SOUNDTRANSIT

ST3 COST ESTIMATE & GENERAL ASSESSMENT SERVICES

TASK 2: Final Report of Review and Analysis of Cost Estimating Methodology

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INTRODUCTION

In January of 2021 estimates were provided to the Sound Transit Board of Directors (Board) indicating substantial increases in the cost to complete the ST3 expansion program. These increases, combined with reduced revenues because of COVID-19, could require adjustment to the original timelines for completion of ST3 unless there are alternative revenue sources.

Through a realignment process and after gaining input from the public and partner organizations, the Board will establish clear expectations about updated project delivery timelines.

To confirm affordability of the ST3 plan the Board retained a team led by Triunity, Inc. with team members Ott-Sakai & Associates, LLC, Commonstreet Consulting, Capo Projects Group, and Arcadis (Assessment Team) to perform an independent review and analysis of four of the ST3 projects: West Seattle and Ballard Link Extensions (WSBLE), Tacoma Dome Link Extension (TDLE), Operations and Maintenance Facility South (OMFS) and Bus Rapid Transit (BRT) program.

The assessment is performed on the ST3 (2016), the Phase 1 (2019) and Phase 2 (2020) cost estimates.

This independent review is comprised of three tasks with a report to the Board as a deliverable for each of the tasks:

- **Task 1:** Review, analysis, and preparation of an independent assessment of the cost estimate trends for specific ST3 capital projects.
- **Task 2:** Programmatic review and analysis of the agency's cost estimating methodology used to develop the ST3 construction and real estate estimates.
- **Task 3:** Review of and recommendations for the WSBLE management methodology.

This report is the deliverable for **Task 2.**

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TABLE OF CONTENTS

1.0 – EXECUTIVE SUMMARY

This report is the deliverable for the second of three tasks in the Cost and General Assessment reports to the Sound Transit Board of Directors (Board).

The first deliverable provided a review, analysis, and preparation of an independent assessment of the cost estimate trends for specific ST3 capital projects: West Seattle and Ballard Link Extensions (WSBLE), Tacoma Dome Link Extension (TDLE), Operations and Maintenance Facility South (OMFS) and Bus Rapid Transit (BRT) program. This Task 2 deliverable is focused on the programmatic review and analysis of the agency's cost estimating methodology used to develop the ST3 construction and real estate cost estimates.

As discussed in the previous Task 1 report, Sound Transit has observed significant upward trends in the cost estimates between the original ST3 Plan and the most recent Phase 2 updates. After review of the methodologies used to create these estimates, the Assessment Team has developed both key takeaways as to why the costs increased so rapidly, as well as recommendations which can be utilized as preventive measures for future estimates. Due to the vast methodology differences between construction cost estimating and right-of-way (ROW) cost estimating, those methodologies have been separated for clarity throughout the report.

Table 1.0 below references the cost estimates previously presented to the Board for the four projects (I-405 BRT, SR-522 BRT and Bus Base North are considered one project for the report) at the various stages of development.

Table 1.0 – Previous Cost Estimates Presented to Board

Project	*ST3 Plan (2016)*	*Phase 1 (2019)*	*Phase 2 (2020)*
WSBLE	$7,094M	$7,929M	$12,103 - $12,581M[1]
TDLE	$2,431M	$2,999M	$3,308M
OMFS	$649M	$759 - $1,366M	$1,167 – 2,424M[2]
I-405 BRT (BRT Program)	$1,037M	$1,088M	$1,016M
SR-522 BRT (BRT Program)	$481M	$658M	$544M
Bus Base North (BRT Program)	$191M	$208M	$238M

Note: The numbers in the table above are based on 2019 dollars. Since the actual expenditures will happen after 2019 the dollar amounts adjusted for inflation will be greater than those shown.
1 – range reflects the two elevated preferred alternatives in Alaska Junction
2 – range reflects the three preferred alternatives at S. 344th St, S 336th St, and Midway Landfill

1.1 Key Takeaways

The Assessment Team found the methodology set forth in Sound Transit's Project Control Policies and Procedures (PCPP), PCPP-02 Cost Estimating, is mature and complete. It appears all construction cost estimates followed the same methodology for all estimate phases. To clarify, the two fundamental costing elements (quantities and unit price) did not stay the same, but the overall approach was consistent for all estimate phases.

What is unclear is why the full potential of the methodology was not utilized in early design. For example, PCPP-02, Section 5.5 discusses the option and/or need for a second opinion cost estimate for projects that are highly complex or have greater risk. These estimates are intended to be procured to an independent cost consultant whose second opinion is used to validate the cost estimate. It is understood that an Expert Review Panel (ERP) did perform an assessment on the original ST3 cost estimates, but their focus was on estimating process more than it was accuracy of the individual estimates. Due to the nature and complexity of the projects making up the ST3 program, a thorough review of the estimate accuracy is recommended even at the earliest design stage.

Furthermore, PCPP-02, Section 8.2 states the Real Estate division is responsible for developing the appropriate estimates for the ROW budget based on the alignment and footprint established by each project team. After discussions with various members of Sound Transit (ST) staff, the Assessment Team found that the working relationship between the Real Estate division and the design consultants who developed the original ST3 estimates was inadequate. Guidelines were set by ST in advance of the estimate development without specific project elements being analyzed. If the Real Estate division had been more involved in these original ST3 estimates, it is the Assessment Team's expectation that the accuracy would have been substantially improved.

Based on the methodology review, the Assessment Team has identified the eight (8) biggest drivers contributing to why the cost estimates saw over $6 billion of increases from ST3 to the current Phase 2 estimates. These drivers are listed below, generally in the order of greatest contributor to least. Table 1.2 includes a rough order of magnitude (ROM) percentage that each driver contributed toward the total increase of the overall cost estimates. Please note that the percentages shown are an opinion of the Assessment Team and not an exact quantification. In fact, some of the drivers are not quantifiable and the percentages could be viewed as subjective.

1. Inaccurate original assumptions for major design elements such as stations, foundations, storm water requirements and sitework were contributing factors to cost increases from ST3 to Phase 2. The use of a robust analysis from ST's programmatic design team appeared absent based on various interviews with ST staff.

2. Utilization of a ROW methodology that employs a formulaic approach that is repeatable and can be applied consistently to a wide variety of projects and alternatives. This formula contains many inputs including contingency and was updated to reflect current market conditions throughout the estimate phases.

