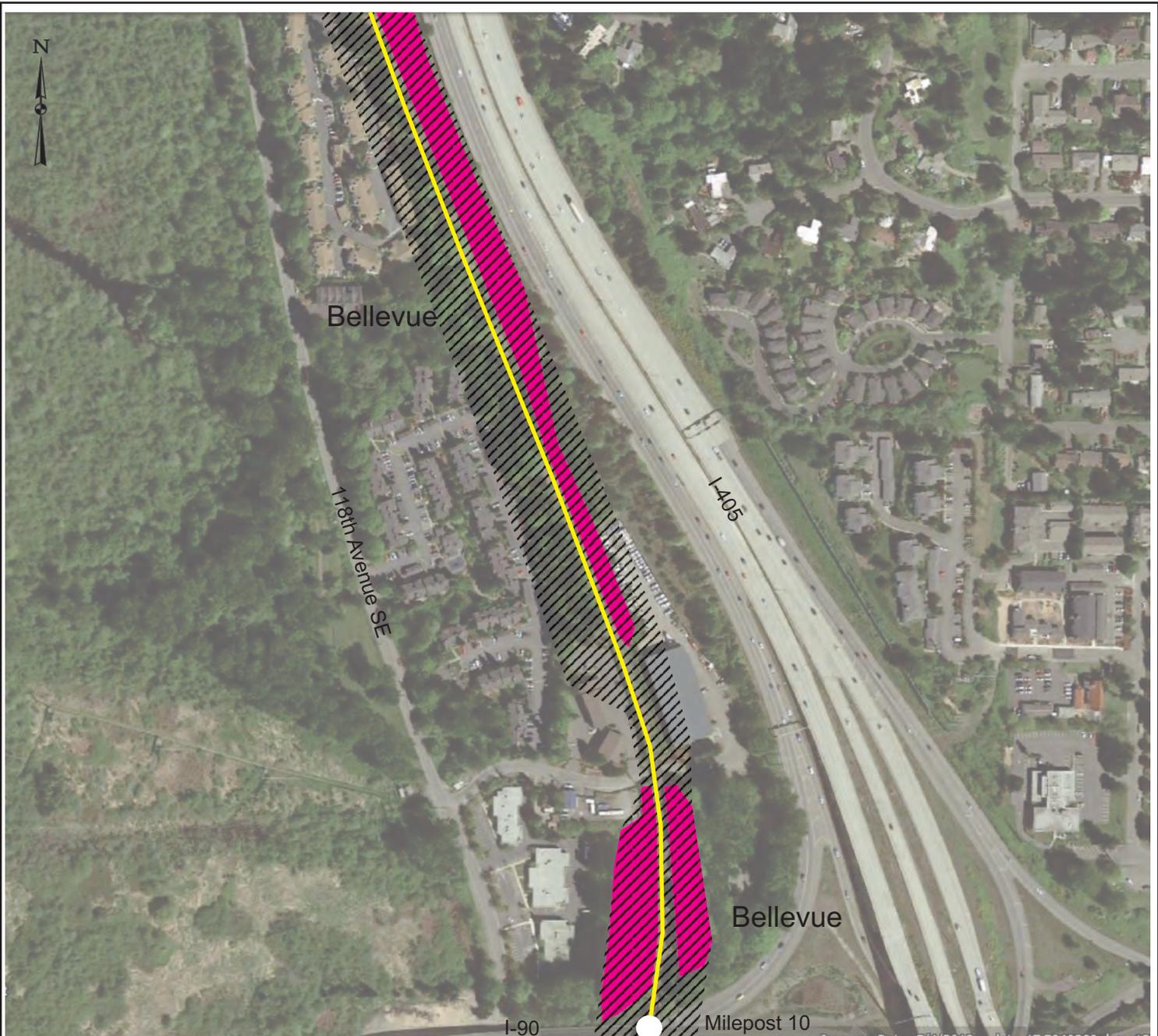
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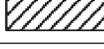
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Geologically Hazardous Areas

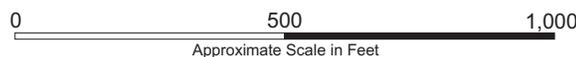
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LEGEND

