

Attachment 2 EX4.1

Appendix C

EXECUTIVE SUMMARIES OF PEER REVIEWS

Executive Summary – Review of TTC schedule & cost analysis model

In February 2019, TTC commissioned Risk Decisions to review a Predict! Risk Analyser quantitative risk analysis model for one of their subway extension projects. The project is at 30% design and TTC are proceeding to a Stage Gate to get approval and set the project baseline. The analysis combines cost, schedule and risk information.

The scope of the review was to make a technical assessment of the construction, robustness and validity the analysis, considering the influence of the way it was built on outputs that may be used to support business case decisions. The scope excluded reviewing of any assumptions, or the accuracy and validity of the input data.

TTC adjusted the analysis throughout the review process. Risk Decisions' conclusions of the final analysis is that it is thorough, comprehensive, and well thought-out and constructed.

Below is a summary of the conclusions:

- General
 - The analysis is robust and produces reliable decision-making results based on the input data (and clarification statements from TTC where applicable).
 - Mathematical calculations are correctly made and cross-referenced.
 - Mechanisms to simulate correlation between elements of the analysis have been correctly implemented.
- The schedule
 - Partial progress of the schedule has been appropriately implemented to ensure that calculations to complete the schedule are valid.
 - Considered judgements have been made in identifying and ensuring that important activities are structured for analysis of their impact on key milestones.
 - TTC have explained the presence of any schedule constraints.
 - Risk Decisions has provided advice on changing the types of links used between some activities. These aren't activities that TTC are currently concerned with, though the advice would allow better modelling of risk and uncertainty against these activities should the need arise in the future.
 - Risk events have been appropriately linked into schedule activities to analyse their effects on key milestones.
- Costs
 - TTC has done an excellent job of representing the various uncertainty factors that could affect the cost of the project (rates, contractors' indirect uncertainty etc.).
 - Level-of-effort costs are calculated appropriately.
 - The calculations for the top-level total cost of the analysis are robust. Advice has been given on structuring the next layer of the analysis to aid clarity and understanding on how the costs calculations are broken down.

Document version: 27 March 2019

TTC Line 2 East Extension Project

Review DBB Master Construction Schedule EXECUTIVE SUMMARY

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TORONTO TRANSIT COMMISSION

30% Design Construction Schedule Review

TTC Line 2 East Extension Project

Toronto Transit Commission

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Document No: Can19352-50-RSR-001

21 March 2019

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Turner & Townsend

1 EXECUTIVE SUMMARY

The purpose of this report is to review and assess the constructability of the DBB Master Construction Schedule and Basis of Assumptions for Stage Gate#3 Document No.: SSE-PC-SCH-0001-BA submitted by Toronto Transit Commission. The review will highlight areas for improvement for further developing the schedule for future phases. Additionally it will also highlight where best practice are adopted.

Turner & Townsend was appointed by Toronto Transit Commission (TTC) to undertake a 30% design and estimate schedule review for the Line 2 East Extension, formerly the Scarborough Subway Extension (SSE).

The review utilizes qualitative and quantitative techniques based on the Turner & Townsend's model of excellence that incorporates AACE Recommended Practices to highlight gaps and provide recommendations for schedule development for future program phases.

1.1 Summary of Findings and Recommendations

1.1.1 Findings

- The Construction Schedule has been developed in accordance with the 30% design and estimation completion and based on the information available.
- The Project Scope Statements are well-defined and Work Breakdown Structure is well developed. All activities are well defined, sequentially and logically linked. All activities have predecessors and successors and Logic of schedule and sequence of activities are well-structured in schedule network as well as explained in basis of assumptions. Milestones are well-defined and support the entry and exit of each phase of project. The cascading approach has been reviewed and the WBS has been developed in-line with scope of the work packages.
- Revenue Start Date has been defined as completion date of phase and the rest of activities will be completed after Revenue Start Date.
- Duration allocated to work packages are reasonable and total duration is comparable with other similar projects in Canada.
- We have reviewed TTC's Line 2 East Extension Integrated Schedule-Cost Quantitative Risk Analysis report received on 8th March 2019, our schedule risk assessment is showing TTC schedule risk assessment is reasonable.