3. The use of a "buffer method" for defining preliminary ROW impacts instead of a properly defined project footprint that evaluated ROW requirements in light of construction needs.

4. A dynamic real estate market with rapidly rising property values and the redevelopment of lower density uses to higher density uses.

5. Updates to ST's Unit Cost Library (UCL) to more reasonable units. Areas contributing as large cost drivers were bridge and tunnelling cost per route foot and vertical conveyance (i.e., elevators). It appears ST updated these units based on similar projects in lieu of escalating older information that was previously utilized.

6. The rigid nature of the estimate practices. For example, environmental costs were originally captured using high, medium, and low-cost allocation per route foot of the alignment. While having a system in place to ensure these items are not overlooked is important, it also creates an environment where an outside opinion from the design consultant performing the estimate appears unnecessary.

7. ROW Ownership was not utilized to the extent it should have been due to the primary focus being on ST2 projects that were going on at the same time.

8. Second opinions were not utilized to the extent they should have been. ERP approved methodology but did not perform an in-depth assessment on the accuracy of the cost estimates that could have identified inaccuracies earlier than what were presented.

Table 1.2 ROM Estimated Percentage of Impact

Category	Driver	Estimate Impact (%)
Construction	**Inaccurate Original Assumptions**	40%
ROW	**ROW Formula (including contingency)**	20%
ROW	**ROW Quantities (buffer method)**	20%
ROW	**Market conditions (as pertains to real estate)**	10%
Construction	**Unit Cost Library Updates**	10%
Construction	**Prescriptive Estimating Practices***	N/A
ROW	**ROW Ownership***	N/A
Construction	**Second Opinions***	N/A

** Driver is not quantifiable.*

Each of these key takeaways will be expanded on in this report in the following format:

a. Methodology Comparison – Comparison between the agency's cost estimating methodology and standard industry practices, with identification of potential gaps.

b. Recommendations for Methodology Adjustments – Recommendations for how to adjust the estimating methodology for the early planning stages of project development.

c. Recommendations for Roles and Responsibilities – Recommendations for how the agency could adjust cost estimating roles and responsibilities for consultants, contractors, and/or staff.

d. Recommendations for ROW & Contingencies – Recommendations for managing ROW and other contingencies through design development.

All recommendations for opportunities are summarized in Appendix A.

2.0 – METHODOLOGY COMPARISON

2.1 Current Policies and Procedures at Sound Transit

ST's Program Control Policies & Procedures (PCPP) defines the standard practices and responsibilities for developing, reviewing, updating, and approving cost estimates for the agency. Typically, the design consultant is responsible for the development of construction cost estimates during the design phase. Design packages and corresponding estimates are identified as specific deliverables in design contracts. The level of detail in a construction cost estimate reflects the current level of design development.

As defined in the PCPP, before starting the construction cost estimate, a Cost Estimating Methodology Report (CEMR) is to be developed. That CEMR is to be reviewed and accepted by ST. All construction cost estimates are priced in current year dollars. Escalation to year-of-expenditure (YOE) is to be done in accordance with the corresponding project schedule and the cost indices approved by the ST Finance Division. Appropriate levels of contingencies are applied to the construction cost estimates.

To ensure that costs are reasonable, and that the scope of work is completely covered, the PCPP requires that deliverables for each milestone be reviewed and signed by the following key members of the project team including:

- Lead ST Cost Engineer (ST-CE)
- ST Project Control Lead (PCL)
- Engineering Lead (e.g., Corridor Design Manager)
- Project Director (PD) or Project Manager (PM)
- Independent Outside Reviewer (optional)
- Program Manager Cost Engineering (PM-CE)
- Director of Scheduling, Estimating, Risk & Value Engineering (D-SERVE)
- Deputy Executive Director Project Control & Value Engineering (DED-PC & VE)
- Executive Director (ED)

For projects that are highly complex or have greater risk, ST may procure the services of an independent cost consultant to provide a second opinion to validate a cost estimate submitted by the designer or other consultants.

As defined in the PCPP, the Real Estate division is responsible for developing the appropriate estimates for the ROW budget for each Project based on the alignment and footprint established by the project team. This includes the determination of the actual real estate costs, the appropriate relocation and settlement costs, administration costs, as well as contingency costs. The Real Estate division has established formulas for calculating these components of the estimate. These have been utilized by ST for many years on a wide range of projects and have historically produced generally successful results, according to agency staff. The Phase 2 ROW Basis of Estimate (BOE) for the WSBLE project, produced in December 2020, describes the general methodology as follows:

"Property values are estimated based on land-use type, location and a market-based adjustment of assessed values, as well as alignment profile. Sound Transit appraisers and ROW engineers developed appropriate factors to determine property values relative to the assessed value and then applied a ROW contingency to account for administrative costs, unknown property conditions, relocations etc.

The Cost estimating formula is summarized as follows:

*[% of property being acquired * Assessed property value * Real estate adjustment factor * Profile factor] + ROW contingency."*

2.2 Identification of Potential Gaps

2.2.1 Construction Overview

Based on review by the Assessment Team, it appears all construction cost estimates followed the same methodology throughout each of the three estimate phases referred to as ST3, Phase 1, and Phase 2, except for minor variations occurring on a case-by-case basis.

Generally, the design consultant develops the quantities for each project and utilizes ST's Unit Cost Library (UCL) to generate the estimate. Estimators (primarily consultants) are estimating what is shown on the design documents that are available at the time the estimate is performed. If project teams advance design and those documents change, the updated estimates reflect those changes. This happened frequently in the period from the original ST3 ballot estimates to the latest Phase 2 estimates and in this case caused substantial cost increases to the estimates. Further, estimators are constrained to using ST's UCL, which could present challenges to certain firms depending on the processes they already have in place, as well as their overall familiarity with ST's system.

Another area that the Assessment Team believes caused some of the estimate cost increases is the prescriptive nature of the estimate practices. For example, environmental costs were originally captured using high, medium, and low-cost allocation per route foot of the alignment. While having a system in place to ensure these items are not overlooked is important, it also creates an environment where an outside opinion from the design consultant appears unnecessary, which has the potential to lead to estimate shortfalls. This holds true for areas of the estimate such as vertical conveyance where estimators assign quantity only to a provided unit rate that could be inaccurate.

