



Calgary

City Auditor's Office

**Green Line Program Baseline Schedule Audit
November 9, 2022**

THIS PAGE LEFT INTENTIONALLY BLANK

Table of Contents

Executive Summary	5
1.0 Background	6
2.0 Audit Objective, Scope and Approach	8
2.1 Audit Objective	8
2.2 Audit Scope	8
2.3 Audit Approach	8
3.0 Results	9
3.1 Develop Schedule Management Plan	10
3.2 Schedule Level	10
3.3 Identify and Consider Risks.....	10
3.4 Document Schedule Basis and Assumptions	11
3.5 Define, Sequence, Estimate Activity Durations and Develop Project Schedule.....	11
3.6 Due Diligence – Baseline Schedule Review and Constructability Review.....	12
3.7 Monitor Performance and Change Management, and Report Progress.....	13
4.0 Observations and Recommendations	15
4.1 Key Performance Indicator Evaluation and Inclusion in Progress Reports	15

The City Auditor's Office conducted this audit in conformance with the *International Standards for the Professional Practice of Internal Auditing*.

Executive Summary

The Green Line Program is the largest infrastructure project in Calgary's history with Stage 1 costs estimated at \$5.5 billion, including financing costs. Stage 1 will be built in two phases. Phase 1 will consist of 18km of LRT track with 13 stations from Shepard up to and including Eau Claire. Phase 2 from Eau Claire to 16 Avenue N will include two stations and 2km of track. As of February 2022, costs related to Phase 1 totaled \$715 million¹. As part of the approved stage gate process, the Green Line Board will assess the risk and resources available before Phase 2 work will begin.

The Green Line Program Baseline Schedule (GL Baseline Schedule) for Phase 1 was approved by Green Line Senior Management in December 2021. The creation of a robust Baseline Schedule combined with effective on-going monitoring processes supports on-time Program completion and mitigates the risk of delays with associated financial and reputational impact.

The objective of this audit was to assess the effectiveness of the design and operation of processes to create and monitor the GL Baseline Schedule. We evaluated Green Line's key controls and processes to create and monitor the GL Baseline Schedule using guidance/criteria from Project Management Institute (PMI) and the Association for the Advancement of Cost Engineering (AACE). The assurance from the audit was limited to commenting on the design and effectiveness of processes relating to the creation and monitoring of the Baseline Schedule and should not be relied upon as representing our views on the future performance of the Green Line Program.

We concluded that processes to create and monitor the GL Baseline Schedule were designed and operating effectively. Green Line incorporated best practice guidance from both PMI and AACE, where applicable, in processes and controls to develop and monitor the GL Baseline Schedule. Specifically our audit work confirmed:

- The Schedule Management Plan established criteria and activities for developing, monitoring and controlling the GL Baseline Schedule.
- The development of the GL Baseline Schedule incorporated AACE/PMI guidance, as appropriate, including identifying and considering risks, documentation of schedule basis and assumptions, defining and sequencing of activities, and the completion of due diligence activities related to baseline schedule and constructability reviews.
- The design and operation of monitoring and reporting processes were aligned to AACE/PMI guidance.
- The design of the change process was also aligned to best practice guidance. We could not test the operation of change management processes as there were no changes to the critical path during the audit period.

We identified one opportunity related to reporting to further support the Green Line Board in its governance and oversight role (recommendation one).

Green Line agreed with the recommendation and indicated in their response a commitment to implement an action plan no later than November 30, 2022. The City Auditor's Office will monitor the status of commitments as part of its ongoing recommendation follow-up process.

¹ Green Line Board (April 1, 2022) - GLB2022-004 (8.1)

1.0 Background

The Green Line Program is the largest infrastructure project in Calgary's history with Stage 1 costs estimated at \$5.5 billion, including financing costs. Stage 1 will be built in two phases. Phase 1 will consist of 18km of LRT track with 13 stations from Shepard up to and including Eau Claire. Phase 2 from Eau Claire to 16 Avenue N will include two stations and 2km of track. As of February 2022, costs related to Phase 1 totaled \$715 million. As part of the approved stage gate process, the Green Line Board will assess the risk and resources available before Phase 2 work will begin.



Source: Green Line Program website <https://www.calgary.ca/green-line.html>

The scope of Phase 1 includes design development, procurement, construction, commissioning and demobilization activities, and utility relocations, land preparation, environmental remediation, and transit improvements that will prepare the right-of-way for major construction.

