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Sightline Report:

Cost Overruns For Seattle-Area Tunnel Projects

Eric de Place, October 2009

Summary

The Washington transportation department plans to replace the Alaskan Way Viaduct along Seattle's waterfront with a deep-bore tunnel underneath downtown Seattle. Yet the plan's fiscal plausibility has become a source of controversy. The state estimates that the entire project—including the tunnel, utility realignments, a seawall upgrade, street and transit improvements, and other features—will cost $4.2 billion, of which $1.9 billion is estimated for the tunnel itself. But the estimates are preliminary; according to the state, engineers had completed only one percent of the eventual design work when they issued the estimates. There is no way to know whether the actual costs will be lower or higher.

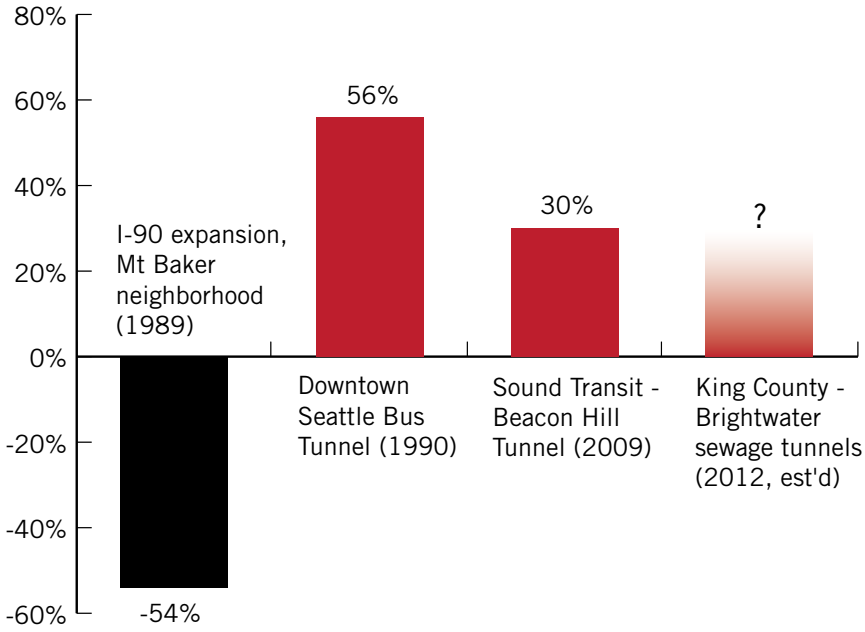
Tunnel supporters point to the Interstate 90 expansion tunnel beneath Seattle's Mount Baker neighborhood as an example of a tunneling project coming in under budget. But many other recent tunneling projects have exceeded their budgets.

- **Cost overruns are commonplace.** The downtown Seattle bus tunnel experienced a cost overrun of more than 56 percent beyond early estimates. Sound Transit's tunnel underneath Beacon Hill exceeded expected costs by 30 percent. And King County's bored tunnels for the Brightwater Sewage Plant are over budget, but the final overrun is unknown because two of the tunneling machines are damaged and trapped underground.
- **The Mount Baker Tunnel may be a poor comparison.** Although the tunnels are similar in diameter, the geology of Mount Baker was better understood because the original I-90 tunnel had already been constructed through the ridge. Also, the deep-bore tunnel would be more than six times as long as the bored portion of the Mount Baker Tunnel.
- **Small overruns could be costly.** Even small cost overruns on the deep-bore tunnel could be risky for Seattle property owners. A cost overrun of $100 million—2.4 percent of the project's total $4.2 billion price tag—could cost a Seattle family of four almost $700. A 25 percent cost overrun could saddle Seattle taxpayers with more than $1 billion of new tax liability.

As a way to inform the debate over Seattle's deep-bore tunnel, Sightline has prepared

a basic comparison of other high-profile tunnels recently constructed in the area. The costs of these tunnels tell a cautionary tale: the under-budget Mount Baker Tunnel appears to be an exception to the rule.