2.2.2 Original Design Assumptions

Inaccurate original assumptions for major design elements such as stations, foundations, stormwater requirements, and sitework were contributing factors to cost increases from ST3 to Phase 2. The use of a robust analysis from ST's programmatic design team appeared absent from the original ST3 estimates based on various interviews with ST staff. The integration of input from the programmatic level design team and ST executives on decisions involving substantial cost is best practice and encouraged by the Assessment Team. These now known major cost drivers should be documented and discussed with substantial involvement from the programmatic level design team on future projects.

2.2.3 Unit Cost Updates

An area that changed from the original ST3 estimates to the current Phase 2 estimates is updates in the UCL. Areas contributing as large cost drivers were bridge and tunnelling cost per route foot and vertical conveyance. It appears ST updated these units based on similar projects in lieu of escalating older information that was previously utilized. Although this method led to substantial cost increases, particularly in WSBLE, this two-tiered approach is considered a best practice by the Assessment Team and was a major contributor to improvements in the Phase 2 estimates that were validated in Task 1.

2.2.4 Environmental

The UCL uses low, medium, and high-cost allocations for both hazardous waste and environmental mitigation. The approach of using a low, medium, or high without analysis potentially creates a situation where estimators are allotting dollars without a thorough understanding of where the dollars will be used. It is best practice for the estimate to be transparent regarding what is included in the unit price in the form of an assembly or other descriptive item. This allows the design team to confirm or question the proper allocation of funds. For example, dump fees for contaminated waste are $90/CY and $400/CY for dangerous waste. Using this information, the estimator can specify what each low, medium, and high category covers in costs, such as low category buys 'X' number of cubic yards per

route foot, etc. Other examples can include historical cost data based on previously experienced cost impacts found on ST2.

2.2.5 ROW Overview

Real estate estimates are also generated by the design consultants, however, tighter methodology requirements exist. In the early planning estimates (ST3 and Phase 1), quantities were created utilizing a buffer method that had been recognized as an appropriate methodology at ST based on previous projects. Next, the prescribed ROW cost estimating formula gets applied with relative consistency across all projects. As will be discussed in the following paragraphs, the success of this method relies upon the predictable behavior of statistically aggregated data rather than on the accurate estimation of property-specific data. In other words, while the estimate for any given property may be individually inaccurate, the overall estimate may be accurate if the data, as a whole, conforms to the statistical parameters applied. The obvious benefit of the formulaic approach is its consistency and repeatability. Potential pitfalls of this approach, however, are the oversimplification of complex property issues and the risk that statistical outliers may grossly skew the data, particularly in the case of high-value properties in dense urban corridors (i.e., WSBLE).

2.2.6 Percentage of Property Being Acquired

The first step in the application of the ROW cost estimating methodology is to determine the percentage of the property that is being acquired. This is accomplished through the review of available design plans, in conjunction with area calculations provided by the ROW engineering team. Based on certain standard assumptions combined with the judgement of an analyst, a determination is made as to whether the proposed acquisition results in a full-take or a partial-take. If the acquisition is deemed a full-take, 100% of the total property area is used; if deemed a partial-take, the percentage for acquisition is the take area divided by the total property area. This is consistent with industry standard practices used by agencies and cost estimators across the country and warrants no further discussion.

2.2.7 Assessed Property Value

The next step is to multiply the percentage of the property being acquired by the assessed property value. The assessed value is determined by the County Tax Assessor, based on the annual analysis performed by appraisers working for the County. In Washington, properties are assessed by law at market value, so, in theory, a property's assessed value should be equal to its market value. However, in practice, it is widely known that properties do not often transact at their assessed value. To account for this, ST developed a real estate adjustment factor, which will be discussed further in Section 2.2.8.

Since not all areas within the same property necessarily have equal values there is still an inherent risk to over or understate the value of the acquisition when simply multiplying the assessed value by the percentage of the property to be acquired. For example, a portion of a property that is encumbered with various existing easements may have a lower acquisition value than an unencumbered portion, all else being equal. Similarly, a proposed acquisition that places limitations on some essential functionality of the property, such as parking or access, may have a proportionally greater value impact than simply its pro rata unit value. In other words, not all acquisitions impact properties equally, and the flaw with this approach is the lack of analysis to specific property impacts. This is presumably accounted for in the general ROW contingency, which is discussed in greater detail in the sections below. However, the Assessment Team believes a contingency will not accurately predict actual severance damages for a given parcel. These should be assessed by qualified appraisers or ROW professionals as required by ST's recommended existing procedure.

2.2.8 Real Estate Adjustment Factor

As previously stated, a property's assessed value is rarely equal to its market value in actual practice. ST's ROW methodology rightly recognizes this fact and applies a real estate adjustment factor to the assessed value. The factor, developed by ST appraisers and regularly updated, is determined by comparing actual market-based sales of

properties with the assessed values of those same properties. Multiple factors are developed to account for property type and locational characteristics. As may be expected, the comparison of assessed values to market transactions yields a wide range of factors, which are then averaged to arrive at a single adjustment factor that is applied to a given property type in a particular location. As with all statistical analysis, the predictive capabilities are dependent on the application of the formula to a large enough sample and population size. A major risk of this approach, with relevance to the WSBLE corridor, is that a very high-value property may not be accurately represented by the uniform adjustment factor and, consequently, could drastically skew the result in either direction.

In contrast, standard valuation techniques include the Sales Comparison approach, whereby a property is valued by comparing sales of similar properties to a subject property; the Income approach, whereby a property's net operating income is capitalized to arrive at a value; and the Cost approach, wherein the depreciated cost of improvements is added to the land value. The application of one or all of these valuation principles is much more likely to produce a credible cost estimate than the application of a uniform adjustment factor and is recommended. For example, Washington State Department of Transportation's (WSDOT) "true cost estimate" format that is used by local public agencies starts with the assessed value as well. However, WSDOT's methodology requires the user to apply a confidence factor to the assessed value, which essentially allows them to "back in" to an estimated value using more traditional valuation methodologies.