Green Line is following a Design Build Finance model with a Development Phase. On March 31, 2022, Green Line released the Request for Qualification for Phase 1, from Shepard to Eau Claire. The Green Line Board anticipates selecting a Development Partner in 2023 following the Request for Proposal (RFP) stage. Key dates and milestones will be available as the Program moves into implementation.

The Green Line Board is a committee of Council with the mandate to use its collective expertise to govern and oversee the successful delivery of the Green Line Stage 1 Program, and to carry out Council direction provided to administration and to the Green Line Board related to the Delivery of the Program. In December 2021, Green Line Senior Management approved the Green Line Program Baseline Schedule (GL Baseline Schedule) for Phase 1, which includes the Program execution strategy, key Program deliverables, activity planned dates and milestones. The GL Baseline Schedule was created utilizing Primavera, a leading project management software for large construction projects. The GL Baseline Schedule will be used as a reference to compare with the actual results and to measure progress. When establishing processes and controls, Green Line management referred to best practice guidelines from the Project Management Institute (PMI) and the Association for the Advancement of Cost Engineering (AACE).

The City Auditor's Office plans to conduct a series of audits on the Green Line Program given its magnitude, complexity, and significant capital budget. This audit is the fifth in the series and was included on our 2022 Annual Audit Plan with a focus on processes and controls to develop and monitor the GL Baseline Schedule. The creation of a robust GL Baseline Schedule combined with effective on-going monitoring processes supports on-time Program completion and mitigates the risk of delays with associated financial and reputational impact.

2.0 Audit Objective, Scope and Approach

2.1 Audit Objective

The objective of this audit was to assess the effectiveness of the design and operation of processes to create and monitor the GL Baseline Schedule to mitigate the risk of delays with associated financial and reputational impact.

2.2 Audit Scope

The audit scope included processes utilized to create the GL Baseline Schedule approved by Green Line Senior Management and processes to monitor and report on performance against the GL Baseline Schedule up to March 31, 2022.

The assurance from the audit was limited to commenting on the design and effectiveness of processes relating to the creation and monitoring of the GL Baseline Schedule. Audit results should not be relied upon as representing our views on the future performance of the Green Line Program or be interpreted as providing assurance over the technical feasibility of the GL Baseline Schedule (i.e. we did not complete a Forensic Scheduling Analysis or a Constructability Review).

2.3 Audit Approach

The audit approach evaluated key controls and processes utilized to create and monitor the GL Baseline Schedule using guidance/criteria from PMI and the AACE. Our approach included interviewing Green Line Program staff, reviewing documentation related to the creation and monitoring of the GL Baseline Schedule, reviewing schedule details in Primavera, and analyzing a sample of Work Breakdown Structure (WBS) activities.

3.0 Results

A Baseline Schedule is the approved version of a schedule model that can be changed only through formal change control procedures and is used as a basis for comparison to actual results. The Baseline Schedule is what all schedule change and progress is measured against. We reviewed key controls and processes to create and monitor the latest GL Baseline Schedule (revision #4) and assessed design and operating effectiveness while considering best practice guidance/criteria from PMI and AACE.

We concluded that processes to create and monitor the GL Baseline Schedule were designed and operating effectively. Green Line incorporated best practice guidance from both PMI and AACE, where applicable, in processes and controls to develop and monitor the GL Baseline Schedule. We identified one opportunity to evaluate KPI and associated mitigating strategies to be included in Green Line Board Progress Reports (Progress Reports) to further support the Board in its governance and oversight roles (recommendation one). Further details of our testing for each of the process categories are provided below.

PROCESS CATEGORY	SUB-CATEGORY	CRITERIA (PMI/AACE)	AUDIT RESULTS
Schedule Management Plan	Develop Schedule Management Plan (3.1)	The Schedule Management Plan should establish the criteria and the activities for developing, monitoring and controlling the schedule.	Met criteria
	Schedule Level (3.2)	The levels of schedule details should be identified based upon degree of project definition required by stakeholders.	Met criteria
Develop Baseline Schedule	Identify and Consider Risks (3.3)	Significant risks impacting the Baseline Schedule should be included.	Met criteria
	Document Schedule Basis and Assumptions (3.4)	The Schedule Basis should be documented to support analysis and change management.	Met criteria
	Define Activities (3.5)	Specific actions to produce project deliverables should be identified and documented to provide a basis for estimating, scheduling, executing, monitoring and controlling the project.	Met criteria
	Sequence Activities (3.5)	Relationships among project activities should be identified and documented to define the logical sequence of work.	Met criteria
	Estimate Activity Durations (3.5)	Number of work periods needed to complete individual activities with estimated resources should be estimated.	Met criteria
	Develop Project Schedule (3.5)	Sequences, durations, resource requirements and schedule constraints should be analyzed to create a Project Schedule.	Met criteria
	Due Diligence-Baseline Schedule Review and Constructability Review (3.6)	A review of the overall quality and completeness of the Project Schedule should be completed.	Met criteria
	Approval Baseline Schedule (3.6)	The Baseline Schedule should be approved by Senior Management	Met criteria
Baseline Schedule Monitoring and Reporting	Monitor Performance and Change Management, and Report Progress (3.7)	The status of the Project Schedule should be monitored to update the schedule and manage changes. Details on the status of project milestones and the current schedule should be reported.	Met criteria

