

CAPITAL LINE SOUTH LIGHT RAIL TRANSIT EXTENSION PROJECT

ABSTRACT

The Capital Line South LRT is an LRT extension catering to the rapidly expanding residential areas south of Anthony Henday Drive and providing a viable transportation alternative to the University of Alberta and downtown Edmonton. The new alignment is integrated into neighborhoods, supports transit-oriented development, and emphasizes Sustainable Urban Integration principles, minimizing the need for the gates, bells, and lights associated with high-floor LRT lines, while ensuring safety.

The Capital Line Value Engineering workshops, comprising 50 participants, began with an overview of the vision, design effort, and work undertaken to date. As part of the function analysis phase, the Functional Analysis System Technique diagram was composed days before the main workshop with a small group. It was then presented to participants to build an understanding of the objectives/goals of the project. Participants then engaged in the Creativity Phase to generate new ideas.

The sessions concluded with an initial assessment of the options, removing those considered infeasible and classifying the remainder as design suggestions or full options. Participants performed a Holistic Value Index evaluation on the full options to determine which ones should be taken forward for further analysis and cost estimating.

The workshops generated 216 ideas and design suggestions, 21 of which were carried forward for further analysis. The workshop resulted in a total savings of \$194M. While certain options did increase cost, they also significantly increased the overall value/function of the project, whereby the owner called the workshop a complete success.

AUTHOR DETAILS

Sean Newstead, MSc, VMA has provided project management services on various projects, including the City of Edmonton's North LRT Drainage Projects and WESS stage W13 project, which received Consulting Engineers of Alberta Showcase Awards of Excellence and of Merit in Project Management, respectively. In addition to his training and computing expertise, he draws upon technical experience providing project controls management for drainage construction projects, including tunneling and open-cut installations. He is also the certified safety officer for the company having completed COR certification (Certificate of Recognition of Safety Excellence) from the Alberta Construction Safety Association. Having participated in construction project management, project risk analysis, constructability reviews, value engineering, safety management and audit, site inspections, and project planning and controls, Sean has extensive experience in these areas.

Adonis Dichoso, PEng, MBA, PMP understands emerging trends in oil and gas, transportation, and municipal engineering, blending industrial knowledge with design and construction, from project conception to completion. Adonis has experience in the seamless management, implementation, and execution of multiple projects and is a tenacious problem solver who can bring down cost, increase efficiencies, reduce operating downtime, improve teamwork, advance communications, and promote information flow. He successfully identifies, evaluates, and manages engineering requirements for complex oil/gas and transportation projects and has successfully streamlined operations of client projects through scope and objective development, preliminary project planning and design, and determining resources and timelines. Adonis is a cost-effective, proactive contributor with a proven ability to create and implement cross-functional processes, solve problems, and issue resolutions. Adonis maintains current knowledge regarding the trends in the ever-changing oil, transportation and Infrastructure industry.

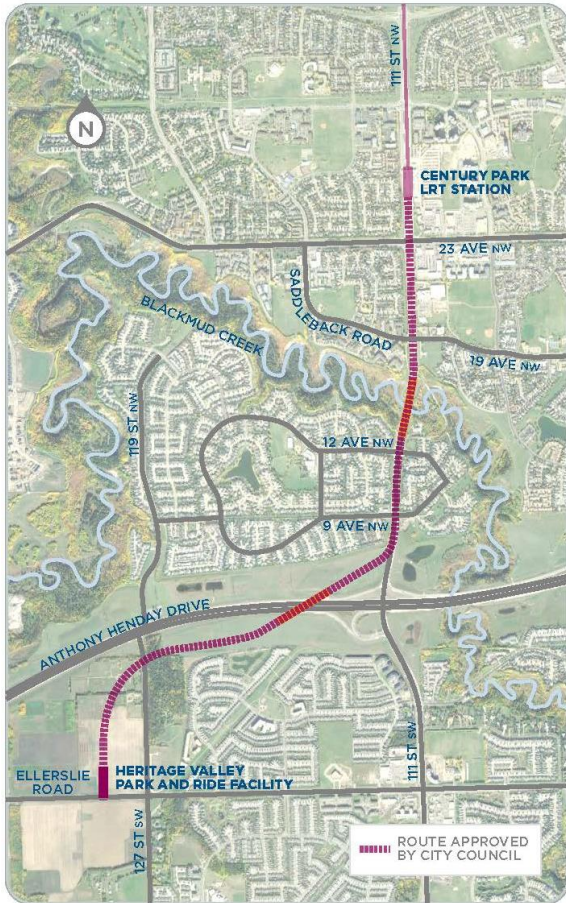


Figure 1 Project Area of the Capital Line LRT South Extension

locations have been

identified along the alignment.