Recent Tunnels in the Seattle Area:
Percent over/under budget



Mount Baker / Interstate 90 Expansion Tunnel

As part of a 1980s expansion project for the section of Interstate 90 between Bellevue and Seattle, a pair of tunnels were bored underneath Seattle's Mount Baker neighborhood. Roughly 1,500 feet long, the new bored tunnels are contiguous with 1,900 feet of cut-and-cover tunnels, making for a total tunnel length of about 2/3 of a mile. At 63 feet in diameter the tunnels are considered the world's largest bored tunnels in soft soil.[1] The tunnel opened for traffic in 1989.[2]

The Washington Department of Transportation estimates that the new tunnels were built at 54 percent below their budgeted cost.[3] The project's savings have been attributed largely to two factors. First, labor and materials were cheaper than expected because the US economy experienced a recession after the project costs had been estimated. Second, the soil conditions were relatively well understood in advance of the cost estimates, in part because an adjacent tunnel (the roadway for the original Interstate 90) had already been dug beneath the Mount Baker neighborhood in 1940.[4]

Downtown Seattle Transit Tunnel

The 1.3 mile long project consists of parallel twin tunnels running between 35 and 50 feet below surface streets. The tunnels are roughly 18 feet in diameter and are interrupted by five station platforms. Primary excavation was completed in 1988; the

tunnel was finished in 1989; it opened for bus service in 1990.[5]

In 2007, the Federal Transit Administration, an arm of the US Department of Transportation, published a detailed analysis of contractor performance for specific transit projects across the United States, including the downtown Seattle tunnel project. Adjusting for inflation, the federal report found that the project's actual capital costs exceeded estimates by 56.5 percent. Estimated to cost slightly less than $299.6 million, the project was eventually completed for $468.7 million. The Federal Transit report concludes that: "Capital cost estimates for the project improved as design progressed, but significantly underestimated actual costs."[6]

Among the reasons for the cost overrun were unanticipated soil conditions, complaints from downtown interests, a worker fatality, and procurement problems.[7]

Sound Transit's Link Light Rail Beacon Hill Tunnel

Opened for light rail service in the summer of 2009, Sound Transit's Beacon Hill Tunnel consists of twin tunnels, each about 1 mile in length and some 165 feet underground at the Beacon Hill Station. The tunnels were completed in 2008 after a 21 foot diameter boring machine passed beneath Beacon Hill.[8]

When the tunnel project went out to bid, Sound Transit's engineers estimated that the project would cost $238.6 million. But Obayashi Corporation won the contract with a low bid of $280 million, a 17 percent increase.[9] During construction, the project's costs subsequently escalated the contract to $309 million for a total cost overrun of 30 percent.[10]

King County's Brightwater Sewage Conveyance Tunnels[11]

Still under construction, the Brightwater sewage conveyance system includes multiple bored tunnels as part of a larger sewage treatment plan project. The East Tunnel is 2.7 miles in length and 16.6 feet in diameter. The Central Tunnel actually consists of two tunnels, 2.2 miles long and 3.8 miles long, both 14.3 feet in diameter. The West Tunnel is 4 miles long and 12 feet in diameter.[12] The Brightwater sewage treatment plant is projected to open in 2011 with the tunnels becoming fully operational in 2012.

According to newspaper accounts, the projected cost of the total Brightwater project—including a conveyance system for transporting sewage underground, a marine outfall system, and a new wastewater treatment facility—has already exceeded its initial estimates by more than 100 percent.[13] However, this figure is based on an early cost estimate from 1999 of approximately $880 million, which in turn was based on a conceptual design of a wastewater system, without taking into account the actual length and route of the tunnels, the actual cost, or inflation. Cost estimates released in 2004, when the project design was 30 percent complete, established a higher budget baseline that accounted for actual design and siting choices, as well as inflation for materials and labor. Using these updated figures, the total Brightwater project has exceeded its baseline budget by, at most, 24 percent.[14]

A portion of the cost overruns may be attributed to the tunneling, which has proved more difficult and time-consuming than expected. Currently, the two tunneling

machines deployed to construct the Central Tunnel are stopped underground where they await repairs. (The first machine was idled in May 2009, the second in June 2009.[15]) If the repairs proceed according to plans, one of the machines will again be operational this autumn, while the second machine may not be restored to service until December or later.[16] As of July 2009, King County was still estimating that the tunneling contracts had increased by only 3 percent beyond their initial amount, although the same report showed that only one of the four tunnels had been completed.[17]

The West Tunnel was 63 percent completed, while the Central Tunnels—with immobilized boring machines—are 49 percent and 66 percent completed, respectively.[18] It remains to be seen whether the repairs, delays, or other factors will result in future price increases—and who will pay for the almost inevitable further cost overruns.