1.1.2 Recommendations & Improvements

For the next phase of the project we recommend the following issues be addressed as opportunities for improvement and are listed in order of priority:

- Review activities with a duration greater than two months can be further broken down, particularly those that are on the critical path. However, we understand that this is not a construction control schedule.
- We found over 50% of the activities have float greater than two months (high float). However, no open ends were found. We recommend TTC review the activities with high float to determine whether the consumption of that float is sensible and / or reasonable.
- Task / activities by WBS level(s), inconsistencies should be reviewed as some activities are grouped at WBS level 1 with none at level 3 or no activities grouped at WBS level 1 but tasks exist at level 3.
- Enhance activity codes, activity resources and other activity attributes, a more comprehensive activity code structure can help in filtering, grouping, and sorting activities.
- Review and address the 220 days of lag on the near critical path activity.
- If the contract is awarded as a single Design Bid Build (DBB) a single contractor will be in a better position to coordinate resources across work packages to optimize the schedule and work durations to provide flexible schedule to accelerate the work, reduce their risk and yield significant cost savings.
- Major long lead items such as tunnel boring machine manufacturing, special track work for example turnout, crossover, are recommended to be included and visible in the next phase of schedule development.
- The site constraints or difficult work conditions should be considered in the schedule which has the potential to decrease construction crews productivity, for example
 - Installing piles under existing water main or electrical duct banks,
 - Working near railroads, highway or historical buildings
 - Dealing with environmental hazards
 - Working in areas with limited space and room
 - Vibration, noise and dust restriction which will impact the neighbourhood
 - Related scope that requires need traffic diversion, such as road widening, restoration, utilities relocation, utilities connection, etc.
 -

According to contractors' standard practice, winter condition allowances are usually between 10 to 12 days per calendar year. Extreme weather conditions such as freezing rain, cold temperatures, heavy rainfall and snowfall or flooding due to existing old storm sewers, can be evaluated during risk analysis.

- When work can only be performed at night or after TTC operational hours, the schedule should reflect night time or after hours construction activities, e.g. work to connect existing TPSS and Kennedy Station.
- The timing of a project's advertisement and issuing to the market will have an impact on bid prices from tender returns. The recommended bid closing months are April or May before the peak in construction activities for other major projects and programs.
- Construction Schedule of the following work packages should be developed in the next phase:
 - SCS Electrical/Mechanical breakdown and logic.
 - Line 2 East Extension Wide testing and commissioning breakdown.
 - Utilities.
 - SCS construction breakdown.
 - Impacts from extreme weather, e.g. extreme winter condition, flooding, earthquakes or major climate change.
 - Changes in regulatory requirements.
 - Changes in science or technology or in health & safety requirements.

TTC Line 2 East Extension Project

30% Design Estimate Review Executive Summary

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TORONTO TRANSIT COMMISSION

30% Design Estimate Review, Executive Summary, CAN19352-30-CSR-001

TTC Line 2 East Extension Project

Toronto Transit Commission

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15 February 2019

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30% Design Estimate Review Line 2 East Extension Estimate Review

1 EXECUTIVE SUMMARY

Turner & Townsend were appointed by Toronto Transit Commission (TTC) to undertake a 30% design estimate review of the Line 2 East Extension (L2EE), formerly Scarborough Subway Extension (SSE) project. The review focuses on the accuracy, correctness and reasonableness of the cost estimate for coming TTC stage gate requirement.

According to TTC Estimate Guideline and the American Association of Cost Engineers (AACE) International, Baseline Class 3 Estimate is recommended to be prepared by top-down (e.g. \$/m2), factor based, and parametric approach.

Line 2 East Extension Cost Estimate has been prepared based on 30% Design submission and produced using a bottoms-up approach. The Cost Estimate includes more than 7,000 cost item details detailing quantity take-off material, union labors rates, equipment rates, crew assemblies and productivities, man hours, cost allowance supported by historical project data, contractor markup, owner's staff resources, risk, contingency and escalation.

In summary, Turner & Townsend finds that TTC has substantially met the objective to setup the baseline estimate for coming project stage requirement. The Estimate Review team did not find any items that could be classified as Critical. 85% of the items reviewed were considered as accurate, correct and reasonable while 15% can be improved in the next submission.

Our findings, as substantiated in this assessment, are:

- TTC properly developed and supported its baseline estimate for L2EE Project in conformance with TTC guideline and exceed AACE International guidance Class 3 requirement.
- TTC estimating process is robust and thorough in the development of the L2EE Project baseline estimate. The process used for developing the majority of the L2EE Project work packages was thorough and well-defined.
- TTC's process for developing the estimate baseline was generally successful in advancing the maturity of the work, and was consistent in characterizing its project estimates. As noted, approximately 90% of the

30% Design Estimate Review Line 2 East Extension Estimate Review

project estimates achieved sufficient maturity to be characterized as Class 2 or 3 levels.

- The Cost Estimate is aligned with our experience for Greater Toronto Area (GTA) mega transit capital projects for his nature and can form the basis for a robust project controls regime and budget approval.