



MEMO

July 24, 2005

TO: Joni Earl, Chief Executive Officer

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SUBJECT: First Hill Station Recommendation

Per your request, we are submitting for your consideration the Link Department's recommendation regarding the status of the First Hill light rail station as part of the North Link project scope. This memorandum is technical in nature and presents information and findings primarily related to the engineering, geology, construction risks and other challenges associated with the First Hill station. It provides the technical basis in support the Department's recommendation.

We recognize the importance of First Hill as a vital regional employment center that has long been a planned destination for Sound Transit's Link light rail line. While acknowledging the role of First Hill, this memorandum distinguishes between the transit needs and benefits of First Hill and the technical issues related to construction, and generally focuses on the latter. This approach is not intended to diminish the importance of providing quality transit service to First Hill, but rather to highlight the challenges associated with delivering this portion of the North Link project.

The Link Department's recommendation is based on the following considerations and conclusions:

- **Background.** Conceptual engineering for the segment between Downtown and the University District was initiated in 1998. After the unsuccessful design/build procurement for the tunnels and stations to the University District in 2000, the Sound Transit Board re-initiated the North Link program in 2001 by directing staff to re-examine the location of tunnel routes and stations with the goal of reducing construction costs and risks.
- **Early Design Efforts.** Negotiations with contactors who responded to the 2000 design/build procurement for the light rail tunnels and station between Downtown Seattle and NE 45th Street pointed to the risks and very high costs associated with the First Hill station. Sound Transit engaged the contractor with the best proposal to identify modifications to the First Hill station design that would reduce costs. Although some of the contractor's proposals have been incorporated into the current design, many of the significant design changes proposed by the contractor were determined to be unacceptable, due largely to insufficient information regarding significant cost savings and risk reductions, and concerns regarding safety and fire protection issues.
- **Preliminary Engineering and Beacon Hill Lessons.** Design for the Beacon Hill station, including construction of a test shaft, and design refinements during construction underscore the complexities associated with the type of construction required for the First Hill station. Selected risk mitigation measures adopted at Beacon Hill, such as the concrete slurry wall construction for station access shafts, were incorporated into the current First Hill station design. However, key risk mitigation measures that are being employed at Beacon Hill, such as proactive geotechnical explorations and application of ground improvements in advance of critical mining operations, cannot be effectively applied from the ground surface at First Hill given the nature of the underlying fine-grain subsurface soils, the station depth, and surface building obstructions.

- **Station Considerations.** The First Hill station would serve one of the region's preeminent transit markets. Land use patterns, topography, and unstable soil conditions contribute to a very deep station at First Hill. Deep subway stations pose engineering and construction challenges and involve significant cost and schedule risks. Alternate station locations do not reach the First Hill transit markets as effectively. After consideration of a broad range of station configurations and construction means by design consultants, technical oversight, transit peers, and contractors, the current station design represents the most economical and safe configuration.
- **Costs Estimates.** Incorporating previous design efforts, including feedback received from contractors, and lessons learned from the ongoing Beacon Hill construction, the design for the First Hill station has been enhanced to address, to the extent possible, the anticipated challenges posed by the construction of this station. Adoption of construction means and methods suitable to address the First Hill station construction challenges, including the use of slurry wall construction for access shafts and excavation support measures for the sequential excavation mining of platform caverns, result in a preliminary engineering (30 percent design completion) cost estimate for the First Hill station and associated tunnel length increase of \$350 million.
- **Risk Assessment.** Comprehensive risk analyses conducted at the completion of preliminary engineering conclude that the First Hill construction adds considerable schedule and cost uncertainty to the scope of any North Link extension.

RECOMMENDATION

Given these factors, the Link Department recommends that construction of the First Hill station be removed from the scope of the preferred North Link project. While construction of the First Hill station is technically feasible, we conclude that schedule and cost risks warrant elimination of this station.

A. BACKGROUND

Light rail service connecting Downtown Seattle to the University District and beyond has been a critical component of high-capacity transit planning efforts in this region for the last two decades. The ridership potential and high construction costs due to topography, densely developed neighborhoods, and lack of grade-separated right-of-way options has made this corridor a very desirable yet challenging one to serve.

