5.13 Geology and Soils

Geology is the study of the origin, history, materials, and structure of the earth, along with the forces and processes operating to produce changes within and on the earth. When we consider the geologic features of a project area, we must consider how improvements will interact with the soils, groundwater, and topography, as well as the area's unique physical features. Through focused study, we can make determinations about erosion, suitability of soils for construction, slope stability, and other factors.

Landslide area within the project vicinity

How did we evaluate geology and soils for the Renton to Bellevue Project?

WSDOT scientists and planners studied the geology, soils, topography, physical features, and potential for erosion in the study area. Our data sources included geological maps, aerial photos, and geotechnical reports.

Please refer to the Renton to Bellevue Project Geology, Soils, and Groundwater Discipline Report in Appendix Y (on CD) for a complete discussion of the geology and soils analysis.

What is the geology of the project area?

Most of the I-405 Renton to Bellevue project area is located along the west-facing slopes of the topographic trough occupied by Lake Washington. The alignment also crosses or runs adjacent to several drainages, most notably the Cedar River, May Creek, and Coal Creek. These drainages are typically occupied by relatively loose or soft soils. Several ancient landslides and areas of landslide-prone soils are located along the project alignment, especially between May Creek and Coal Creek.

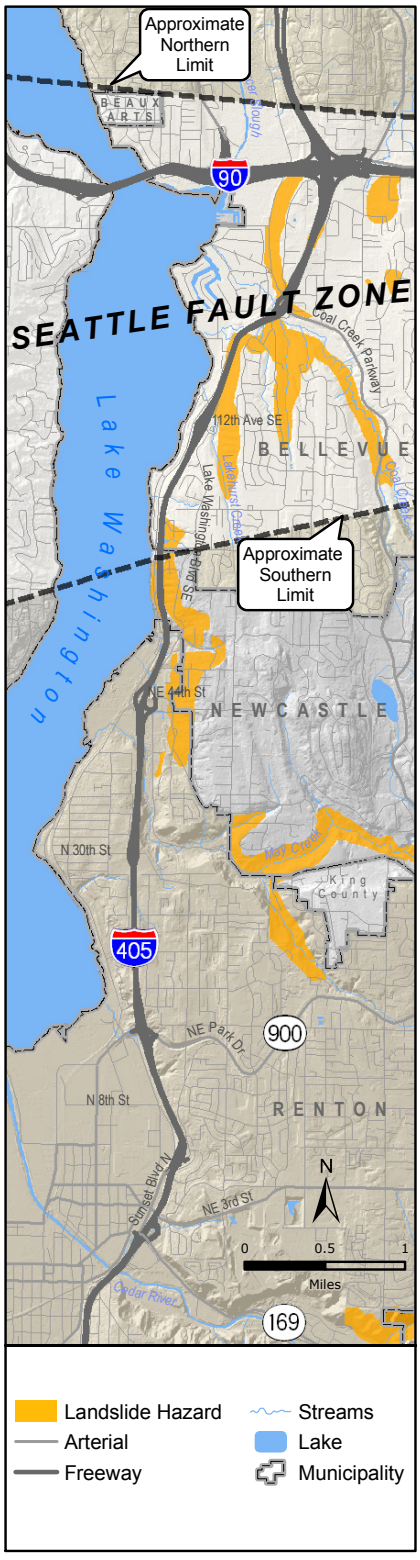
Landslide Conditions

Geologists identified a number of landslide conditions along I-405 in the project area. In the Kennydale area, we identified several small, relatively shallow landslides, along with one larger, and presumably deeper, one along the north side of NE Park Drive. Shallower debris slide and debris flow-type failures are possible where cuts are planned that intersect swales along west-facing slopes. It is relatively easy to control this type of landslide.

What is a landslide?

A landslide is the sudden release of a mass of rock and earth down a slope.

Exhibit 5.13-1: Landslide areas



What soils are found in the project area?

Generally, the project area is underlain by dense glacial soils. Notable exceptions include the alluvium (deposits from the streams and rivers) in the stream drainages that cross the project alignment, localized areas of artificial fill, lake and peat deposits, and recessional outwash (deposits of sand and gravel from glacial meltwater).

Many of the upland slopes in the study area are sites of prehistoric landslide activity (see Exhibit 5.13-1). The landslides likely occurred during and after the retreat of glacial ice at the end of the last glaciation. Many of the ancient landslide deposits have been relatively stable; however, they can become reactivated when disturbed by development.

Geologists also identified numerous shallow landslides and three large deep-seated landslide complexes in the Coal Creek area. The largest of these landslide complexes is located north of May Creek and appears to extend to Lake Washington on its northern end. No landslide slopes were identified near SR 169.

Liquefaction Hazard Areas

Liquefaction occurs during a strong earthquake when ground movements cause loose, saturated granular soils to lose their strength and essentially become a heavy liquid. Liquefaction can result in ground settlement, lateral spreading or movement of ground, and foundation failure. In the Renton portion of the project area west of I-405, the potential for liquefaction is high. Likewise, the potential for liquefaction in the May Creek area is high and moderate in the Coal Creek area. Geologists do not consider liquefaction of soils to be an issue in the Kennydale area.