Because the Brightwater tunneling project is not finished—and because a firm timeline for completion cannot be established—it is impossible to accurately determine the amount by which project's actual costs may exceed its initial estimates.[19]

Lessons for the Highway 99 deep-bore tunnel in Seattle

The bored tunnel that has been proposed to replace Seattle's Alaska Way Viaduct would be 1.7 miles in length, 52 feet in diameter, and travel between 60 and 200 feet under the surface of downtown.[20] State officials estimate that the tunnel will cost a little more than $1.9 billion and be completed by 2015. In addition to the deep-bore tunnel, the Alaska Way replacement project includes other elements, including replacing the waterfront seawall, replacing a southern portion of the viaduct in its current location, reconfiguring streets, and making improvements to Seattle's waterfront and to transit service in the area. The total price tag for the project is estimated to be $4.2 billion.[21]

Tunnel proponents have argued that the deep-bore tunnel is unlikely to exceed its estimated costs because the estimates are already padded by 22 percent to account for unforeseen problems.[22] On the other hand, the deep-bore tunnel cost estimates are based on a very early design stage—much earlier than the initial costs used in the tunneling projects analyzed here. The deep-bore tunnel project's costs were first estimated when the project's design was considered only 1 percent complete. Today, the project is considered to be 5 percent designed, but the state has declined to release updated cost estimates until it is 15 percent designed.[23] Also, the geology of the deep-bore site varies from soft soils to hard and dense soils, making it more difficult to ascertain the risk of delays.[24] Additional hazards may arise from the difficulty of the site—near sea level, crossing a seismic fault zone, and underneath one of the densest urban areas in the western United States.[25]

There may also be cautionary lessons from the other tunneling projects. It may be tempting to believe that the deep-bore tunnel would prove to be as inexpensive as the Mount Baker Tunnel. But while the diameters of the tunnels are similar, other factors are dissimilar: the geology of Mount Baker was better understood at the time that cost estimates were made, and the waterfront tunnel would be more than 6 times as long as

the bored portion of the Mount Baker Tunnel.

Seattle's experience with the construction of the downtown bus tunnel—which occurred during the same time period as the Mount Baker expansion tunnels—may prove to be a more apt comparison. The bus tunnel project had to contend with the complexities of construction in the same dense urban environment as the deep-bore tunnel; and the tunnels are of similar length.

Other comparisons are also worrisome. For example, the Beacon Hill Tunnel exceeded its initial estimated costs by 30 percent, despite the fact that engineers were able to closely examine the site's geology in a test shaft, an advantage that the deep-bore tunnel estimates did not have.

Seattle's experience with cost overruns is not unique. Oxford University professor Bent Flyvbjerg published a study of 258 infrastructure megaprojects around the world. He found that 90 percent experienced cost overruns—and by an average of nearly 30 percent.[26]

Notably, the cost overruns included in Sightline's analysis are almost certainly conservative. They account for the contracted services deployed to construct tunnels, but they do not include a range of costs such as government staff time, overhead, project management, and other operations that are not directly included in the contracts. They also do not include financing costs.

Even a relatively small cost overrun in the downtown deep-bore tunnel could present a sizeable risk to Seattle taxpayers. The state legislation approving the tunnel includes an unusual caveat making local property taxpayers responsible for cost overruns on the state highway project:

"Any costs in excess of two billion eight hundred million dollars shall be borne by property owners in the Seattle area who benefit from replacement of the existing viaduct with the deep bore tunnel."[27]

There is a chance that the deep-bore tunnel and related projects would end up costing less than $2.8 billion, in which case Seattle taxpayers would face no additional liability beyond the roughly $900 million for which they are already responsible under a current funding agreement.[28] (The state specifically declined to provide any funding for relocating utilities or improving the seawall or waterfront promenade; and full funding has not yet been identified for the entire project.[29]) On the other hand, there is a chance that the project will exceed its estimated costs. A 25 percent cost overrun beyond the project's total price tag would saddle Seattle area property owners more than a billion dollars of new tax liability.

In a plausible worst-case scenario—if the deep-bore tunnel project were to exceed costs in the manner of the King County Brightwater project or Boston's "Big Dig"—then Seattle property owners could be faced with severely onerous demands for tax revenue.[30] It is unclear whether lawmakers would come to the aid of Seattle taxpayers. State transportation dollars are in much demand and legislators from elsewhere would likely want to keep the cost overrun burden where current law stipulates: on Seattle's property owners.