In 1996, voters approved the regional *Sound Move* transit plan that included light rail service to connect Downtown Seattle, First Hill, Capitol Hill and the University District, and to Northgate, if additional funds became available. More detailed engineering work in the north corridor began in 1998. And as described later in this memo (see part B and C), further work advanced until 2000 when the project was put on hold. In September 2001, the Sound Transit Board approved the work program for North Link, to re-examine routes to determine whether there were ways of reducing project costs and construction risks.

Soon after, an environmental process was initiated, conceptual engineering was conducted on a number of different routes and station locations, and community outreach and agency coordination was undertaken. In early 2004, conceptual engineering and Draft Supplemental Environmental Impact Statement (SEIS) and addendum were completed. In April 2004, the Board considered a variety of North Link route and station options, including a route that served First Hill and a route that by-passed First Hill and directly connected to a station on Capitol Hill. On May 20, 2004, the Sound Transit Board identified the North Link preferred route that included a station at First Hill, despite its higher construction cost and expected construction risk. Preliminary engineering was initiated on the preferred alternative in June 2004.

Preliminary Engineering and Final SEIS

Preliminary engineering (PE) design work (30% design completion) on the preferred alternative serving the First Hill station was completed in April 2005. A quantitative risk assessment was conducted in May 2005 and preliminary cost estimates were completed in June 2005. Partner agencies have been reviewing the PE design work in June and July 2005. Completion of these activities has given Sound Transit a good sense of the expected cost, risks and financial requirements needed to complete the North Link Project.

Sound Transit expects to issue the Final SEIS in December 2005, following the issuance of a new Draft SEIS in August which will document recent design changes adopted during PE. The FTA is expected to issue a Record of Decision (ROD) by February 2006, granting final environmental clearances for the North Link Project.

New Starts Process

As one of the first steps in seeking federal funding for North Link, Sound Transit must transmit a New Starts Report to the FTA. This report defines the preferred project proposed for federal funding participation including ridership, cost and other information. In order to maintain a 2016 project schedule and to be evaluated in this year's cycle of potential New Starts projects, Sound Transit must submit its report by August 15, 2005.

To meet this approaching FTA deadline, the Sound Transit Board needs to make some preliminary decisions about the North Link Project, including any potential changes in the preferred alternative, before a New Starts submittal can be completed. A decision on whether the First Hill station remains as part of the preferred alternative, or is excluded, is needed before the New Starts report can be submitted by August 15th.

B. EARLY DESIGN EFFORTS

In January 1998, Sound Transit initiated Conceptual Engineering (CE) for the North Corridor of the Central Link Project (*including work on First Hill*). Link assembled a highly-qualified team of civil, tunnel and geotechnical consultants with extensive local tunnel experience to conduct the engineering studies. In conjunction with the Link Department, this team established a Peer Review Panel, comprised of internationally recognized underground design and construction experts. This Panel performed intermittent reviews of the design work and offered advice and recommendations including the geotechnical exploration program.

In the fall of 1998, at the end of CE and the start of PE, Sound Transit made a number of decisions regarding the design and construction of the tunnels and subterranean stations in the North Corridor for Central Link Light Rail. Two major decisions at the time included: (a) the agency must make a substantial investment in geotechnical studies to obtain enough data to characterize and evaluate subsurface conditions and establish a basis for evaluating claims or disputes relating to the nature of the physical site conditions; and (b) the use of design-build procurement for the heavy civil underground construction in the North Corridor to meet an objective of opening the entire system by November 2006.

Design Development

In November 1998, the ST Board adopted a program to expand the geotechnical studies for the entire Central Link Project. In the discussion paper for this motion, ST staff outlined a number of general guidelines for the overall program which included the following recommendations:

- along tunnel alignments, drill every 250 feet (similar to the spacing and investigation completed for the Downtown Seattle Transit Tunnel (DSTT)); and
- for underground stations, drill eight (8) boreholes per station (similar to the configuration of boreholes for the stations along the DSTT).