3.1 Develop Schedule Management Plan

The Schedule Management Plan (SMP) is used to define how the Program schedule is managed. It is a component of the project management plan that establishes the criteria and the activities for developing, monitoring and controlling the schedule. The SMP is a living document and is updated on an ongoing basis to reflect a change in the way the schedule is managed.

We reviewed the latest Green Line SMP, updated February 2022 (revision #2). The SMP included descriptions of key milestones and contractual events and details on maintaining, updating and reporting on the status of the schedule, as well as, defining the roles and responsibilities over the maintenance of the schedule. Scheduling updates are done on a bi-weekly basis and shared with the Green Line team. Changes to the GL Baseline Schedule are controlled and recorded through the schedule change control process (section 3.7).

Schedule activities were defined into nine WBS, which made up the GL Baseline Schedule and included the entire project scope. The Green Line group responsible for each WBS was identified along with updating and reporting responsibilities. The SMP defined the base time unit used in the scheduling software (Primavera). Based on our review and suggested guidance from AACE and PMI, we concluded the SMP was developed utilizing appropriate best practice guidance.

3.2 Schedule Level

There are a variety of accepted methods to describe/identify the levels of schedule details. The three generally acceptable methods are: Numeric Schedule Levels; Engineering, Procurement, Construction Schedule Levels and Descriptive Methodology.

Green Line utilized the Numeric Method, which is the most commonly used method within the construction industry. The numeric based approach often correlates the schedule level to the project's WBS. As noted above, the GL Baseline Schedule is comprised of nine WBS that feed into the GL Baseline Schedule.

Schedule levels within each WBS were consistent with guidance on the level of project information required by stakeholders. The GL Baseline Schedule was at Level 1 and displayed the highest or summary level of project information along with high-level Program milestones to enable progress tracking. We noted each of the WBS schedules feeding into Level 1 were designated as Level 2 or 3, which provides a more detailed breakdown of the project scope and a good level of detail for overall project control. Overall, schedule level details were consistent with AACE recommended practice.

3.3 Identify and Consider Risks

We reviewed significant risks included in the Risk Management Plan which may impact the GL Baseline Schedule and assessed if the risks were factored into the development of the GL Baseline Schedule. We noted the GL Baseline Schedule considered significant risks. The activities from different stages of land acquisition (negotiation, expropriation, demolition, possession) were forecasted with dates for each activity and included in the schedule. This aligns to AACE guidance, which states critical risks that may occur during the execution of the project should be considered when developing the baseline schedule.

3.4 Document Schedule Basis and Assumptions

The schedule basis is a document that defines the basis for the development of the project schedule and assists the project team and stakeholders in identifying key elements and assumptions. AACE states the documentation of the schedule basis is an important step in reaching the objective for successful use of the project schedule. It is considered a living document and updated as the project progresses to reflect changes to the GL Baseline Schedule resulting from the change management process.

We reviewed the Green Line Program Schedule Basis approved by Senior Management in December 2021 and compared it to guidance from AACE, which outlines the following elements for consideration:

- Project description, schedule integration process;
- Execution strategy;
- Planning and cost basis;
- Issues and concerns;
- Assumptions/exclusion/exceptions;
- Schedule reserve;
- Scope of work (WBS);
- Key project dates;
- Critical path;
- Risks and opportunities;
- Baseline changes/reconciliation; and
- Project buy-in.

Our review of the Green Line Program Schedule Basis concluded the document was consistent with guidance from AACE. Risks were not specifically mentioned in the basis document as Green Line's Risk Management Plan outlined the risk strategy, including risk identification/quantification, risk analysis, risk mitigation and escalation.

The basis document identified the critical path, including specific critical activities along the path. Primavera calculates the critical path based on activity durations and then colour codes activities along the critical path.