2.2.9 Profile Factor

The next step is the multiplication of the previous product by a profile factor, corresponding to the profile of the alignment on a given property. According to the Phase 2 ROW BOE for the WSBLE project, the profile factors utilized, with some minor adjustments for certain considerations, were as follows:

- *At-grade* *1.00*
- *Cut-and-cover tunnel* *1.00*
- *Construction staging* *1.00*
- *Elevated* *0.75*
- *Shallow tunnel (<70 feet) easement* *0.65*
- *Deep tunnel (>70 feet) easement* *0.05*

These factors were developed based on historical appraisal and actual acquisition data from previous projects and are considered reasonable and appropriate. They do not differ from standard industry practices and warrant no further discussion.

2.2.10 ROW Contingency

In the final step of the ST ROW cost estimating methodology, a contingency is added to the previous product to arrive at a total estimate. The contingency accounts for administrative costs, relocation, temporary construction easements (TCEs), changes in market conditions and other unknowns or potential changes. Although the contingency is added on a "per parcel" basis, the methodology acknowledges that it is intended to be understood as applying to the aggregate, rather than any individual parcel. The Phase 2 ROW BOE for the WSBLE project states the following:

"The Administrative costs, Relocation, and TCEs markups are not meant to be the estimated value of these costs of any particular parcel where these markups are applied to. The costs of these elements for individual parcel would require further investigation of the property and would vary based on the complexity and unique circumstances of individual parcel. Due to the lack of design definitions at this stage, these markups are used as a way to account for the 'known-unknown' administrative, relocation and TCEs costs for the project. These markups should be viewed as a lump sum dollar amount in the cost estimate that would be utilized to account for known-unknown costs for the entire project—not individual parcel."

In the case of the WSBLE project for example, a 75% contingency was applied to the project, encompassing 15% for administrative costs; 20% for relocation; 5% for TCEs; 5% for market conditions, and 30% for unknowns/changes. According to agency staff, the components of the contingency are based on actual data from previous ST projects. The Assessment Team was not provided with the historic data and therefore, was unable to independently verify this. If the percentages are, in fact, based on typical ST project data, then it appears that the contingency could be considered reasonable. With that being said, the contingency factor is much larger than what is typical for standard industry practices, which involve estimating the individual components to the greatest extent possible. It should be noted that relocation costs have no direct correlation to the price of real estate, and that all projects are unique in terms of their impacts and characteristics. The percentage of one of these components, relative to real estate costs, may be substantially different in a rural or suburban environment than it is in a high-density urban environment.

3.0 – RECOMMENDATIONS FOR METHODOLOGY ADJUSTMENTS

3.1 Process and Procedures

The Assessment Team believes the methodology set forth in ST's PCPP-02 Cost Estimating, is mature and complete. What is unclear is why the full potential of the methodology was not utilized in the original ST3 estimates. PCPP-02, Section 5.5 discusses the option and/or need for a second opinion cost estimate for projects that are highly complex or have greater risk. These estimates are intended to be procured to an independent cost consultant whose second opinion is used to validate the cost estimate. It is understood that an ERP did perform an assessment on the original ST3 cost estimates, but their focus was on estimating process more than it was accuracy of the individual estimates. Due to the nature and complexity of the projects making up the ST3 program, executing this option is recommended even at the earliest design stage.

Regarding the original ROW estimates, PCPP-02 Section 8.2 states the Real Estate division is responsible for developing the appropriate estimates for the ROW budget for each project. After discussions with various members of ST staff, the Assessment Team believes that the working relationship between the Real Estate division and the design consultant developing the estimates was inadequate. Guidelines were set by ST in advance of the estimate development without specific project elements being analyzed. If the Real Estate division were the true responsible party for these estimates, it is the Assessment Team's expectation that the accuracy would have been substantially improved.

The Assessment Team believes large programs should have a reporting structure that involves continually refining project cost estimates as scope definition improves and project configuration progresses. At a minimum, all program components should be thoroughly evaluated on an annual basis. A consistent reporting format should be developed to show the growth/reduction of cost estimates such that the overall program cost can be easily summarized and communicated to leadership and program stakeholders. An explanation of the individual project stage, how the estimate was prepared, how contingency was applied, etc., should be included for each project. Discussion of primary risks and any relevant assumptions should be reported. A consistent escalation strategy and application to all relevant estimates should be addressed.

3.2 Opportunities to Move Best Practice Forward (into early design)

The Assessment Team found that there is an opportunity to utilize existing resources to improve early design estimates. Adding additional line items from similar past projects to take into account the predictable known risks is one area. This can be established through workshops that include vast participation from Operations. It is understood that some of these workshops do exist, however, a more targeted and robust utilization of these events is recommended, something that should be defined in a Program Management Plan. Once additional items are discovered, these should be added to the UCL creating a menu list of items that cannot be easily overlooked when generating early design estimates. In addition to Operations, program level design team oversight in planning is another area that could substantially increase the accuracy and help to control cost of early design estimates. Through various interviews with ST staff, it appears the newly formed Portfolio Services Office (PSO) may be enacting this.

3.3 Unit Cost Library Utilization

As indicated previously, ST and their consultants use an internal estimating database known as their UCL to perform estimating functions. The UCL is managed and updated internally by ST staff. The Assessment Team found the database to be well developed and robust in comparison to industry peers. However, to increase independence it is recommended that a second estimate, or validation assessment be performed outside of the already established UCL to vet for accuracy.

3.4 Environmental Future Code Changes

Long duration project planning requires cost planning beyond escalation. Pricing adjustments to the UCL may require the need for adjustments for code changes and line items for adjustments from 2014 to 2021. In addition, the need for future unknown changes regarding more stringent codes may be required. Many times, code changes can be seen as scope change or scope creep. Examples include:

- *Code changes do not incorporate into the UCL from 2014 to 2021 – low impact development impacts to ST projects and storm water changes.*
- *Change in environmental regulation from the Trump administration to Biden administration.*
- *Structural Code changes:*
  - *https://www.hartcrowser.com/2019/11/12/a-seismic-shift-in-the-international-building-code/*
- *Polyfluoroalkyl Substances Code changes:*
  - *https://www.epa.gov/pfas/epa-actions-address-pfas*

3.5 ROW

As discussed previously, ST staff has stated that the existing ROW cost estimating methodology has produced results that have been generally reliable on past projects. However, the WSBLE project, with its complex acquisitions of high-value property situated in a densely populated urban environment, demonstrated that this methodology may not work equally well for every project. The ROW budget increased over 300% from the ST3 Plan (2016) to Phase 1 (2019), and over 300% again between Phase 1 (2019) and Phase 2 (2020), the specific causes of which have been discussed at length in a previous report. The Assessment Team has the following recommendations for adjusting the estimating methodology, when dealing with high property values in dense urban environments.