Throughout 1999, the Sound Transit staff and the team of consultants worked on PE for the North Corridor of the Central Link Project. During this period, the team met on regular intervals with the Peer Review Panel to review and discuss the development of the Corridor (*including the First Hill Station*). The focus of these discussions included the following:

- review of the geotechnical work with emphasis on assessing the adequacy of the data acquisition; the characterization of the hydro-geologic conditions; and the evaluation of the engineering properties;
- review of the design of the sequential excavation with emphasis on the primary support methods to address the variable geotechnical and groundwater conditions at First Hill and associated engineering properties; and
- review contract packaging strategy for the North Corridor in light of the Board's decision to utilize an alternate design-build procurement.

In the fall of 1999 (near the end of PE), Sound Transit procured the services of three individuals experienced in heavy construction to serve as Link's Technical Oversight Panel (TOP). This panel was hired to assist in the development of Link's design/build contract documents and supplement the Peer Review Panel. This TOP was provided as a resource for Link staff and Sound Transit management. Depending on issues at hand, specific members or all members of the panel were available to review designs and contract provisions and assess the technical risks associated with underground construction.

At the end of PE (first quarter of 2000), Link convened the first of a series of meetings with members of the TOP. For the First Hill Station, the TOP reviewed the geotechnical information and design development for the sequential excavation mining (SEM) technique. For this station, the TOP reviewed the designs based on fourteen (14) borehole explorations drilled during the CE and PE design stages. The TOP was informed of the following:

- the station platforms have been sited in the most favorable geology in terms of "stand-up" time between excavation and installation of primary (initial) ground support;
- the station platform and concourse tunnels have been sited in a mixed-face of hard silts and clays and dense dry sands;
- cohesionless silt and fine sand were sampled near the crown of both station platforms and these units are water-bearing with hydrostatic heads of 80 to 90 feet above the station crown and if encountered, these soils will flow into the excavation, unless they are stabilized first by some form of ground improvement or dewatering;
- the station shafts are expected to encounter similar layers of cohesionless silt which could be especially troublesome, since they are commonly water-bearing and will flow unless supported and drained (the flowing conditions was experienced in similar soils during the construction of DSTT);
- the SEM design includes a prescriptive base for the primary (initial) support and provisions for additional support measures to be defined and quantified to allow bidders to price this potential additional work (i.e., the "tool-box" of additional support measures);

- the SEM design for First Hill and the other deep stations was based on lessons learned from case histories world-wide including discussions in Germany with members of the German Railway Authority working on a design/build contract including SEM in soils; and
- the design and construction for First Hill and the other deep stations is pushing the state-of-the-practice for underground construction in North America and would be the deepest application of SEM in soils on this continent.

Based on this information, the TOP agreed that the PE design for First Hill was appropriate for the design/build procurement package. The TOP also advised ST that the design/build team would still have to review, assess and comment on the adequacy of both the geotechnical exploration program and the SEM designs as part of the negotiations before a contract is signed. The TOP also acknowledged that the design/build contract was a large package that would require qualified contractors and designers experienced in tunneling using both SEM techniques and earth pressure balanced machines (EPBM). The TOP recommended a two-step procurement process which involved pre-qualification in the first step followed by a request for proposal.

Design/Build Procurement

In January 2000, Sound Transit advertised a Request for Proposals for the Design-Build Tunnel Contract (LB235) for the North Corridor of Central Link. This advertisement followed a pre-qualification process where three joint venture teams were short-listed. In July 2000, Sound Transit received cost proposals from two teams and both proposals were substantially above the Engineer's Estimate. In August 2000, after intensive work sessions, Modern Transit Constructors (MTC) was selected for negotiations. MTC was asked about their willingness to work on design alternatives to provide the basis for a negotiated agreement. MTC indicated a willingness and MTC was authorized a 3-month professional services contract with Sound Transit with a target date to have a final price for the LB235 Contract ready for the Board in early December 2000.

From August through October 2000, Sound Transit staff, consultants, and the TOP worked with MTC on design alternatives to reduce costs and to establish a framework for price negotiations. During this period and after reviewing the geotechnical exploration program, MTC agreed that the First Hill station platforms and concourse tunnels have been sited in the most favorable geology. To address technical and cost concerns, MTC presented a number of design alternatives, including a mono-tube tunnel and large side-platform loading stations for the deep-mined stations, including the First Hill station. This alternative modified the loading pattern from a center-platform design to a side-platform design for all deep stations. MTC's alternative maintained two station entrances at First Hill on either side of Madison Street. These station entrances were centered above the station platform rather than located at each end of the platform, as had been designed previously.