 Rail Line Centerline and Milepost

 Milepost 5



REGIONAL CRITICAL AREAS MAP



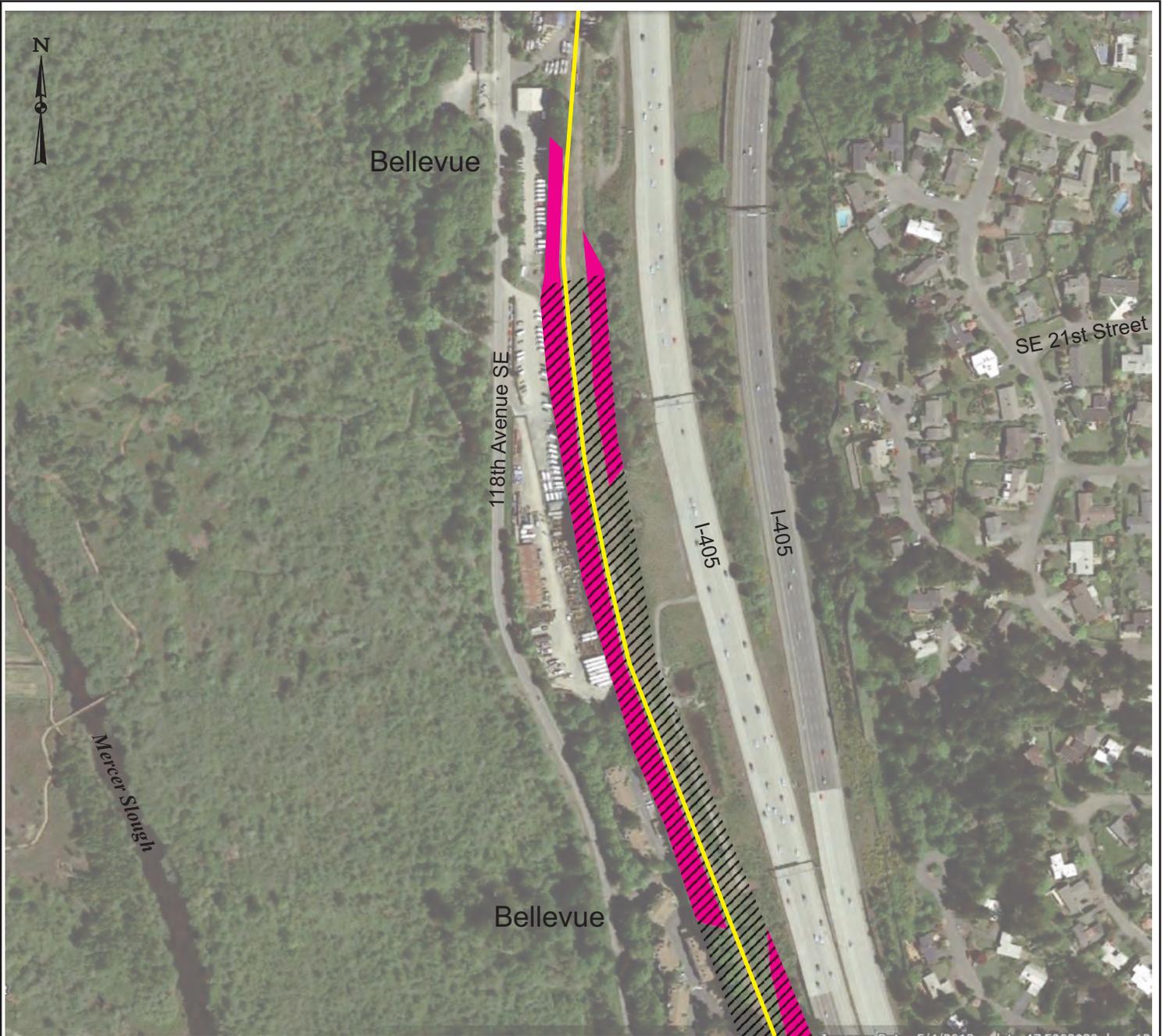
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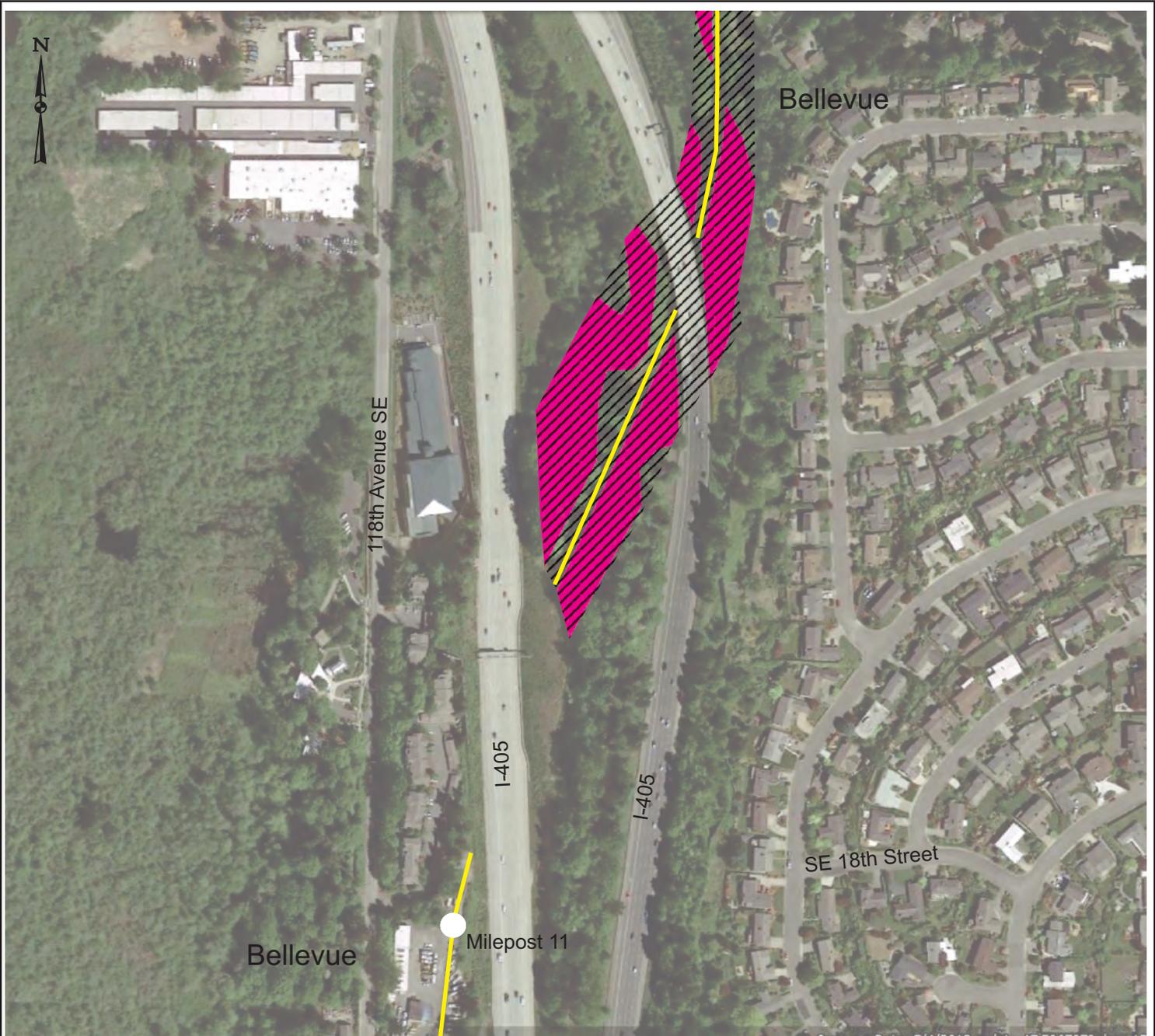
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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

	Steep Slope Hazard Area (Bellevue LUC 20.25H.120 (2); >40% grade and >10 feet in height)
	Landslide Hazard Area (Bellevue LUC 20.25H.120 (1))
	Seismic Hazard Area (see Note 4)
	Erosion Hazard Area (see Note 4)

LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
Milepost 5	



REGIONAL CRITICAL AREAS MAP



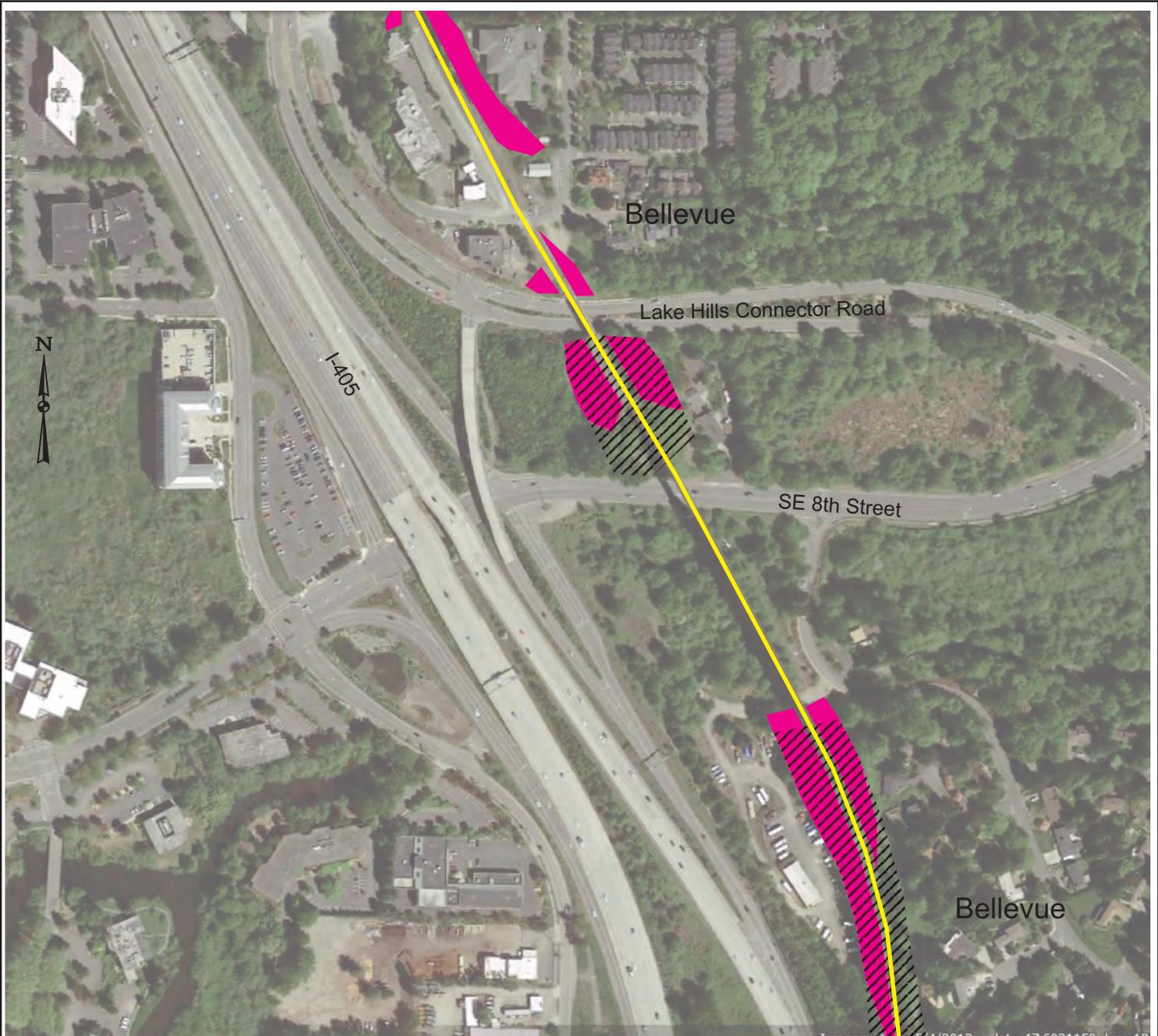
EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As Shown
DESIGNED: ---
DRAWN: BRB
CHECKED: KSK
DATE: 01/21/15

ICE FILE NO.
0105-012
Map
16



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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	Seismic Hazard Area (see Note 4)
	Erosion Hazard Area (see Note 4)

LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
Milepost 5	



REGIONAL CRITICAL AREAS MAP



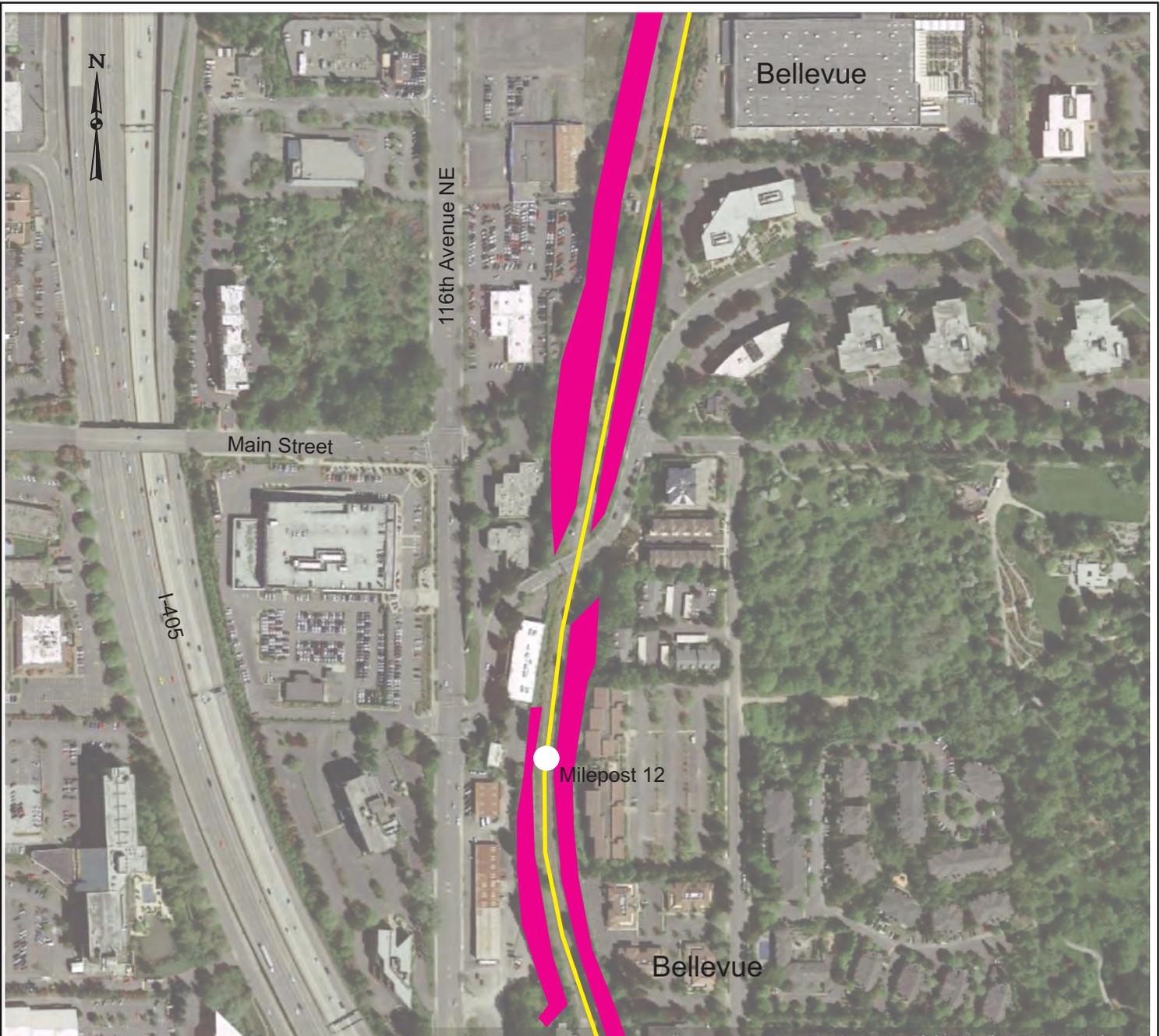
EASTSIDE RAIL CORRIDOR



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SCALE: As Shown
DESIGNED: ---
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DATE: 01/21/15