3.5.1 Implement a market-based approach to property value

The weaknesses of the {assessed value * adjustment factor} approach have been discussed above, but bear repeating here. Namely, assessed values are rarely equal to market values in practice, and while a uniform adjustment factor may prove to be useful from a statistical perspective, it cannot be expected to be reasonably accurate for property-level analysis. Instead, analysis relying on commonly accepted valuation principles like the Sales Comparison approach, Income approach and Cost approach, will be much more likely to provide accurate estimates of property values. This is not to say that every property requires a full appraisal or an overly complicated analysis in the early planning stages, but rather that spending time to deal with the complexities of a particular parcel will yield more accurate and beneficial results than simply applying an average multiplier.

3.5.2 Involve specialists early in the process

To implement the first recommendation above, it will be necessary to involve discipline-related specialists early in the process and allow them to contribute in a meaningful way. Involving specialists, such as appraisers, real estate consultants, relocation experts, property managers and environmental professionals would provide specific analysis pertaining to severance damages, relocation costs and other factors, as appropriate, that would lead to more precise parcel-level estimates. The natural result of this would be a more accurate overall estimate, which in turn, would lead to a higher degree of overall confidence and minimization of excessive contingencies.

To some degree, ST already recognizes the merits of this approach. This is evidenced by the fact that appraisers were brought in on the WSBLE project to reevaluate property needs, albeit after the costs had already substantially increased. The OMFS team also applied this approach on the Phase 2 estimates for the three site alternatives. In each alternative, estimators deviated from the methodology on certain high value properties, resulting in the development of a more refined and reliable cost estimate.

Another benefit of a specialized approach to the ROW estimate is that the individualized estimates would allow a project team to focus more attention on the challenging parcels and provide early opportunities to modify design elements or develop mitigation strategies to reduce impacts.

3.5.3 Incorporate construction/constructability impacts into ROW analysis

Although much has been said in a previous report about the use of the buffer method for estimating ROW impacts on the WSBLE project in contrast to the use of an established project footprint, the impact this had on ROW costs cannot be overstated. Indeed, the use of an actual project footprint in the Phase 2 estimate, with a more accurate understanding of construction/constructability impacts, accounted for a $1.4 billion increase (not including TCEs) from the Phase 1 estimate, which relied solely on the buffer method. The unique construction challenges of the WSBLE project, including elevated structures and tunnels within the confines of a high-density urban environment in one of the strongest real estate markets in the country, are not applicable to every project, and the cost risks are exaggerated in comparison to other potential projects. Nevertheless, this extreme recent example illustrates the need to incorporate constructability impacts as early as possible.

3.5.4 Limit ROW contingency to actual unknowns

The ROW contingency, which is added as the final step of the ROW cost estimate, accounts for administrative costs, relocation, TCEs, changes in market conditions and other unknowns or potential changes. As previously stated, the contingency is applied on a "per parcel" basis but is meant to apply to the estimate on aggregate, rather than to indicate specific uncertainties on a given parcel. The Assessment Team recommends limiting the contingency to actual unknowns and estimating the other components separately.

A true contingency is meant to account for some degree of uncertainty, which appears to be what is rightly captured under the "unknowns/changes" category accounting for 30% of the total amount. Similarly, the 5% market change factor is also reasonable, in principle, although it may be noted that actual property values increased between 5% and 12% per year between 2016 and 2020, depending on property type, and more care should be taken when analyzing a real estate market as dynamic as Seattle over the past decade.

Relocation costs, however, have no direct correlation to property values and should be analyzed and estimated individually by a qualified professional. Relocation experts can provide reliable ballpark estimates for most property types based on their experience. This would result in a more credible cost estimate than the percentage method, which could either significantly over or understate the cost as a percentage of the real estate. Similarly, TCEs impacts cannot be properly quantified as simply a percentage of the total real estate estimate. In many cases, TCEs involve more complex issues than fee takings and should be estimated individually whenever possible. Even when design has not progressed to a point of specific final TCE configurations, it would be prudent to at least estimate TCE impacts from certain parameters based on reasonable engineering assumptions.

4.0 – RECOMMENDATIONS FOR ROLES & RESPONSIBILITIES

4.1 Roles and Responsibilities of Staff

To achieve uniformity and consistency within project and program level estimates it is important to follow sound cost methodology across all departments. Also, stronger efforts to utilize the talents of all departments are encouraged. As mentioned previously, ownership of the estimates needs to be clearly identified and followed. ST has the tools in place such as the matrix shown below in Figure 4.1. Refinement and follow through of these existing tools are recommended.