These design concepts were discussed with Link staff, the design team, members of the TOP. Discussions were also held with the Seattle Fire Department, the Department of Planning and Development, and other members of Link's Fire and Life/Safety Committee. After an extensive series of meetings and discussions, Link staff and members of the review team concluded that MTC's proposed alternatives did not provide substantial savings and introduced design concerns, and, therefore, Link Staff did not recommend acceptance of these alternatives.

In other discussions with MTC, the design/build team expressed heightened concerns about the nature of the variable glacial soils and groundwater conditions (i.e., hydrostatic pressures) anticipated at First Hill. They expressed concerns about the potential "flowing" behavior of these soils compared to the anticipated

geotechnical and hydro-geologic conditions and ground behavior anticipated during construction of the deep-mined stations at the University District. MTC also expressed concerns about the effectiveness of pre-treating and dewatering the inter-layered fine-grain soils prior to excavating the shafts and station passageways. MTC informed Link that the design/build team was exploring the viability of slurry wall or ground freezing techniques to address the anticipated "flowing" ground conditions described in Link's geotechnical baseline report. In addition to the ground conditions, MTC expressed concerns about the ability to comply with permit regulations on First Hill. In particular, MTC expressed concern about the ability to comply with requirements in Link's technical noise variance.

With the expiration of the 3-month professional services contract, MTC, our consultants, TOP and ST staff efforts to reduce the costs and risks associated with the North Link were not successful and resulted in Sound Transit's cancellation of the LB235 contract. This led to the Sound Transit Board's decision, in September 2001, to adopt the North Link work program with the specific goals of reducing project costs and construction risks.

C. NORTH LINK WORK PROGRAM

Conceptual and Preliminary Engineering (2002 to 2005)

Because of the substantial tunnel engineering and geotechnical information already available for the First Hill station, CE resources were focused on new routes and station locations identified at the start of North Link conceptual engineering (5% design completion) in early 2002 through 2003. No new design work was conducted on the First Hill station during CE.

Once the Board reaffirmed the First Hill station as part the preferred alternative in May 2004, the North Link design team revisited the First Hill design and geotechnical data. The North Link team also had the benefit of applying lessons learned from Sound Transit's experience with the final design and initial construction of the deep station at Beacon Hill. Lessons learned include the observations of ground behavior in the test shaft constructed prior to the completion of final design and the observations from construction activities from the surface including slurry walls, jet grouting, and dewatering techniques.

First Hill Station Design Changes

Staff began North Link PB in June 2004, incorporating lessons learned from the previous procurement efforts and the completed Beacon Hill design. Design efforts for the civil and architectural teams focused on ways of reducing cost and risk, updating fire/life/safety standards, and updating projected patronage levels to confirm vertical circulation needs and emergency evacuation requirements. Key design changes for the First Hill station and updated construction approaches are summarized below:

- **Reduced deep basement structures.** Ventilation and other equipment rooms that were previously located in deep-basement structures below each entrance headhouse were moved to the surface or the second floor above to reduce the amount of structural excavation, cost and construction complexity.
- **Station platform concourse design changes.** To reduce the amount of SEM needed to construct the underground station platform chambers, as a means for lowering costs and potential risks, several design modifications were made to simplify the structures and improve the ease of breakout from the tunnel liners, based on the Beacon Hill experience.
- **Slurry wall construction for the primary (initial) support of station shafts.** Based on Beacon Hill experience, the proposed method of construction for the two deep station shafts (215') for the First Hill station is slurry walls. The application of slurry wall construction on Beacon Hill has been successful to cast the primary support for the station's deep shafts while mitigating (i.e. eliminating)

risks (cost, schedule, safety) associated with handling flowing ground conditions. While other techniques, such as ground freezing, may be a viable option to mitigate similar flowing ground conditions, slurry wall construction at Beacon Hill has demonstrated how to successfully handle Seattle's complex glacial soils and highly-variable groundwater conditions.