Soft Ground Areas

Areas underlain by soft, compressible organic and clay soils can present settlement and subgrade stability problems for road construction. Embankments placed on these types of conditions can cause substantial settlement or induce an embankment foundation failure. In addition, structures or walls located in areas underlain by soft ground conditions are likely to experience much stronger shaking in an earthquake than adjacent areas. With the exception of the area to the west of I-405, soft soils are generally not likely to be encountered in the Renton portion of the project area. Geologists have

identified soft ground areas in the vicinity of both Coal Creek and May Creek where measures will need to be taken to account for potential settlement and stability. Geologists do not consider soft ground areas to be an issue in the Kennydale area.

How will the project affect geologic features?

Soils and erosion

Construction will involve substantial earthwork, including major cuts (excavations) and fills. Cut materials will be reused in areas of the project that require fill. However, there will likely be areas where the excavated soils are unsuitable for reuse, particularly during wet weather. Unsuitable soils will be exported offsite for disposal. Similarly, we expect to import some fill soils for use along the alignment. New fill materials (over 50 cubic yards) used in the Renton Aquifer Protection Area must be certified by WSDOT as contaminant free.

Seismicity is a factor within the study area because the Seattle Fault Zone crosses the project alignment (see Exhibit 5.13-1). If a fault exhibits surface displacement during future project operation, considerable damage to the roadway, utilities, and structures can result. The current WSDOT bridge design philosophy for seismic events is to preserve life-safety through the prevention of collapse. Major changes in bridge geometry and even non-serviceability following the design level seismic event are potential results; however, the bridge must not collapse.

Erosion will be a concern during construction. Implementing a temporary erosion and sedimentation control (TESC) plan, as described later, will substantially reduce the volume of erosion and the potential for discharge of silt-laden runoff to nearby bodies of water.

What measures are proposed to avoid or minimize effects to geology and soils during construction?

Seismicity

- WSDOT will meet American Association of State Highway and Transportation Officials (AASHTO) design standards with a design seismic event equivalent to a 10-percent chance of exceedance in 50 years (425-year return period).

- WSDOT will implement design methods to make project elements stable under the design AASHTO event and limit susceptibility to collapse under an unlikely larger event.

Liquefaction-prone Areas

- WSDOT will identify areas where liquefaction prone soils may be located.
- WSDOT will evaluate the potential effects to structures from liquefaction, if structures underlain by liquefaction-prone soils are identified.
- WSDOT will use appropriate measures to reduce long-term liquefaction and lateral spreading risks if it is determined that liquefaction risks are unacceptable.
- WSDOT will develop the means and methods to avoid or minimize settlement resulting from construction vibrations associated with measures to reduce liquefaction risks, if liquefaction prone soils are identified.

Soft Ground Areas

- WSDOT will take appropriate measures to assess and reduce potential settlement problems associated with existing utilities or structures in areas underlain by soft, compressible soil.
- WSDOT will design the structures and embankments to accommodate or avoid the settlement if the potential settlement is unacceptable.
- WSDOT will develop the means and methods to avoid or minimize settlement resulting from construction vibrations in areas underlain by soft or loose soils.

Slope Stability and Landslide Areas

- WSDOT will develop appropriate construction procedures to maintain or enhance slope stability in areas underlain by landslides or with landslide-prone geology. The design through these areas will include suitable wall types such as soldier piles with tiebacks, possibly supplemented with enhanced drainage such as improved surface drainage or horizontal drains.

- WSDOT will design earthwork and wall placement sequencing plans, construction drainage plans, and a slope monitoring program.
- WSDOT will drain suspected or observed seepage to reduce the risk of landslide and surface sloughing through the use of gravel drainage blankets, french drains, horizontal drains, placement of a surface rock facing or other methods.

Dewatering

- WSDOT will use properly designed, installed, and operated dewatering systems.
- WSDOT will control dewatering discharge to avoid adverse effects.

Erosion

- WSDOT will prepare and implement a TESC plan.
- WSDOT will take additional action to minimize erosion, maintain water quality, and achieve the intended environmental performance, should any BMP or other operation not function as intended.

Earthworks

- WSDOT will place and maintain stockpiles properly to avoid erosion or slope stability problems.

Permanent Drainage Systems for Cut Slopes

- WSDOT will locate areas where permanent drainage will be required by site conditions for cut slopes.

What measures are proposed to avoid or minimize effects to geology and soils during operation?

Seismicity

- WSDOT will implement its procedures for inspecting critical highway elements following a major seismic event.

Soft Ground

- WSDOT will conduct long-term monitoring of embankments or walls constructed on soft ground to ensure that they are not experiencing unacceptable settlement.

Slope Stability and Landslides

- WSDOT will conduct long-term maintenance of surface and subsurface drainage in areas of landslide risk. If installed, horizontal drains will be periodically inspected and maintained, as these drains tend to clog with time. If identified as a need during the design geotechnical investigation, long-term monitoring of slopes and walls may be appropriate in selected areas.