GREAT PLACES SW Corridor

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Tunnel Alignments

Executive Summary, May 2015

Three tunnel alignments are currently being considered to be part of a Southwest Corridor Plan high capacity transit project:

- Marquam Hill-Hillsdale 2.4-mile bored tunnel for light rail
- Capitol Highway/Hillsdale Loop cut and-cover tunnel for light rail or bus rapid transit
- a light rail cut-and-cover tunnel to Portland Community College (PCC) Sylvania

This summary highlights the geological conditions, likely construction techniques, and cost estimates for each of the three tunnels under consideration.

The plan's Steering Committee will decide in July 2015 whether any of these tunnel options should be considered for further study, and possible inclusion in the Preferred Package for the plan.

About Transit Tunnels

Tunnels are most often used when major ridership areas cannot effectively be served by surface alignments. In major transit systems in the country, including those in Portland, Seattle, and San Francisco, tunnels have been considered when these factors are present:

- slopes are steep (more than 5 to 6 percent)
- large physical barriers (hills, rivers) to cross
- right-of-way is inadequate for at-grade or elevated profiles
- the density of homes and businesses is high
- there is high ridership and high train or bus frequencies that would make street-level transit operations impractical

Tunnels carry greater design and technological challenges, are much larger undertakings, and have more construction risks. These factors results in tunnels carrying substantially greater costs.

Cut-and-cover construction excavates the tunnel or a station from the surface, creating a trench or box, and covers it up once the tunnel or station structure is in place. Cut-and-cover techniques are commonly used for stations unless they are very deep. All surface features above the tunnel alignment or the station must be removed.

Bored or mined tunnels are constructed underground using tunnel boring machines (TBMs). Many transit tunnels are actually two bored tunnels, with one tube for each direction. Bored-tunnel stations can be either mined from underground, or built from the surface as cut-and-cover. If stations are more than 100 feet deep, they are usually mined.

Tunnel Portals are permanent entrances to the tunnel. Portals are major points for construction. They are used to launch tunnel boring machines, remove tunnel spoils, bring in other equipment and materials, and provide workers access to the tunnel.

Tunnel stations need at least two points of entry from the surface, with connecting shafts for stairs, elevators, and, in some cases, escalators. They are several hundred feet long, with platforms large enough and long enough to handle peak passenger loads. They also have ventilation, power, transit control and extensive fire/life/safety systems.

Construction Staging Areas are needed at portals and stations and at other points where construction is at the surface. Three to six acres are usually needed at portals, and one to four acres are desired for stations.

Tunnel portals and staging areas

Tunnel Options for the SW Corridor

Marquam Hill-Hillsdale Deep-Bored Tunnel for LRT

The 2.4 mile tunnel alignment would run under Marquam Hill through to Hillsdale and Burlingame and include two deep underground stations at Oregon Health Sciences University and Hillsdale. The north portal for the tunnel would be off SW Barbur Boulevard near Duniway Park. The south portal would emerge at Burlingame, near SW Bertha Boulevard and Barbur.

Geological conditions

Conditions in Marquam Hill are highly complex and challenging with a series of basalt stone layers, cut by faults and many transitions between different layers of earth. With two-thirds of the tunnel beneath the water table, groundwater will be present and in some areas high flows into the tunnel are expected. The tunnel would pass through multiple sections of solid rock, fractured stone, and looser soils with cobble- to boulder-sized blocks of intact rock, silt and clay.

Likely Construction Techniques and Impacts

Tunnel boring machines (TBMs) are best suited for Marquam Hill's varied geological conditions. The most likely method would be twin 20-foot-diameter bored tunnels, with two deep mined stations connected to the surface through 30- to 50-foot-diameter shafts.

The north portal would bring in the tunnel boring machine and other heavy equipment, tunnel linings and structures, and would continuously transport out large volumes of earth, rock and potentially groundwater. Similar tunnel projects have needed 5 or more acres for staging, and generated up to 200 truck trips daily. Deep mined stations also need several acres on the surface above for construction of surface features and shafts, and can generate 30 to up to 100 truck trips daily.