- **Increased number of elevators.** Based on updated station boarding forecasts for 2030 (previously used 2020 forecasts) and emergency evacuation requirements, the number of elevators required for the First Hill station increased from six to eight.
- **Contract packaging approach.** To ensure competition for tunnel and station construction contracts, the SEM construction of the First Hill station is now identified as a stand alone contract to attract the specialized contractors of this work and not burden the tunnel boring contract with significant specialized work.

D. FIRST HILL STATION SITING CONSIDERATIONS

Staff believes that the current First Hill site is the optimal location for this station. It is located near the center of the First Hill ridership market, is convenient for easy bus transfers on Madison Street and Broadway, and is adjacent to marginally adequate construction staging areas.

The current First Hill tunnel route starts at the Pine Street stub tunnel at DSTT, travels east and crosses under I-5, and then travels south towards Madison Street, swings northeast to the First Hill station site and then travels north to Capitol Hill station. Between DSTT and First Hill, the line and grade of the running tunnels have been designed to (a) pass through the massive substructure of I-5 without adversely impacting the freeway system; (b) meet operating speed requirements with adequate curves to complete this out of direction route; and (c) establish a straight (tangent) section along the alignment (at the station platform) to provide level boarding. In 1998 and 1999, ST and WSDOT worked together for over one year to identify methods that would allow the tunnels to pass through the massive cylinder pile walls which form the retained cut structures of the freeway at Pine Street (i.e., "Point A"). During this same period, Sound Transit identified the recommended depth of the First Hill station platform to avoid wet sands and silts (potentially flowing ground conditions) (i.e., "Point B"). The remaining design work connected Point A with Point B.

Point A is essentially fixed by the tunnel bores passing underneath I-5. Between Point A and Point B, a distance of over 2000 feet, the PE design grade for the running tunnels is 1.5%. Increasing the grade of the running tunnels between Points A and B to as much as 4% to 6% would decrease the depth to the station platform but would locate the station platform and concourse tunnels in a mixed-face of wet sand and silts (i.e., flowing ground conditions). This mixed-face condition is not as favorable as the current PE design and would require more extensive ground improvement and dewatering to control these soils during the excavation. Pre-construction ground control measures from the surface are not a viable option due to limited access at the surface. Ground control measures would have to be accomplished from within the excavation during construction, which increases the risk to cost and schedule.

If the First Hill station is moved further south it will have an impact on the cost model and possibly the operations of the rail. Moving the station south while maintaining adequate travel speed will add substantial additional length to the tunnel route which increases the cost. Alternatively, increasing the curvature of the tunnels to minimize the additional length of tunnel route will reduce train speeds operating through this section of the alignment.

If the station is moved further north, it would create a greater walking distance for riders going to or from the major institutions (all located south or southeast of the current station site). Moving the station further north would also further the overlap with the Capitol Hill station catchment area. The net result would be less efficient service to the First Hill ridership market without gaining more riders to the north.

In addition, First Hill is already densely developed and lacks other large sites easily available for construction staging of a station at a different location, without substantial additional right-of-way and relocation costs.

Finally, even if an attractive new station site was identified, there is no guarantee that soil conditions there would be any better than the current site. Our tunnel design experience in Seattle's upland areas (i.e. First Hill, Capitol Hill, University District and Beacon Hill) have confirmed that the regional geology of the upland areas are a complex sequence of inter-layered fine- and course-grain soils with highly-variable groundwater regimes.

E. COST ESTIMATES

The North Link capital cost estimates prepared at the conclusion of PE encompass the full project scope, including construction, procurements, real estate, engineering, management, and administration. Capital cost estimates include a hierarchy of allocated and unallocated contingencies. Project cost estimates are expressed in terms of year of expenditure (YOE) dollars and include inflation costs in accordance with the preliminary project schedule.

Construction estimates are based on engineering that has generally been advanced to approximately 30 percent completion. Designs for selected structures, such as the bored tunnels and critical SEM facilities, are advanced somewhat further. Station architectural designs have been advanced to somewhat less than 30 percent completion. Construction cost estimates are generally built "bottom up" detailing the labor, material, equipment, and supplies that are expected to be required for individual construction activities.