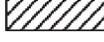
ICE FILE NO.
0105-012
Map
17



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



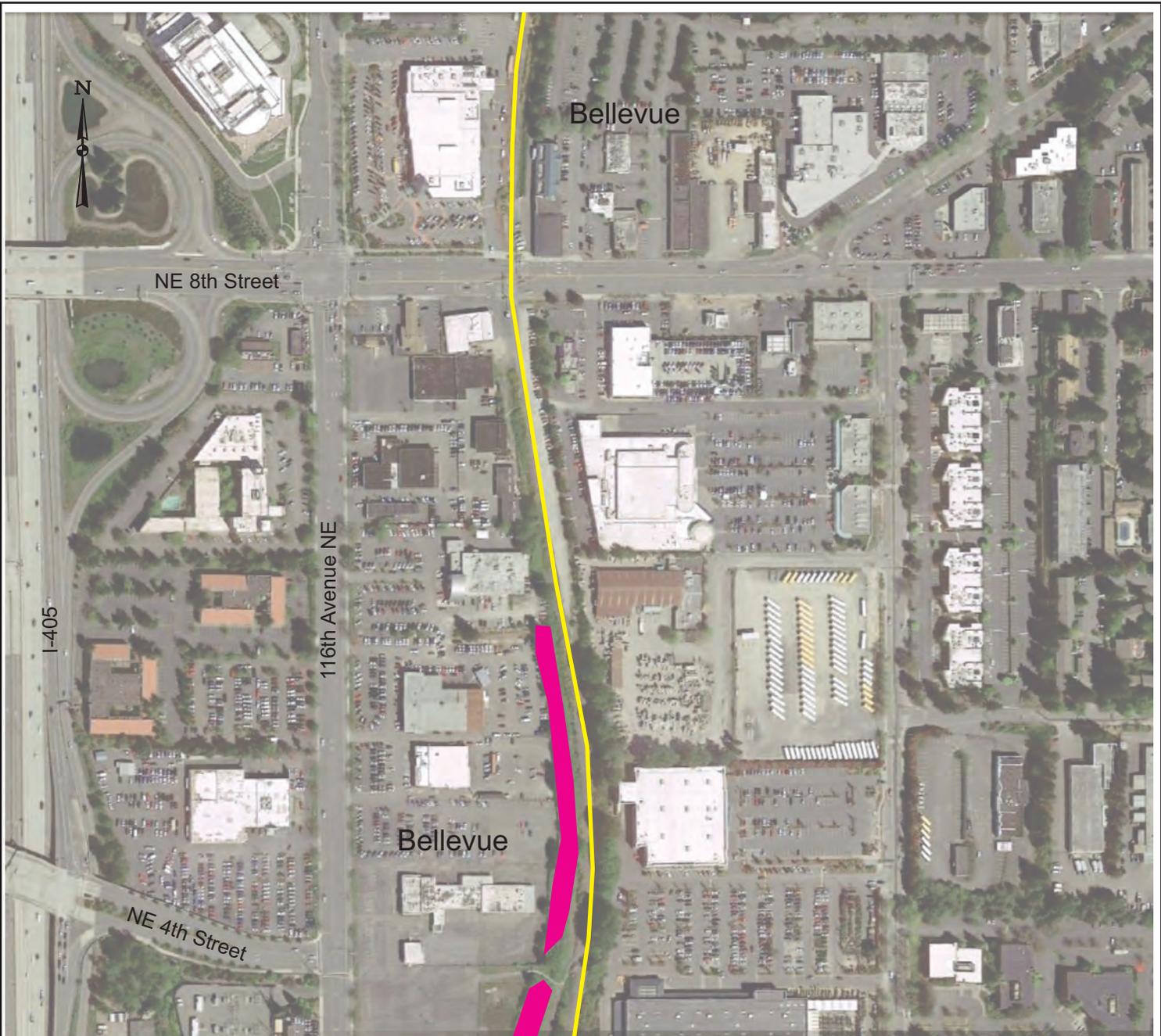
EASTSIDE RAIL CORRIDOR



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Carnation, Washington 98014
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CHECKED: KSK
DATE: 01/21/15

ICE FILE NO.
0105-012
Map
18



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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	Erosion Hazard Area (see Note 4)

LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



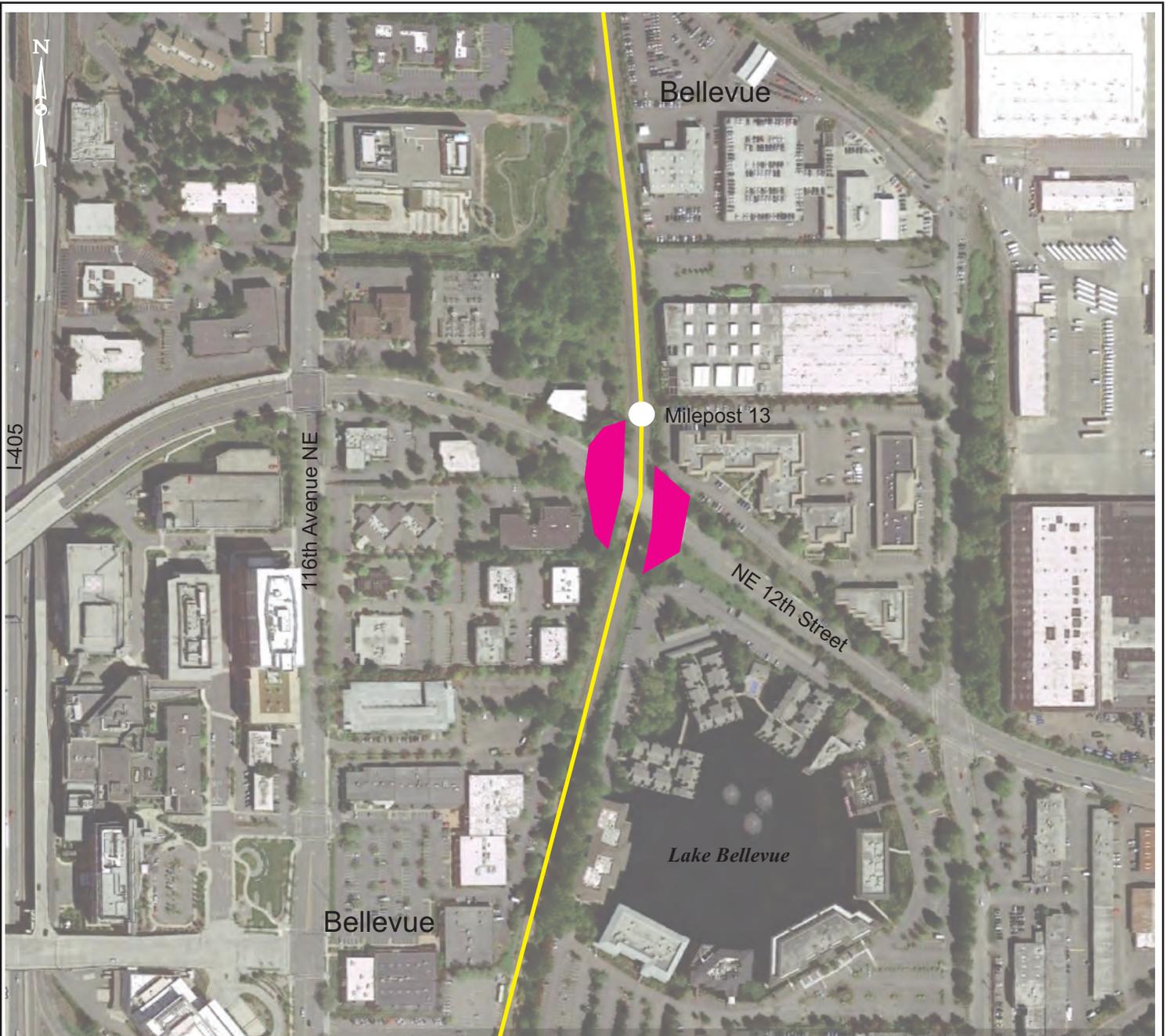
EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As Shown
DESIGNED: ---
DRAWN: BRB
CHECKED: KSK
DATE: 01/21/15