Figure 4.1 Estimating Responsibility Matrix

WBS ESTIMATE CATEGORY	AA to CE PHASE			PE through FD PHASE			
	LEAD	METRIC	RESPONSIBILITY	LEAD	PC	METRIC	RESPONSIBILITY
ADMIN	PC Lead	6% x ALL	**PCL LEAD** to provide "Top-Down" calc into Budget Estimate; with Construction value determined, use ST3 %'s to calculate the remaining WBS categories > **CONSULTANT** may be required to utilize ST Cost Estimate Summary Worksheet with these %'s already populated.	PM	PC Lead	Bottom-up	**PCL LEAD** to work with Divisions within DECM > Respective **DIVISION LEADS** to develop "Bottom-up" estimates > **PCL LEAD** to review and compare to historical data with SERVE support and then enter into Budget Workbook
PRELIMINARY ENGINEERING	PC Lead	5% x Const*		PM/DCM	PC Lead	Bottom-up	
THIRD PARTY	PC Lead	2% x Const*		PM	PC Lead	Bottom-up	
FINAL DESIGN/ DSDC	PC Lead	10% x Const*		PM/DCM	PC Lead	Bottom-up	
CONSTRUCTION MANAGEMENT	PC Lead	9% x Const*		CM	PC Lead	Bottom-up	
RIGHT OF WAY (ROW)	PC Lead	ROW Method	> **CONSULTANT** to provide Parcel Map(s) for alternatives, showing properties affected and indicating type of construction for affected areas > **ROW** to research Assessed values and determine Market Value based on information from Consultant > **PCL LEAD** to work with ROW to determine estimates: = Market Value x 1.75	ROW	PC Lead	Bottom-up (incl Relocation)	> **CONSULTANT** to provide Parcel Map(s) for alternatives, showing properties affected and indicating type of construction for affected areas > **ROW** to research Assessed values and determine Market Value based on information from Consultant > **PCL LEAD** to work with ROW to determine estimates: = Market Value x 1.75
CONSTRUCTION	SERVE/ Design Consult	ST3 Unit Cost Library (updated to Current Year $)	> **SERVE** provides ST3 Unit Cost Library ($2014/$2017-$2018) to Consultant for use in developing Cost Estimates > **CONSULTANT** to develop and submit "Top-Down" cost estimates using DBB method (any deviations to standard UCL values need to be noted and explained > In addition, **CONSULTANT** will develop UNIT COSTs for a typical or unique facilities with/PC SERVE support > **SERVE** estimators will Review and Comment on estimates > Final agreed upon Construction estimate will be added to Budget Estimate by **PCL LEAD**	SERVE/ Design Consult	SERVE/ PC Lead	Bottom-up	> **CONSULTANT** to develop and submit detailed "Bottom-up" cost estimates (per PCPP-02 standards and with templates as provided by SERVE) > **SERVE** estimators will Review and Comment on estimates > Final agreed upon Construction estimate will be added to Budget Estimate by **PCL LEAD**
OTHER CONSTRUCTION	PC Lead	see side	> **PERMITTING = 0.5% x** Construction* Total > **STARTUP & TESTING = 1.5% x** Construction* Total > **CONSULTANT** may be required to utilize ST Cost Estimate Summary Worksheet with these %'s already populated.	Permit Operations	PC Lead	Bottom-up	**PCL LEAD** to work with Divisions within DECM > Respective **DIVISION LEADS** to develop "Bottom-up" estimates
CONTINGENCY	PC Lead	varies	> **DESIGN ALLOWANCE = 30% x** each Construction Line Item > **ALLOCATED CONTINGENCY = 15% x Direct/DA** Construction > **UNALLOCATED CONTINGENCY = 10% x** Construction* Total > **CONSULTANT** may be required to utilize ST Cost Estimate Summary Worksheet with these %'s already populated.	PC Lead	PC Lead	% - varies	> Contingency to be determined based on Risk Assessment

4.2 Size and Strengths of Staff

Generally, it is best practice to have a balance of general estimating support along with discipline specialized estimators. Appropriate experience and certifications are also advisable, as applicable. The Assessment Team believes that ST has the appropriate staffing to create accurate estimates, even in early design. The recommendation is to require better transparency and increased involvement at various stages of the project, across various departments. Estimators are trained to predict the cost of various scope elements that make up a project and are not trained and/or qualified to engineer the project. Handoff of responsibilities between disciplines and agency/consultant/contractor should be documented and followed.

4.3 Coordination Between Disciplines (planning, design, constructability, ROW)

Estimators are not discipline specific engineers (Geotech, Structural, Civil, etc.). Estimators work with engineers and use the information from them to create the estimate. For this reason, the Assessment Team recommends the review of each estimate from station to station with Design Discipline Leads or Subject Matter Experts (SME). Utilizing simple visuals such as the Ecology Website or Google Earth and taking note of the designers' comments and suggestions can substantially improve estimate accuracy.

4.4 ROW

As previously stated, a collaborative, multidisciplinary approach to the ROW estimating process, involving design, construction, appraisal, acquisition, relocation, and environmental experts is the most significant adjustment that could be made to the management of the ROW estimating team. It is likely that the extremity of the WSBLE ROW cost increase could have been mitigated by a more collaborative approach, involving all of these disciplines earlier in the process. Moreover, those responsible for managing the estimating process must recognize when deviations from the methodology are necessary and appropriate.

5.0 – RECOMMENDATIONS FOR ROW & CONTINGENCIES

5.1 Estimating Evolution Throughout Design

Inclusive cost estimating during the early stages of projects is important. Estimates should be refined regularly as scope definition improves. As projects move clear of alternatives and project limits are more accurately defined while design advances through development into the preliminary stages, cost estimate accuracy improves. Throughout this process it is critical to maintain a fully developed risk register with associated cost implications considered. Peer reviews, financial experts and industry participation should be introduced in the preliminary stages of development to help address any missing elements and strengthen risk accuracy. This will be covered with greater detail in the Task 3 Assessment.

With the ST3 program being in the early planning phase, the Assessment Team recommends separating the task of budgeting and estimating at the program level. The first distinguishable difference between budgeting versus estimating is that budgeting is typically performed at the program level while estimating is performed at the project level. Project level contingencies are considered best practices for accounting for risk in early planning estimates. As risk items become clear, those specific, potential cost impacts can be adopted along with reduced contingency.

In addition to project level contingency, a program level management reserve continency should also be in place. This number can be derived from stakeholder input and the overall health understanding of the program with governance as to how and when to distribute the funds. It is understood by the Assessment Team that in addition to the project level contingencies, a 7% project reserve was used for the original ST3 estimates. The added reserve served as an additional risk contingency to create the high-end range of the original cost estimates. This 7% reserve has since been removed from the current Phase 2 estimates.

Although solely relying on project reserve to create an estimate range would not be considered best practice, the use of estimate ranges is advisable, particularly at the program level. In early design, the lack of defined scope presents substantial cost estimating challenges. It is known that the range of accuracy for early design estimates can be as wide as -50% to +100% depending on the source and design level as shown in Table 5.1. Many of the challenges leading to a wide accuracy range in early design are not only project specific but instead span across the program level in the form of systemic risks. Below is what the Association for the Advancement of Cost Engineers (AACE International) identifies as the most recognized systemic risks to a program:

- Level of familiarity with technology
- Unique/remote nature of project locations and conditions and the availability of reference data for those
- Complexity of the project and its execution
- Quality of reference cost estimating data
- Quality of assumptions used in preparing the estimate
- Experience and skill level of the estimator
- Estimating techniques employed
- Time and level of effort budgeted to prepare the estimate
- Market and pricing conditions
- Currency exchange

Table 5.1 below shows the relevant expected range of accuracy for cost estimates throughout the design according to AACE International.