Although construction cost estimates have been developed for the entire North Link corridor to Northgate, the development of comprehensive capital cost estimates has focused on the segment between the DSTT and the UW Station. Cost estimates for this segment are structured in accordance with the preferred contracting packaging plan defined during the peer review held in October 2004 and have been reviewed in conjunction with the risk assessment conducted in May 2005.

The estimated capital cost of the LRT extension to the UW Station, including the First Hill station, is \$1.85 billion based on a schedule completion in 2016. With the elimination of the First Hill station, the estimated capital cost for the segment to the UW Station is estimated to be \$1.50 billion. The \$350 million cost associated with the First Hill station reflects the station facilities and the reduction in the overall tunnel length that would be associated with the elimination of this station, including associated property and other capital cost elements.

F. RISK ASSESSMENT

Link conducted a comprehensive project risk assessment for North Link to validate schedule and cost estimate assumptions and to identify areas of risk as a means for targeting value engineering efforts. The North Link risk analyses were prepared in accordance with recent FTA guidance and are based on Link's experience from similar risk assessments conducted for the Initial Segment.

Link initiated the North Link risk assessment in May 2004 when a workshop was convened to identify and rank project risks in order to help guide the preliminary engineering effort. In May 2005, at the conclusion of preliminary engineering, a second workshop was held to collect information for the quantitative analysis. Workshop discussions covered the full North Link corridor to Northgate. Given the pending resolution of the alignment and Brooklyn station location in the northern University District, the quantitative analysis focuses on the segment to the UW Station.

The May 2005 risk workshop underscored previous observations that the construction of the First Hill station represents a significant construction risk. Given the prominence of this risk element, subsequent quantitative analyses were structured to separately analyze the project between the DSTT and the UW station with and without inclusion of the First Hill station.

The quantitative risk analysis indicates that while the complexity of the project between the DSTT and the UW Station poses considerable schedule and cost risks, these risks appear to be adequately addressed by the project schedule and cost estimate and associated contingencies. Simulation results indicate a reasonably high level of confidence that the project schedule and cost estimates are adequate. Results indicate that the First Hill station construction adds uncertainty to the overall schedule and cost, due primarily to the difficult construction methods required for this station and the critical interface between the construction of this station and the bored tunnels.

Schedule model results indicate a 75 percent probability that the segment between the DSTT and the UW Station, including the First Hill station, can be completed by the estimated completion date in the third quarter of 2016. With the elimination of the First Hill station, there is an 85 percent probability that the segment to the UW Station can be completed by in the estimated completion date in the first quarter of 2016.

The lower schedule confidence level associated with the inclusion of the First Hill station is due in large part to risks posed by the construction of the station access shafts and deep station caverns using, respectively, concrete slurry walls and SEM construction. The schedule risk associated with these construction methods is magnified by concerns that construction impacts could trigger the imposition of working hour restrictions. As a result, model results suggest a high probability that the heavy civil station construction would be delayed considerably, potentially extending this high-impact work phase from the two year target duration to three years, causing the planned 5½ year overall station construction period to potentially extend to up to 6½ years.

Cost model results indicate a 75 percent probability that the segment to the UW Station, including the First Hill station, can be completed at a capital cost of \$1.85 billion. With the elimination of the First Hill station, there exists an 86 percent probability that the segment to the UW Station could be completed at a cost of \$1.50 billion. To achieve an 85 percent budget confidence level for the segment to the UW Station including the First Hill station, the capital budget would need to be increased by approximately \$70 million, from \$1.85 billion to \$1.92 billion. Therefore, at the 85 percent confidence level, the capital cost difference associated with the First Hill station is equal to approximately \$420 million.

The lower cost confidence level associated with the inclusion of the First Hill station is in large part due to (1) Sound Transit's exposure to schedule delay claims from contractors who are impacted by a delay in the completion of the First Hill station construction; (2) costs associated with the adoption of alternate station excavation methods in response to unforeseen ground conditions; and (3) costs associated with mitigation measures imposed to reduce visual and noise impacts during construction.