Endnotes

1. Robert Josephson HNTB, "7 Engineering Wonders: Transportation/Infrastructure: Tunnels Keep Traffic Flowing Out of Sight," Seattle Daily Journal of Commerce, September 12, 2007, http://www.djc.com/news/ae/11193032.html; and Rita Robison, abstract of "The Stacked Drift Tunnel," Civil Engineering -- American Society of Civil Engineers, volume 60, number 7, July 1990, pp 40-42, http://cedb.asce.org/cgi/WWWdisplay.cgi?9003383.

2. Robert Josephson HNTB, "7 Engineering Wonders: Transportation/Infrastructure: Tunnels Keep Traffic Flowing Out of Sight," Seattle Daily Journal of Commerce, September 12, 2007, http://www.djc.com/news/ae/11193032.html.

3. Washington Department of Transportation, "A World of Experience: Learning From Local and International Tunnel Projects," Alaska Way Viaduct and Seawall Replacement Program, May 2009, http://www.wsdot.wa.gov/NR/rdonlyres/51A0A12A-985C-4FF2-BED2-8F2B7B25226B/0/Tunnel_Experience_folio_May09.pdf.

4. Seattle Section of the American Society of Civil Engineers, "ASCE History and Heritage International Landmark Nomination for Lacey V. Murrow Memorial Bridge and Mount Baker Ridge Tunnels," August 23, 2007, http://www.seattleasce.org/committees/hh/LaceyBridgeReport.pdf; and Larry Lange, "Will Property Owners Be Stuck With Viaduct Overruns?" Seattle PostGlobe, May 18, 2009, http://seattlepostglobe.org/2009/05/18/will-property-owners-be-stuck-witn-viaduct-overruns.

5. Ron Sims, "King County Executive Ron Sims' Address to the Northwest Regional Conference of the American Underground Construction Association," March 19, 2001, http://www.metrokc.gov/exec/speeches/031901.htm.

6. US Federal Transit Administration, "Contractor Assessment Report," September 2007, http://www.fta.dot.gov/documents/CPAR_Final_Report_-_2007.pdf. FTA published several estimates of the cost-overruns for the downtown Seattle bus tunnel using different points in the project's history as a benchmark to compare to the actual cost. Depending on which benchmark is used, the project exceeded its budget by between 17.2 percent and 63 percent. The most relevant of these figures to the proposed deep-bored tunnel is 56.5 percent because this figure relies on the most even-handed method of accounting for inflation costs and because it uses as a benchmark the cost estimate included in the draft environmental impact statement, rather than estimates developed later when more engineering information was available. (By comparison, the proposed deep-bore tunnel is has not yet been sufficiently designed to allow even for the completion of a draft environmental impact statement.) This analysis does not include the recent retrofit to make the tunnel serviceable for Sound Transit light rail.

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8. Sound Transit, "Beacon Hill Station and Tunnel," Fact Sheet, June 2008, http://www.soundtransit.org/Documents/pdf/projects/link/central/BeaconHill_Fact.pdf.

9. Mike Lindblom, "Light Rail Estimates Are $41 Million Short, But Money Is Still There," Seattle Times, May 14, 2004, http://community.seattletimes.nwsource.com/archive/?date=20040515&slug=tunnel15m; and Jane Hadley, "Sound Transit Suffers More Sticker Shock," Seattle Post-Intelligencer, May 15, 2004, http://www.seattlepi.com/transportation/173504_transit15.html.

10. Sound Transit, "Progress Report: Link Light Rail," August 2009, p. 17. Sound Transit's

archived progress reports are online here: http://www.soundtransit.org/News-and-Events/Reports/Agency-Progress-Report.xml; this report is not yet posted online but was emailed from Jennifer Lemus, Community Outreach Specialist, Sound Transit – Link Light Rail.