Table 5.1 – Expected Range of Accuracy[1]

AACE Class	ANSI Classification	Typical Use	Project Definition	Expected Range of Accuracy: Low Expected Actual Cost	Expected Range of Accuracy: High Expected Actual Cost	Other Terms
Class 5	Order-of-Magnitude	Strategic Planning; Concept Screening	0% to 2%	-50% to -20%	+30% to +100%	ROM; Ballpark; Blue Sky; Ratio
Class 4		Feasibility Study	1% to 15%	-30% to -15%	+20% to +50%	Feasibility; Top-down; Screening; Pre-design
Class 3	Budgetary	Budgeting	10% to 40%	-20% to -10%	+10% to +30%	Budget; Basic Engineering Phase; Semi-detailed
Class 2	Definitive	Bidding; Project Controls; Change Management	30% to 75%	-15% to -5%	+5% to +20%	Engineering; Bid; Detailed Control; Forced Detail
Class 1		Bidding; Project Controls; Change Management	65% to 100%	-10% to -3%	+3% to +15%	Bottoms Up; Full Detail; Firm Price

Note 1: This table is based on AACE International Recommended Practice No. 18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries.

In summary, separating budgeting at the program level from estimating at the project level is recommended. Early design level estimating presents a multitude of challenges as have been discussed throughout the report. Additionally, the systemic risks, some of which that have already been exposed to the program, are also present at the program level which tend to skew estimate accuracy. It is the responsibility of the program level personnel to understand these challenges and budget the program appropriately. The utilization of ranges is recommended as a communication tool to reduce the volatility caused by all the unknowns of estimating in early planning [due to the multiple number of parties involved such as Finance, Risk, and Program Managers, the Assessment Team would need to work closely with ST staff to determine the most appropriate implementation method for the utilization of ranges].

5.2 Environmental – Contingency Strategy

Escalation and contingency can be confused with unknown future design changes such as code changes and changes to federal regulation. Longer term allowance for code change is important for allocating funds for changes to codes, federal guideline, and federal administration changes. It would be recommended that 1%-1.5% annually be carried for such changes over and beyond escalation.

5.3 ROW

Managing the ROW contingency throughout the project development process is a key part in ensuring that the budget is not subject to significant, unexpected increases over the life of the project. Many of the most effective ways to manage the ROW contingency have already been discussed above. The single most effective strategy to manage the ROW contingency is to accurately capture ROW costs in the estimate itself. As discussed, this is dependent on a collaborative, multidisciplinary approach to the estimating that relies on participation and input from all parties. Construction informs ROW, ROW informs design, design informs construction, and so on. When a team of diverse

subject matter experts interacts with a common goal, the right questions are asked, and the right solutions are explored.

In addition to team collaboration, a methodology that adequately estimates actual costs will go a long way toward managing contingencies. Spending the time and resources up front to employ standard valuation methodology like the Sales Comparison, Income and Cost approaches to value, as well as assessing complex property impacts with potential severance damages would serve to reduce overall project contingencies. Similarly, analyzing relocation impacts and TCE impacts on an individual basis would remove the need to include them in the overall ROW contingency. Furthermore, paying close attention to current real estate market trends, such as redevelopment, sales volume, appreciation, and up-zoning, combined with an understanding of basic economic drivers, could help in predicting a more accurate contingency for changes in property values due to market dynamics.

Besides the practices already discussed, the Assessment Team also recommends engaging in active strategies to reduce the potential for future increases in ROW costs. Early acquisition can be an effective tool, especially in a rapidly appreciating real estate market. Acquiring a property with today's dollars eliminates the risk of the property increasing in value in the future due to redevelopment or appreciation for some other cause. Early acquisition is allowed by the Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA) on a voluntary basis provided that doing so does not prejudice the environmental process. One way to ensure an unbiased environmental process is to identify the critical path parcels that are common to all reasonable alternatives and to approach the owner about a voluntary purchase. Once acquired, the costs obviously cannot escalate in the future. However, the risk of purchasing a property that is later determined unnecessary needs to be considered.

Additionally, the project team should put special efforts into the analysis of the high value acquisitions in order to thoroughly understand the relevant issues—both the causes of the issues and their financial impacts. Obviously, this requires the consultation of subject matter experts, as discussed earlier. Once the issues are properly understood, proactive mitigation strategies can be implemented to either eliminate impacts or potentially reduce severance damages.

One example of these strategies is engaging in value engineering exercises to compare locations and types of project improvements and construction methods to their corresponding ROW impacts and costs; this, of course, involves the collaboration of the ROW, construction, and design teams. This helps to alert designers to avoid a high-priced property or avoid small partial takes when a design solution could eliminate the need for a take. Other potential strategies include, but are certainly not limited to, creating alternate access points for properties, considering parking restriping or site reconfigurations where possible, analyzing potential building modifications including cut and reface, and the voluntary purchase of additional properties to mitigate more significant impacts on adjacent properties.

APPENDIX A

Table A-1 – Recommendations

No.	Recommendation	Section	Responsible Party (TBD by ST)
1	Integrate input from programmatic level design team on decisions involving substantial cost and document and discuss these decisions with future projects.	2.2.3 Design Progression	
2	Be transparent with what is included in the unit price in form or assemblies.	2.2.4 Environmental	
3	Estimate actual severance damages for a given parcel using qualified appraisers.	2.2.7 Assessed Property Value	
4	Use standard valuation techniques with individual properties in lieu of uniform adjustment factors.	2.2.8 Real Estate Adjustment Factor	
5	Procure independent cost opinion to validate early cost estimates.	3.1 Process and Procedures	
6	Real Property has ultimate responsibility for ROW estimating including at early phases.	3.1 Process and Procedures	
7	Conduct thorough Annual Program Evaluations.	3.1 Process and Procedures	
8	Develop standard reporting format for Annual Program Evaluation for communication with leadership and program stakeholders.	3.1 Process and Procedures	
9	Include in Project Management Plans requirements for workshops with Operations to improve early cost estimates.	3.2 Opportunities to Move Best Practice Forward	
10	Add items from early Operations workshops to the Unit Cost Library.	3.2 Opportunities to Move Best Practice Forward	
11	Engage PSO in program level design oversight in planning phase.	3.2 Opportunities to Move Best Practice Forward	
12	Prepare second estimates, or validation assessment independent of Unit Cost Library.	3.3 Unit Cost Library Utilization	
13	Implement a market-based approach to property value.	3.4.1 Implement a market-based approach to property value	
14	Involve ROW specialists early in the process.	3.4.2 Involve specialists early in the project	
15	Incorporate constructability impacts into ROW analysis.	3.4.3 Incorporate construction/constructability impacts into ROW analysis	
16	Limit ROW contingency to actual unknowns.	3.4.4 Limit ROW contingency to actual unknowns	
17	Solicit estimates for relocation costs from ROW relocation experts.	3.4.4 Limit ROW contingency to actual unknowns	