CONCLUSIONS

The following issues summarize the challenges of building the First Hill station and lead us to recommend that the First Hill station not be included as part of the North Link preferred alternative:

- **Station Location.** Extensive station area planning efforts confirm that the First Hill station is sited optimally to serve the significant transit markets on First Hill. Limited alternative sites are available to effectively serve First Hill and there is no guarantee that site and soil conditions at a nearby alternate site would be more favorable.
- **Geotechnical Explorations.** Based on geotechnical borings conducted at the First Hill station and review of historical records, Sound Transit has a thorough understanding of soil conditions. The 14 borings performed in the station area exceed the geotechnical guidelines adopted by the Sound Transit Board based on the level of investigations performed for the DSTT stations (eight bore holes per station) and are comparable to the numbers of borings performed for the Beacon Hill tunnel station prior to construction of the test shaft.
- **Station Depth.** Geotechnical explorations indicate that soil conditions at the First Hill station location are highly variable and present significant construction challenges. Identified layers of very unstable soils require that station platforms be located approximately 215 feet below the surface. Extensive engineering analyses over that past six years, including multiple reviews by independent industry experts and feedback from contractors, confirm that the First Hill station platforms are located at an appropriate depth to support safe construction. Raising the platform elevation would increase construction risks and likely increase costs.
- **Ground Stabilization.** Construction of the First Hill station will require complex measures to stabilize soils to support the excavation of platform-level caverns. Given the depth of the platform and surface level building obstructions, ground improvements cannot be applied vertically from the surface, as is currently being done at Beacon Hill, and must instead be applied horizontally from the bottom of the station shafts, approximately 215 feet below the surface. The inability to stabilize soils from the surface in advance of the excavation means that soil improvements can only be applied immediately prior to the excavation, placing this very complex operation on the critical path and thereby creating a significant schedule risk.
- **Schedule and Cost Risk.** The construction of the First Hill station poses significant construction risks and substantially reduces the schedule and cost confidence for light rail extensions to the north. Highly specialized construction methods required for the First Hill station will limit the level of competition for this procurement, adding considerable cost uncertainty. The planned First Hill construction duration exceeds five years and involves high-impact construction methods. Limited construction staging areas, poor surface access, and construction impact mitigation requirements will reduce productivity and create inefficiencies. Site constraints and the sequence of construction required for the First Hill station will likely cause construction delays that expose Sound Transit to delay claims from follow-on contractors and thereby pose a significant cost risk.

We acknowledge the importance of First Hill as a vital regional employment center that has long been a planned destination for Sound Transit's Link light rail line. A First Hill station would provide additional new transportation choices and would attract substantial ridership for a regional transit market that has long proven to be difficult to serve. Major institutions on First Hill and other neighborhood stakeholders have been long time supporters of Sound Transit's *Sound Move* plan and the North Link project.

Transit Service Alternatives for First Hill

Because of the importance of the regional transit market, Link staff has conducted an initial exploration of potential transit service and other improvements that could be considered to improve regional transit access to First Hill, if a light rail station was not built on First Hill. While these investments do not replace the benefits offered by the First Hill Station, we believe that in combination with the Capitol Hill Station service to First Hill can be improved over today's conditions.

Staff revisited employment and population patterns and forecasts for the area, analyzed light rail and bus ridership forecasts for scenarios with and without the station, and further examined the station catchment areas and transfer times. Staff continues to coordinate with King County Metro (KCM) service planners and transit capital project staff, Seattle Department of Transportation (SDOT) staff, and Sound Transit's Regional Express service planners. Discussions have focused on what improvements have been previously implemented, what are the remaining major obstacles for further improvements, what service and transit priority needs still exist, and ideas for possible new improvements.

Based on the work completed to date and initial discussions with KCM and SDOT staff, the following warrant further consideration to improve access from other Link stations to First Hill when North Link service begins in 2016 (the current project schedule), if the First Hill station is not built:

- **Improve transit speed and reliability.** Possible roadway and intersection improvements could include bus lanes, signal priority, queue jumps and bus bulbs.
- **Increase transit frequency.** Provide additional trips and/or consolidate routes to improve service and transfers to and from rail stations and other destinations.
- **Add new connections.** Possible new bus routes between Link stations (e.g. International District station to Capitol Hill station to bypass downtown congestion and improve Sounder rider access) or new express routes to First Hill.

Additional analysis and agency coordination will be needed to fully develop a First Hill service plan, if requested by the Sound Transit Board.