ICE FILE NO.
0105-012
Map
19



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
Milepost 5	



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



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Map

20



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



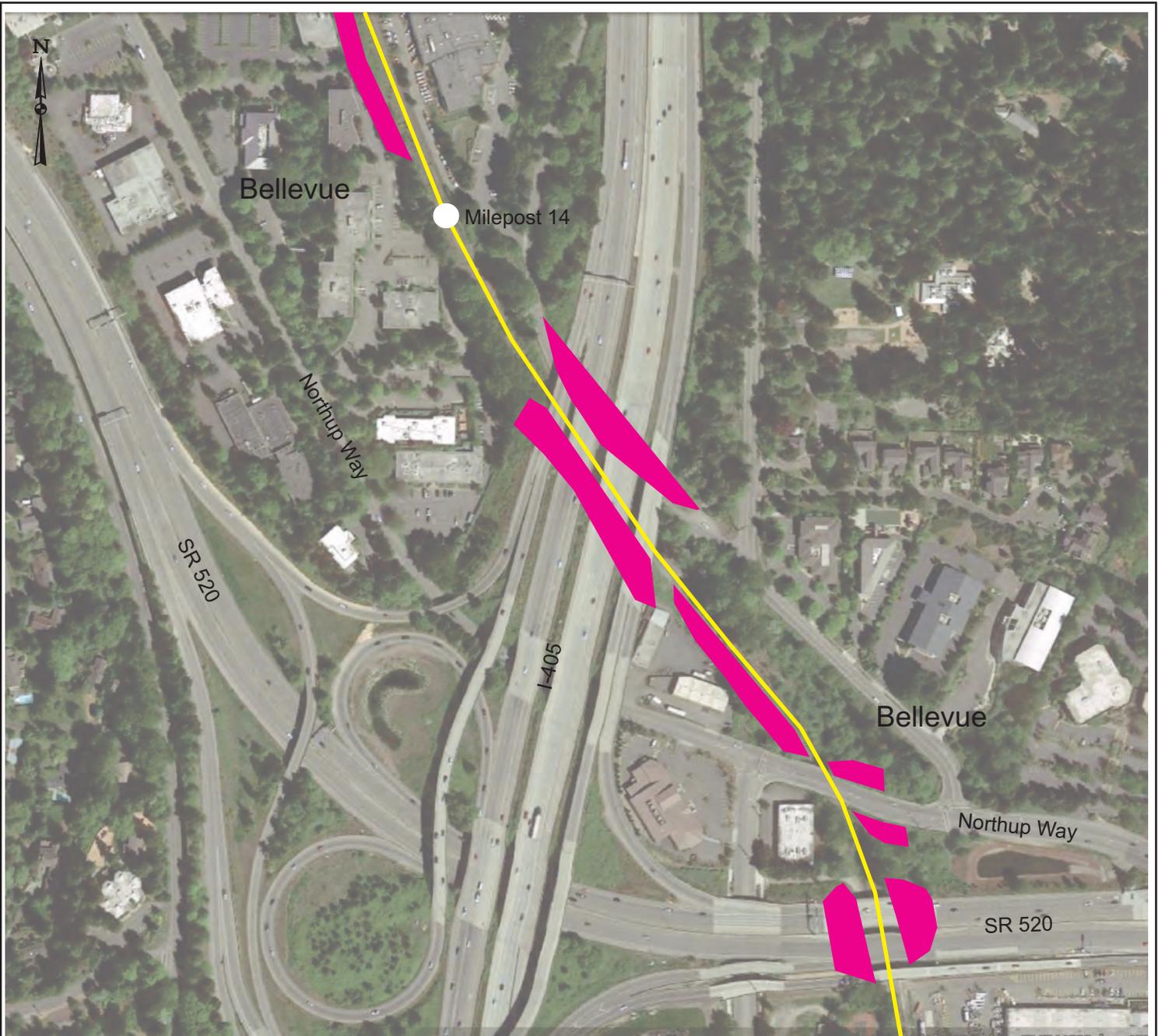
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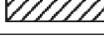
ICE FILE NO.
0105-012
Map
21



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
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DESIGNED: ---
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DATE: 01/21/15

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0105-012
Map
22



Notes

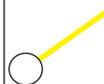
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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



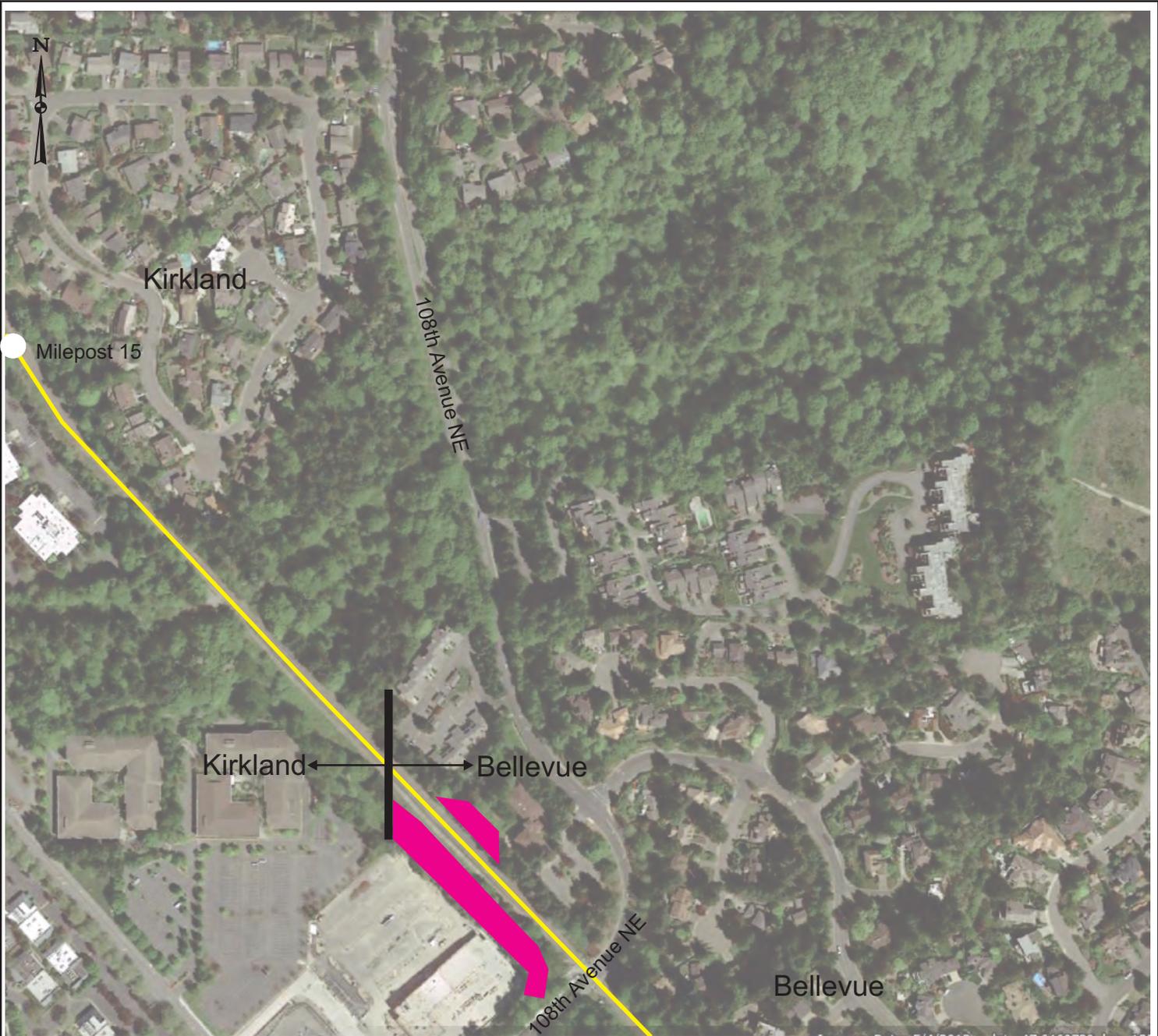
EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
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SCALE: As Shown
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0105-012
Map
23