3.5 Define, Sequence, Estimate Activity Durations and Develop Project Schedule

PMI outlines the following as key components of schedule development:

- Defining activities – process of identifying and documenting the specific actions to be taken to produce project deliverables
- Sequencing activities – process of identifying and documenting relationship among the project activities (logic sequence)
- Estimating activity durations – process of estimating the number of work periods required to complete individual activities within estimated resources

To assess components of schedule development we inquired with the Scheduling Lead how activities were defined, sequenced and how durations were estimated, and sampled two WBS to evaluate if components of schedule development aligned with best practice. Test results indicated the sampled activities were defined based on expert judgment, activities were

sequenced to achieve efficiency and arranged in a logical sequence of work. Lastly, estimating techniques were based on input from subject matter experts, and used relevant historical data to compute duration of an activity.

We also reviewed dangling activities, which are loosely tied activities (i.e. not linked to others in chain/no-start/end-date) since significant dangling activities in a schedule can increase schedule risk. We reviewed a list of Green Line activities and noted that there were a minimal number of dangling activities, which were attributed to non-construction/non-critical path activities that were administrative in nature (i.e. stand-alone activities).

Based on our testing the development of key scheduling components was aligned with best practice guidance.

3.6 Due Diligence – Baseline Schedule Review and Constructability Review Baseline Schedule Review (BSR)

A Baseline Schedule Review focuses on the overall quality and completeness of the original project schedule and overall plan. AACE provides a checklist of items to consider when performing a BSR:

- Inclusion of the entire project scope;
- Constructability;
- Adherence to legal and contractual requirements;
- Resource usage and balance;
- Design and coding of activities and project organization and WBS;
- Sequence of workflow;
- Timing and phasing;
- Unambiguous and clear descriptions of the work;
- Level of detail; and
- Highlight key or critical areas of risk.

Although a formal BSR document was not prepared, several Green Line areas (e.g. Engineering, Construction, Legal, Project Controls Team) reviewed the GL Baseline Schedule approved by Green Line Senior Management December 2021 and provided input. We reviewed correspondence discussing schedule assumptions, dates and durations and procurement activities and determined Green Line included AACE items in the internal review such as resource usage and balance, sequence of workflow, and timing and phasing.

While we didn't re-perform a comprehensive review of the schedule, based on testing under 3.1, we noted the entire project scope was included and activities were organized in WBS in the GL Baseline Schedule. We performed the following additional tests on workflow sequencing and activity code assignment and concluded they were consistent with AACE guidance.

Lead and lag are both used in the development of the project schedule. A lead is the acceleration of a successor activity, while lag is the delay of a successor activity. A schedule may include the use of lag to highlight required delays (e.g. subsequent activity requires a certain number of days before starting predecessor activity (i.e. dependency)) and lead to start discretionary successor activity before the predecessor activity has finished. Green Line

assigned leads and lags on a case-by-case basis based on the relationship between the activities (e.g. discretionary or dependency).

We reviewed the WBS activity code for duplicate/blank or near duplicate descriptions and noted no inconsistencies in activity code assignment.

Schedule Constructability Review (SCR)

An SCR is performed to review the feasibility of the construction plan to assess whether the schedule is comprehensive and complete. It is completed during various phases of a project, such as, design, procurement and execution. An SCR at the design phase can identify potential coordination issues, availability of specified materials, out of sequence work, missed work details and unrealistic durations/potential delays. At the procurement phase an SCR involves reviewing the RFP of potential bidders' procurement and construction schedules.

The audit focused on SCR performed in the design phase since Green Line is transitioning from concept to full design. Our review indicated Green Line performed due diligence of the concept design by assessing construction schedules, activity sequencing, durations and identifying potential coordination issues/missed work details. Based on inquiry with the Scheduling Lead, constraints were accounted for in the GL Baseline Schedule, where applicable. The Scheduling Lead advised that along with the development of design, regular and thorough reviews will be conducted. We noted review activities were built into the schedule and included in Primavera.

Green Line is preparing the RFP for release later in 2022 and has scheduled a review of RFP phase activities in Primavera. Green Line Business Services stated an SCR of the final drawings and the construction schedule of the awarded development partner will occur following the RFP stage.

3.7 Monitor Performance and Change Management, and Report Progress

Reporting and Monitoring of Baseline Changes

Review of the GL Baseline Schedule was done on a bi-weekly basis by the Scheduling Lead. Each activity has an owner who provides an update as to actual and forecast schedule. The Scheduling Lead compiles the Bi-weekly Program Schedule Updates, emails Green Line staff, highlighting key updates, and attaches the updated forecast schedule.