11. More than any other project in this comparison, the inclusion of Brightwater is a judgment call. The Brightwater tunnels are much longer and deeper than the other tunnels being compared here, but the tunnel tunnel-boring technology is similar to what is proposed for the Seattle deep-bore tunnel. Other sewage conveyance tunnels have been constructed recently in the Seattle area, most notably the Mercer Street Sewer Tunnel, which was completed at 23 percent below the engineer's estimated cost. Yet the Mercer Sewer used a different kind of tunneling technology. (See Washington Department of Transportation, "A World of Experience: Learning From Local and International Tunnel Projects," Alaska Way Viaduct and Seawall Replacement Program, May 2009, http://www.wsdot.wa.gov/NR/rdonlyres/51A0A12A-985C-4FF2-BED2-8F2B7B25226B/0/Tunnel_Experience_folio_May09.pdf.)

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13. Scott Gutierrez, "New Sewage Treatment Plan Behind Schedule and Over Budget," Seattle Post-Intelligencer, May 20, 2009, http://www.seattlepi.com/local/406434_brightwater21.html; and Keith Ervin, "How Brightwater Soared to $1.8 Billion – and Why You're Paying More," Seattle Times, March 31, 2008, http://seattletimes.nwsource.com/html/localnews/2004316832_brightwaternew31m.html.

14. King County Wastewater Treatment Division, "Brightwater Cost Update: Current Conditions and Trends," January 2009; and email exchange with David Freed, Brightwater Community Relations.

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17. King County Wastewater Treatment Division, "Brightwater Treatment System: Monthly Project Report," July 2009, p. 18.

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19. Keith Ervin, "Brightwater To Open In 2011 Without Tunnel," Seattle Times, August 15, 2009, http://seattletimes.nwsource.com/html/localnews/2009665476_brightwater15m.html.

20. Washington Department of Transportation, "Alaska Way Viaduct and Seawall Replacement: Learning From Other Tunnel Projects," http://www.wsdot.wa.gov/Projects/Viaduct/

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21. Washington Department of Transportation, "Alaska Way Viaduct and Seawall Replacement: Commonly Asked Questions," http://www.wsdot.wa.gov/Projects/Viaduct/Questions.htm.

22. Washington Department of Transportation, "Bored Tunnel Cost Estimate," http://www.wsdot.wa.gov/Projects/Viaduct/TunnelCostEstimate.htm.

23. Washington Department of Transportation, "Bored Tunnel Cost Estimate," http://www.wsdot.wa.gov/Projects/Viaduct/TunnelCostEstimate.htm.

24. Washington Department of Transportation, "Alaska Way Viaduct and Seawall Replacement: Learning From Other Tunnel Projects," http://www.wsdot.wa.gov/Projects/Viaduct/othertunnelprojects.htm.

25. Washington Department of Transportation, "Alaska Way Viaduct and Seawall Replacement: Bored Tunnel and Waterfront Tunnel Comparison," http://www.wsdot.wa.gov/Projects/Viaduct/tunnelcomparison.htm.

26. Danny Westneat, "Tunnel's Cost May Fool Us All," Seattle Times, April 26, 2009, http://seattletimes.nwsource.com/html/dannywestneat/2009123442_danny26.html; Bent Flyvberg, "From Nobel Prize to Project Management: Getting Risks Right," Project Management Journal, August 2006, http://flyvbjerg.plan.aau.dk/Publications2006/Nobel-PMJ2006.pdf;

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29. Washington State Legislature, "Certificate of Enrollment: Engrossed Substitute Senate Bill 5768," 61st Legislature, 2009 Regular Session, http://www.leg.wa.gov/pub/BillInfo/2009-10/Pdf/Bills/Senate%20Passed%20Legislature/5768-S.PL.pdf.

30. Boston's "Big Dig" was estimated to have exceeded initial cost estimates by 265 percent according to Seth Stern, "$14.6 Billion Later, Boston's Big Dig Wraps Up," Christian Science Monitor, December 19, 2003, http://www.csmonitor.com/2003/1219/p02s01-ussc.html. By many media accounts, the cost of the total Brightwater project – including a conveyance system for transporting sewage underground, the construction of a new wastewater treatment facility, and a few smaller items – has exceeded its initial estimates by more than 100 percent. See, for example, Scott Gutierrez, "New Sewage Treatment Plan Behind Schedule and Over Budget," Seattle Post-Intelligencer, May 20, 2009, http://www.seattlepi.com/local/406434_brightwater21.html; and Keith Ervin, "How Brightwater Soared to $1.8 Billion – and Why You're Paying More," Seattle Times, March 31, 2008, http://seattletimes.nwsource.com/html/localnews/2004316832_brightwaternew31m.html.

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