Notes

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BELLEVUE CRITICAL AREAS
Geologically Hazardous Areas

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	Seismic Hazard Area (see Note 4)
	Erosion Hazard Area (see Note 4)

LUC = Land Use Code

LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

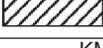
SCALE: As Shown	ICE FILE NO.
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DRAWN: BRB	Map
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DATE: 01/21/15	



Notes

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- 4) Steep slope hazard areas are contained within the KMC definition for high landslide hazard areas.

KIRKLAND CRITICAL AREAS
Geologically Hazardous Areas

	High Landslide Hazard Area (KMC 85.13 4; >40% grade and >10 feet in height)
	Seismic Hazard Area (KMC 85.13 5)
	Erosion Hazard Area (KMC 85.14)

KMC = Kirkland Municipal Code

LEGEND

	Rail Line Centerline and Milepost
Milepost 5	



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As Shown

DESIGNED: ---

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CHECKED: KSK

DATE: 01/21/15

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0105-012

Map

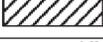
25



Notes

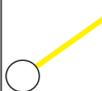
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- 4) Steep slope hazard areas are contained within the KMC definition for high landslide hazard areas.

KIRKLAND CRITICAL AREAS
Geologically Hazardous Areas

	High Landslide Hazard Area (KMC 85.13 4; >40% grade and >10 feet in height)
	Seismic Hazard Area (KMC 85.13 5)
	Erosion Hazard Area (KMC 85.14)

KMC = Kirkland Municipal Code

LEGEND

	Rail Line Centerline and Milepost
Milepost 5	



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR

ICICLE CREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As Shown	ICE FILE NO.
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DRAWN: BRB	Map
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DATE: 01/21/15	



Notes

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- 4) Steep slope hazard areas are contained within the KMC definition for high landslide hazard areas.

KIRKLAND CRITICAL AREAS
Geologically Hazardous Areas

	High Landslide Hazard Area (KMC 85.13 4; >40% grade and >10 feet in height)
	Seismic Hazard Area (KMC 85.13 5)
	Erosion Hazard Area (KMC 85.14)

KMC = Kirkland Municipal Code

LEGEND

	Rail Line Centerline and Milepost
Milepost 5	





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KIRKLAND CRITICAL AREAS
Geologically Hazardous Areas

	High Landslide Hazard Area (KMC 85.13 4; >40% grade and >10 feet in height)
	Seismic Hazard Area (KMC 85.13 5)
	Erosion Hazard Area (KMC 85.14)

KMC = Kirkland Municipal Code

WOODINVILLE CRITICAL AREAS
Geologically Hazardous Areas

	Landslide Hazard Area (WMC 21.24.290 (2b); >40% grade and >10 feet in height)
	Seismic Hazard Area (WMC 21.24.290 (2c))
	Erosion Hazard Area (WMC 21.24.290 (2a))