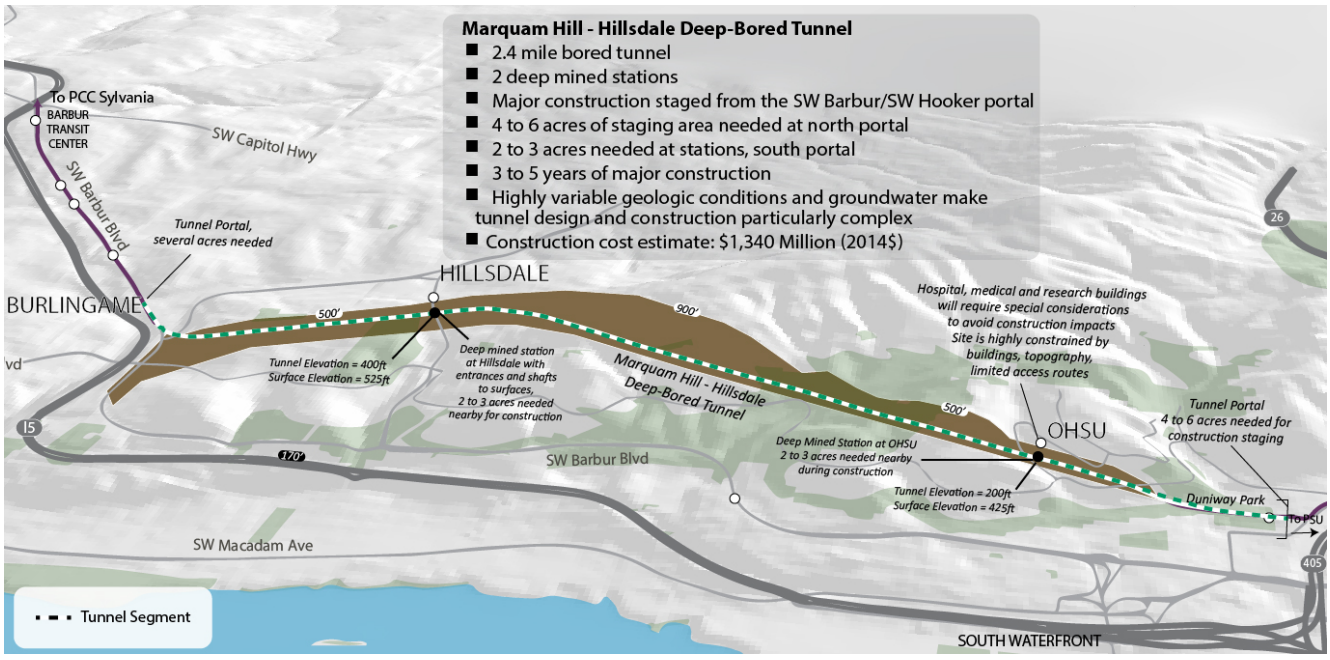
Blasting or other excavation methods are expected at the portals, stations, cross passages and other locations along the alignment.

Construction of a Marquam Hill-Hillsdale tunnel could last 3 to 5 years; construction costs are estimated in 2014 dollars to be $1,340 million.

Tunneling Issues

There is little to no vacant land at the proposed locations for a tunnel portal and stations and impacts to adjacent properties appear unavoidable. At the north portal, the adjacent areas include Duniway Park, residences, and SW Barbur Boulevard. The south portal area is adjacent to residences and large businesses, which would be subject to trucking and several years of construction activities.

The OHSU complex has limited roadway access, hilly topography, and limited locations available for staging of the station entrance buildings and shafts. The OHSU complex includes buildings and operations with sensitive equipment and overnight patients,



these would be especially sensitive to the noise and vibration of tunneling and blasting. The impacts of trucks and large equipment on Terwilliger Boulevard is also an issue.

The Hillsdale station site is at a busy intersection of Capitol Highway, adjacent to two schools, residences and the commercial district. The staging area for the underground station would require several acres, which are not available without displacing multiple existing properties or affecting the schools.

Capitol Highway/Hillsdale Loop Cut-and-Cover Tunnel for LRT or BRT

This .3 mile tunnel would be 35 feet deep with an underground cut-and-cover station near SW Capitol Highway and SW Sunset Boulevard. The northeast portal to the tunnel would begin approaching Sunset Boulevard, and the southwest Portal would be near SW Vermont Street and SW Bertha Boulevard. Two locations for the cut-and-cover tunnel alignment are being evaluated—one along SW Capitol Highway that turns south at SW Bertha Boulevard and another crossing across an elementary school athletic field.

Geological conditions

The area consists of basalt rock below 15 to 40 feet of varied soils, including fill. Key geotechnical issues include the potential for rock excavation, perched groundwater, and loose soils.