18	Estimate individual TCE impacts using reasonable engineering assumptions.	3.4.4 Limit ROW contingency to actual unknowns	
19	Use sound cost methodology across all departments to achieve uniformity and consistency within project and program level estimates.	4.1 Roles and Responsibilities of Staff	
20	Require better transparency and increased involvement at various stages of the project, across various departments to create accurate estimates, even in early design.	4.2 Size and Strengths of Staff	
21	Handoff of estimating responsibilities between disciplines and agency/consultant/contractor should be documented and followed.	4.2 Size and Strengths of Staff	
22	Review of each estimate from station to station with Design Discipline Leads or Subject Matter Experts (SME).	4.3 Coordination between disciplines (planning, design, constructability, ROW)	
23	Update UCL for pricing and line item adjustments beyond escalation from 2014 to 2021	4.4 Environmental Future Code Changes	
24	Perform a collaborative, multidisciplinary approach to the ROW estimating process, involving design, construction, appraisal, acquisition, relocation, and environmental experts.	4.5 ROW; page 14	
25	Identify when deviations from methodology in estimating ROW are necessary and appropriate	4.5 ROW; page 14	
26	Refine estimates regularly as scope definition improves.	4.5 ROW; page 15	
27	From preliminary stages, develop and maintain a fully developed risk register with associated cost implications.	5.1 Estimating Evolution Throughout Design	
28	Separate tasks of budgeting and estimating.	5.1 Estimating Evolution Throughout Design	
29	Include a program level management reserve in addition to project level contingency.	5.1 Estimating Evolution Throughout Design	
30	Use estimate ranges at the program level.	5.1 Estimating Evolution Throughout Design	
31	Use estimate ranges as communication tool in early planning.	5.1 Estimating Evolution Throughout Design	
32	Use 1%-1.5% annually for contingency for changes to code, federal guideline, and federal administration changes for such changes over and beyond escalation.	5.2 Environmental – Contingency Strategy	
33	Actively manage ROW contingency throughout project development process.	5.3 ROW	
34	Analyze relocation impacts and TCE impacts on an individual and separate basis in lieu of including them in the overall ROW contingency.	5.3 ROW	

35	Use Early Acquisition for Real Property.	5.3 ROW	
36	Put special efforts into the analysis of the high value acquisitions in order to thoroughly understand the relevant issues—both the causes of the issues and their financial impacts.	5.3 ROW	
37	Perform Value Engineering exercises (i.e., workshops) to compare locations and types of project improvements and construction methods related to ROW impacts and costs.	5.3 ROW	
38	Create alternative access points, site reconfigurations, potential building modifications, voluntary purchase of additional property or other means to mitigate costly ROW impacts.	5.3 ROW	

APPENDIX B

B.1 Recommended Practices

B.1.1 Federal Transit Administration (FTA)

FTA has a structured Best Practice approach related to cost estimates prepared by its Project Sponsors as well as its evaluation process of said estimates. For a Project Sponsor to successfully secure FTA funding on its projects, FTA's guidelines must be followed. Project Sponsors will need to be able to demonstrate FTA's Best Practices are being adopted. ST has certainly been able to demonstrate sufficient cost estimation Best Practice on the scale of FTA's requirements to have advanced its project programming and delivery to this point. FTA delegates its estimate review process down to its Project Management Oversight Contractors (PMOC). During the review process, the PMOC follows FTA's Oversight Procedure #33 (OP33), Capital Cost Estimate Review. In addition, and specific to risk and contingency, the PMOC will follow Oversight Procedure #40C, Risk and Contingency Review. Specific to Best Practice, FTA points its PMOC, Project Sponsors, and general users to various source information to help benefit overall cost estimating efforts. Links to these reference materials can be found on the FTA website (FTA Best Practice and Reference Documents).

B.1.2 Peer Example: Regional Transportation District (RTD) Denver

RTD has been delivering large capital programs/projects over many years. As RTD's project development and delivery approach has matured its approach to cost estimating has followed suit. Since the FTA has been a consistent funding partner to RTD, RTD has largely adopted the cost estimating recommendations from what is prescribed by FTA of its Project Sponsors. Like most transit agencies, RTD seeks funding opportunities from the FTA which requires RTD follow all of the requirements set-forth by the National Environmental Protection Act (NEPA). Depending on the complexity of an envisioned capital improvement, the NEPA requirements must be adhered to accordingly. RTD's planning group follows established regional governance and federal requirements as appropriate. Per federal requirements, each metropolitan planning organization (MPO) is required, under the United States Code, Title 49 – Transportation, U.S.C. 5303(j), to develop a Transportation Improvement Program (TIP). Once the requirements are complete and the project is adopted in the TIP, RTD's planning group, with participation from local stakeholders, advances the framework of the project and positions it for inclusion in any required Infrastructure Master Plan (IMP) or moving it along to a Major Investment Study (MIS). It is at these stages that top-down cost estimation begins to take shape. Rudimentary levels of work breakdown structure are developed to build initial project costing. As the project advances further into conceptual stages and alternatives analysis progresses, the scope breakdown develops further and can begin to be mapped against reference and historical cost data. RTD has a long history of project data to draw from to cross check like scope elements to further refine its initial, high-level estimates. From this point as revenue projections are considered and funding sources are confirmed, the project budgets begin to firm up and projects are positioned and prioritized to move into development. As delivery options are considered and design commences, in-house or via contracted services, the estimating efforts shift to align with the guidance set-forth in RTD's cost estimating methodology.