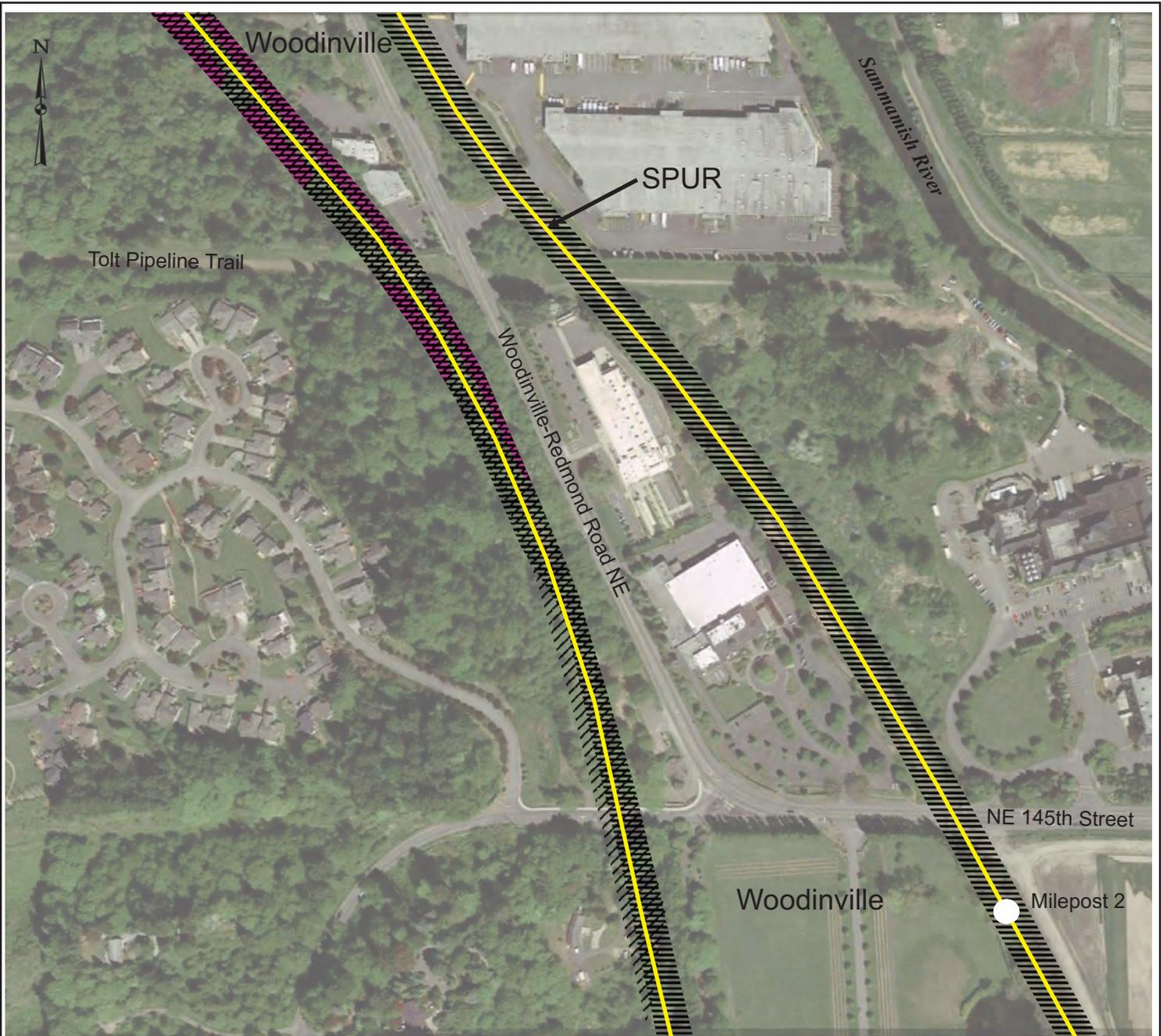
WMC = Woodinville Municipal Code

LEGEND

Rail Line Centerline and Milepost

Milepost 5





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- 4) Steep slope hazard areas are contained within the WMC definition for landslide hazard areas.

WOODINVILLE CRITICAL AREAS
Geologically Hazardous Areas

	Landslide Hazard Area (WMC 21.24.290 (2b); >40% grade and >10 feet in height)
	Seismic Hazard Area (WMC 21.24.290 (2c))
	Erosion Hazard Area (WMC 21.24.290 (2a))

WMC = Woodinville Municipal Code

LEGEND

	Rail Line Centerline and Milepost
	Milepost 5



REGIONAL CRITICAL AREAS MAP



EASTSIDE RAIL CORRIDOR

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29335 NE 20th Street
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SCALE: As Shown	ICE FILE NO.
DESIGNED: ---	0105-012
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CHECKED: KSK	29
DATE: 01/21/15	



Notes

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WOODINVILLE CRITICAL AREAS
Geologically Hazardous Areas

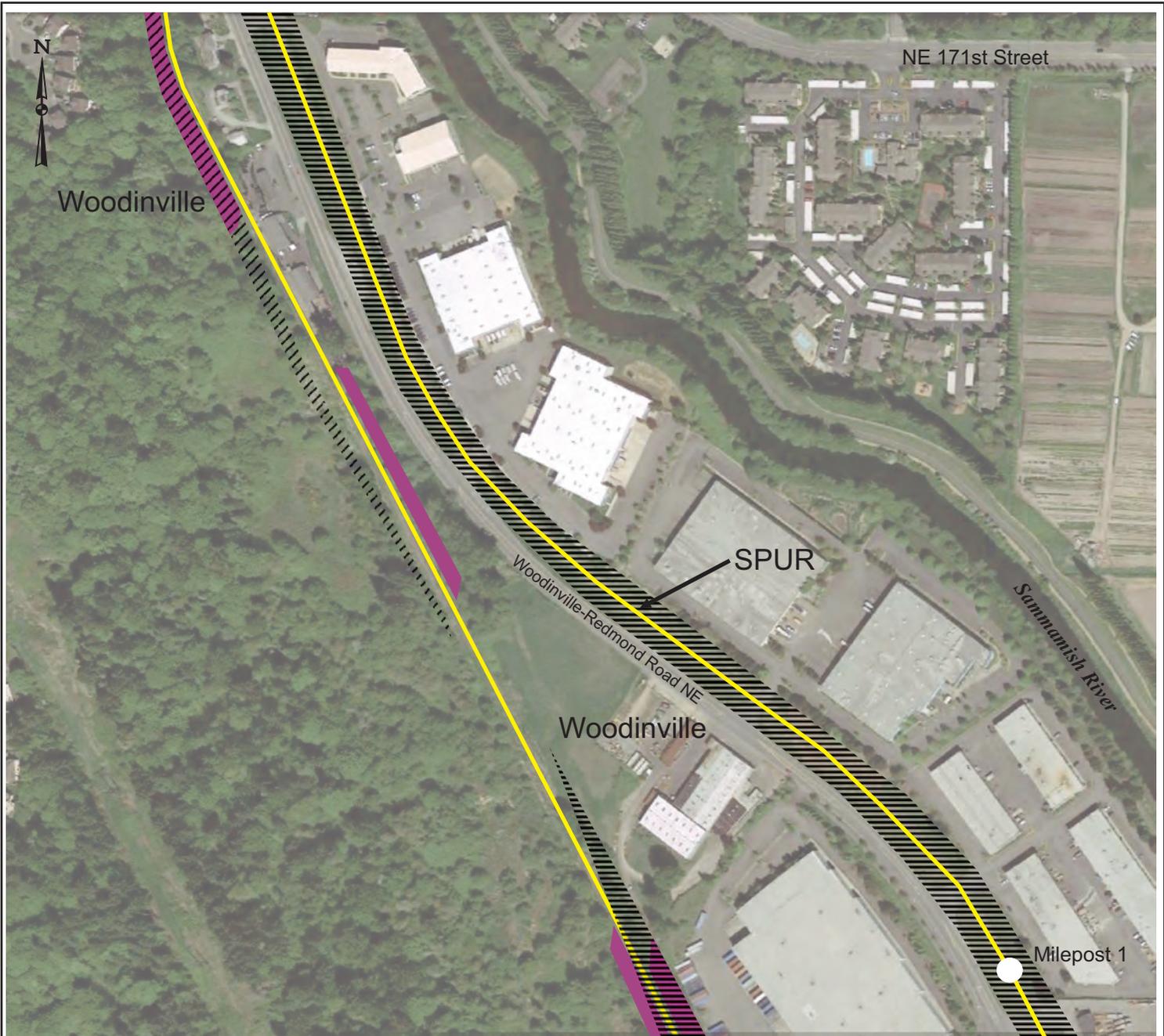
	Landslide Hazard Area (WMC 21.24.290 (2b); >40% grade and >10 feet in height)
	Seismic Hazard Area (WMC 21.24.290 (2c))
	Erosion Hazard Area (WMC 21.24.290 (2a))

WMC = Woodinville Municipal Code

LEGEND

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○	Milepost 5





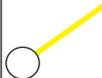
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WOODINVILLE CRITICAL AREAS
Geologically Hazardous Areas