Likely Construction Techniques

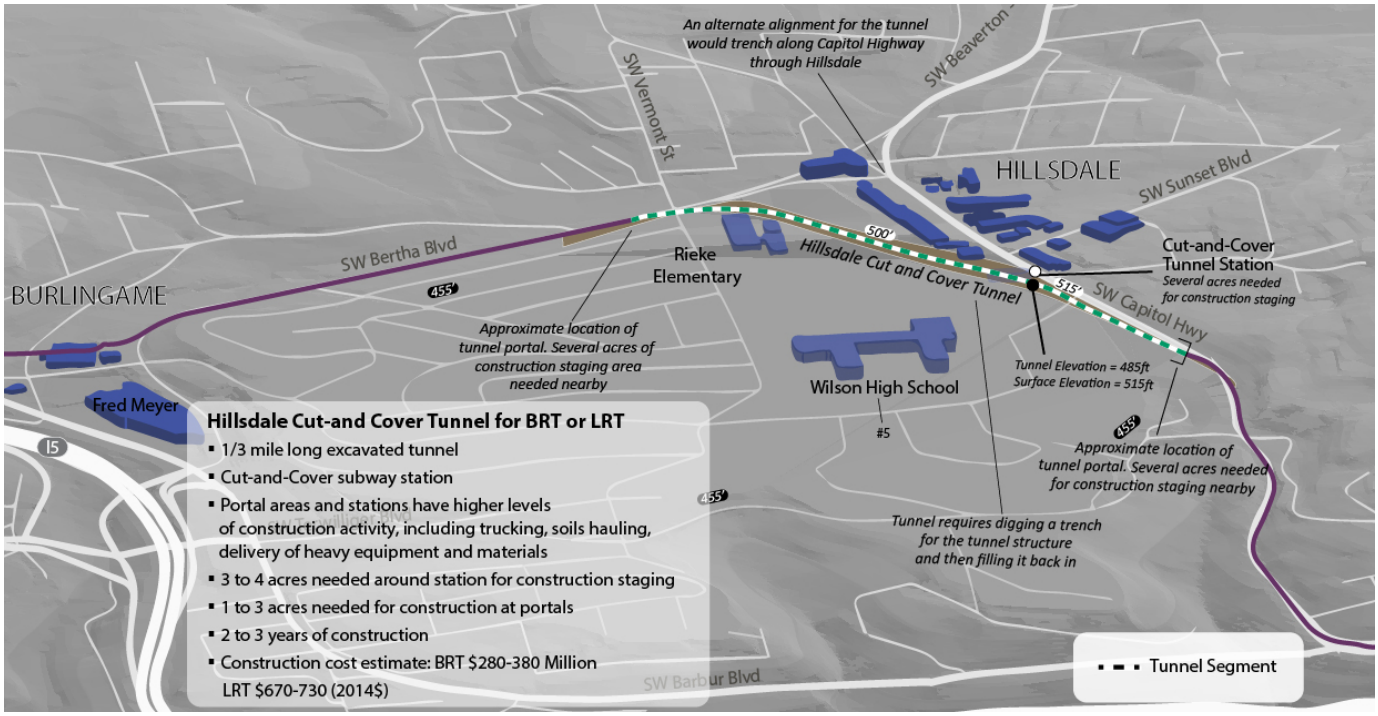
A 40-foot-deep, .5 mile trench would be dug for the tunnel and the station. Rock excavation may be required, which could be done with machines but may also involve drilling and blasting. Groundwater would need to be managed.

A large volume of soil and rock would be hauled away daily, creating 100 to 200 truck trips daily over an extended period. Vertical shoring walls needed during construction would require large equipment for drilling or pile driving. Streets or paths across the alignment would be closed or restricted during much of the construction period, and the areas along trench would be restricted as well.

Construction of a Hillsdale Loop cut-and-cover tunnel could take 2-3 years; construction costs are estimated in 2014 dollars to be $670-$730 million (light rail) or $280-$380 million (bus rapid transit).

Tunneling Issues

The trench for the cut-and-cover tunnel and station would be constructed in areas that are mostly developed. The construction area is bounded by a major roadway, a high school, an elementary school, residential neighborhoods and a commercial district. Property impacts to several blocks of the area appear unavoidable. One potential alignment would cross fields belonging to the elementary school, and the other alignment would affect the commercial district along Capitol Highway.



Access through the Hillsdale area would be affected by the construction site and high levels of truck traffic. In addition to traffic and property impacts, noise and vibration, light and glare would be other issues of concern.

PCC Cut-and-Cover Tunnel

The PCC tunnel cut-and-cover is about .5 mile long, and up to 70 feet deep. One underground station is proposed at about 70 feet deep, in a parking area at the north side of the campus. The tunnel would begin near SW Barbur Boulevard and SW 53rd Avenue, proceed south to the campus, turn west to the station, and continue west. The alignment would then surface near SW Lesser Road before crossing over Interstate-5.

Geological conditions

The alignment is on the flanks of an ancient volcano (Mount Sylvania), with a base of basalt and volcanic cinders below about 40 feet of silt, clay, some sand, gravel and cobbles. At the depth of the current alignment, the conditions for the tunnel will be highly variable, including boulders, blocks of rock, and pockets of groundwater in the upper soils.

Likely Construction Techniques

This is a relatively deep tunnel for a cut-and-cover approach, but the length and depth of the tunnel would also be a challenge for machine boring. Cut-and-cover would require a deep trench for the tunnel, and the excavation will temporarily close SW 53rd Ave, an existing residential street. The variable geological conditions will require a contractor to use a combination of soil excavation, soil treatments, drill-and-blast rock excavation, and excavation support systems.

If the alignment were deepened by 30 to 50 feet, a boring machine could be used. However, this would extend the length of the tunnel, and the station would likely need to be mined, which is more costly.

Tunneling Issues

The alignment is along a .25 mile section of an existing residential street, access to the adjacent residences would be closed. Construction activities causing noise and vibration would also be present. The residences along the street would likely need to be purchased and the residents would be relocated. Houses along the street could also experience some settlement from the excavation, as well as potentially vibration-induced damage from blasting. The high volume of trucks and large amount of soils to be removed and later replaced would affect surrounding areas for several years.

Construction of a PCC cut-and-cover tunnel could take 2-3 years; construction costs are estimated in 2014 dollars to be $515 million.

This report was prepared by Parametrix, 2015