We tested a sample of two WBS to assess schedule monitoring and reporting. We noted the WBS owners provided bi-weekly and monthly schedule updates. We observed that SPI for a December 2021 WBS was below Green Line's acceptable threshold. As a result, the Leader of Business Services took appropriate mitigating actions, which resulted in improvement in subsequent months. We reviewed Bi-weekly Program Schedule Updates from January to March 2022 and noted the concern was included in the January update. Since the concern did not impact critical activities/milestones, or meet the Program KPI thresholds, it was not included in Progress Reports.

The Green Line Board receives monthly Progress Reports, which provide project highlights, key performance indicators (KPI), financial summaries and program commentary. Furthermore, the Green Line Budget and Risk Committee receives monthly dashboard updates, which includes additional information regarding look ahead activities, risk register status, issue management, milestone table, change control and land transactions update.

As the Green Line Program transitions from the design phase to the construction phase, we saw value in Green Line Business Services evaluating KPI and associated mitigating strategies to be included in Progress Reports. We raised a recommendation (recommendation one) to ensure the Green Line Board has relevant KPI information to support them with their mandate to govern and oversee the successful delivery of the Green Line Program.

Change Management Process

The Green Line Change Management Control Plan outlines the process to identify, assess and approve and track changes to cost, schedule and scope. Change control is facilitated using InEight construction contract management software.

To assess the operating effectiveness of the change management process, we reviewed the InEight change list and noted no changes to the GL Baseline Schedule for critical path/key milestones during the audit period. We also reviewed monitoring and reporting for our WBS sample and noted no schedule changes were identified during the audit period. As a result, we were unable to assess operating effectiveness. However, we selected a non-critical path change to walkthrough the change management process and noted the sampled change followed Green Line's change management process and aligned with guidance from PMI.

Earned Value Techniques

Green Line utilizes earned value techniques to monitor performance against the GL Baseline Schedule. The Schedule Performance Index (SPI) measures the conformance of actual performance to planned progress in order to assess project status. There is a Schedule KPI to monitor if the Program is on plan, (SPI > or = 1 or No change to critical activities/milestones), at risk (SPI 0.9-0.99 or Delay of critical milestones by less than 4 weeks), and off plan (SPI < .9 or Critical activities delayed by more than 4 weeks)².

We reviewed the January to March 2022 Progress Reports, and noted the Program was on plan compared to the GL Baseline Schedule in the Schedule Dashboard.

We would like to thank Green Line staff for their assistance and support throughout this audit.

² The Schedule KPI were modified subsequent to the audit to No delay to critical activities or critical milestones (green), Delay to intermediate milestones by less than two weeks (yellow), and Delay to critical activities or critical milestones (red).

4.0 Observations and Recommendations

4.1 Key Performance Indicator Evaluation and Inclusion in Progress Reports

As the Green Line Program transitions from the current design phase to the construction phase, information on KPI variances will play a vital role in supporting the Board’s governance and oversight. There is value in evaluating KPI and associated mitigating strategies to be included in Progress Reports to ensure monthly reporting will assist the Board with its mandate to govern and oversee the successful delivery of the Green Line Program.

The Board Governance Manual describes the Board’s mandate to govern and oversee the successful delivery of the Green Line Program and responsibility to receive regular reports, and monitor Program Plans against KPI. The Progress Reports from January to March 2022 included Appendix 1 listing the Dashboard Legends (i.e. KPI). There is a Schedule KPI to monitor if the Program is on plan.

We tested a sample of WBS to assess schedule monitoring and reporting. We noted that SPI for a December 2021 individual WBS was below Green Line’s acceptable threshold. As a result, the Leader of Business Services took appropriate mitigating actions, which resulted in improvement in subsequent months. We reviewed Bi-weekly Program Schedule Updates from January to March 2022 and noted the concern was included in the January update. Since the concern did not impact critical activities/milestones, or meet the Program KPI thresholds, it was not included in Progress Reports.

Recommendation 1

As the Green Line Program transitions from the current design phase to the construction phase, the Green Line Deputy Director, Business Services, evaluate the KPI metrics and the inclusion of these metrics and mitigating strategies associated with variances in monthly Board reporting.

Management Response:

Agreed.

Action Plan	Responsibility
Include Schedule Performance Index (SPI) reporting in monthly reports as construction work begins.	<u>Lead:</u> Deputy Director, Business Services <u>Support:</u> Senior Manager, Project Controls <u>Commitment Date:</u> November 30, 2022