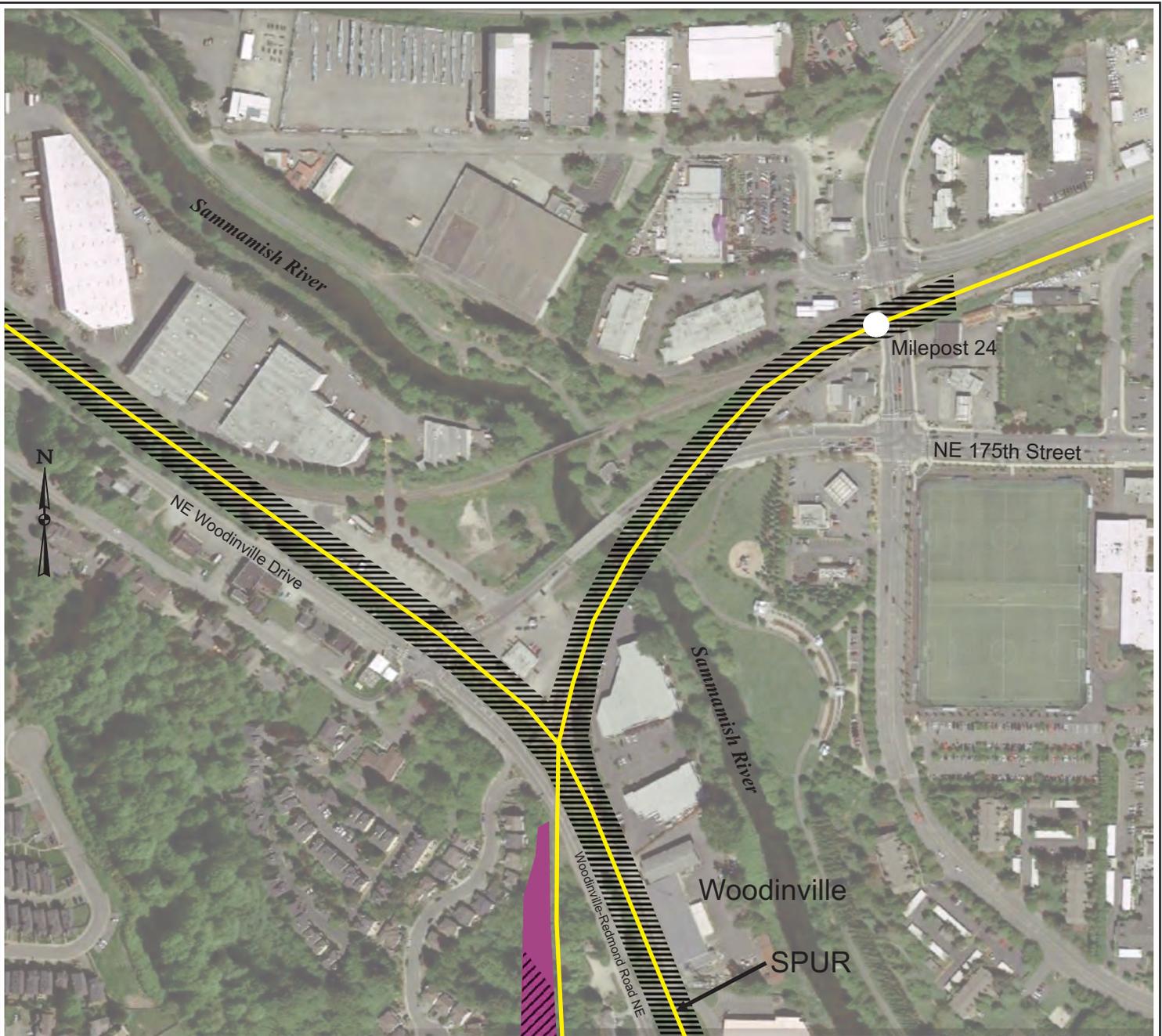
	Landslide Hazard Area (WMC 21.24.290 (2b); >40% grade and >10 feet in height)
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LEGEND

	Rail Line Centerline and Milepost
Milepost 5	





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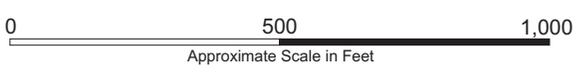
WOODINVILLE CRITICAL AREAS
Geologically Hazardous Areas

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LEGEND

	Rail Line Centerline and Milepost
Milepost 5	





Milepost 5.2 looking south near the intersection of North 29th Street and Mountain View Avenue North (September 11, 2014)

Milepost 5.2 looking north near the intersection of North 29th Street and Mountain View Avenue North (September 11, 2014)



Milepost 5.3 looking north near the intersection of North 33rd Street and Mountain View Avenue North (September 11, 2014)

Milepost 5.8 looking south near the intersection of North 34th Street and Lake Washington Boulevard North (September 11, 2014)



PHOTOS

EASTSIDE RAIL CORRIDOR



29335 NE 20th Street
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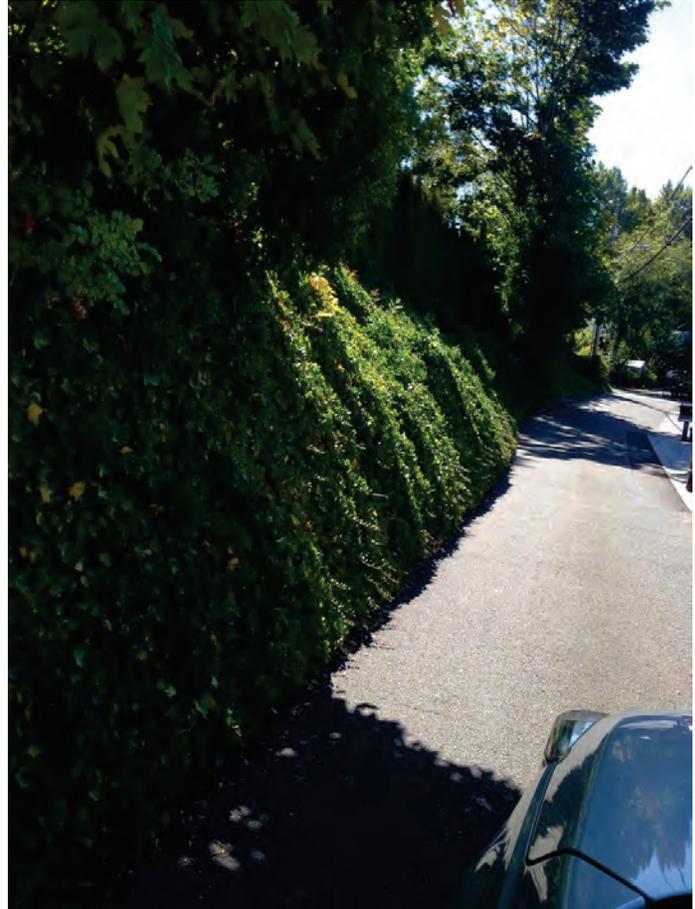
Milepost 6.1 looking northeast near the intersection of Wells Avenue North and Lake Washington Boulevard North (September 11, 2014)



Milepost 7.0 looking north near Ripley Lane North (September 11, 2014)



Milepost 7.8 looking north near Ripley Lane North (September 11, 2014)



Milepost 20.5 looking west near the intersection of NE 126th Place and 135th Avenue NE (September 11, 2014)

PHOTOS

EASTSIDE RAIL CORRIDOR



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0105-012



Milepost 21.0 looking north near the 139th Avenue NE crossing (September 11, 2014)



Milepost 21.0 looking south near the 139th Avenue NE crossing (September 11, 2014)



Redmond Spur Milepost 3.0 looking north near the intersection of Willows Road SE and 141st Avenue NE (September 11, 2014)

PHOTOS

EASTSIDE RAIL CORRIDOR

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EASTSIDE RAIL CORRIDOR REGIONAL TRAIL MASTER PLAN PROJECT

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
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PARAMETRIX

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TOOLE DESIGN GROUP

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