The design of the alignment and stations reflects the City of Edmonton’s (the City) goal of an LRT system that is integrated into local neighborhoods, supports transit-oriented development (TOD), and embraces Sustainable Urban Integration (SUI) principles, minimizing the need for the gates, bells, and lights typically associated with high-floor LRT lines, while still ensuring safety.

Highlights of the proposed alignment are shown in **Error! Reference source not found.** and reflect the locations discussed during the workshop. The Transportation Utility Corridor (TUC) is provincially owned land located directly to the north and south of AHD. The Operations and Maintenance Facility (OMF) will provide a storage and maintenance garage for the LRT cars.

1. INTRODUCTION

The Capital Line South Light Rail Transit (LRT) Extension Value Engineering (VE) workshop sessions were held on July 25 and 26, 2017 at the Sutton Place Hotel in Edmonton, AB, and facilitated by SMA Consulting Ltd. (SMA). The workshop was spread over two days to provide sufficient background information to participants, while ensuring the list of options developed was both comprehensive and fine-grained. Following the workshop, the results achieved were refined and grouped, and high-level costs were developed for the most popular ideas.

2. PROJECT BACKGROUND

The Capital Line South LRT is a 4.5 km LRT extension from the existing Century Park LRT Station to Ellerslie Road via 111 Street, as shown in **Error! Reference source not found.**, catering to the rapidly expanding residential areas south of Anthony Henday Drive (AHD) and providing a viable alternative to commuters from Heritage Valley and Windermere to the University of Alberta (U of A) and downtown Edmonton. The extension includes one station to be incorporated into the Heritage Valley Park and Ride (P&R) on Ellerslie Road, and a potential station at Twin Brooks. Furthermore, three Traction Power Substation (TPSS)

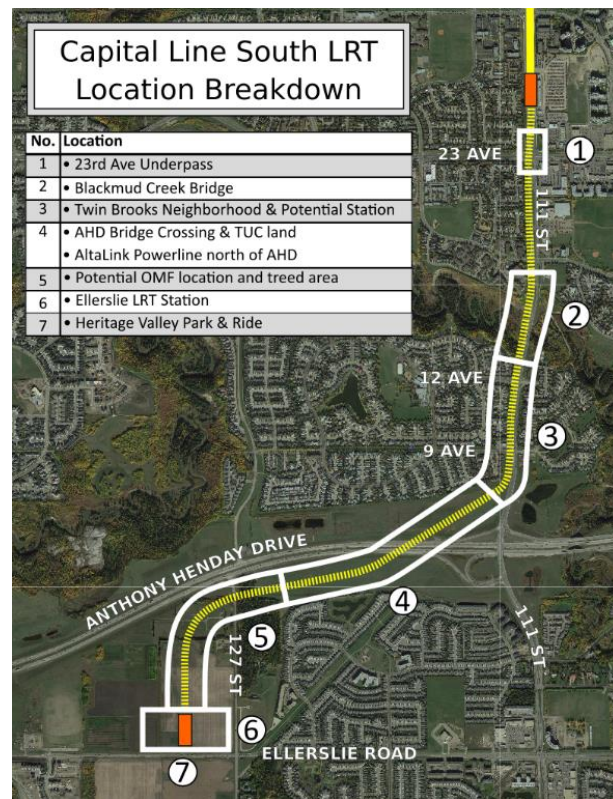


Figure 2 Location breakdown highlights for the alignment

3. METHODOLOGY

The VE workshop session began with an overview of the City LRT vision, design effort, and work undertaken to date. Participants discussed details, including schedule, budget, stakeholders, key constraints, and issues for each project portion. As part of the Function Analysis Phase, the Functional Analysis System Technique (FAST) diagram was created by a small management project team comprising various design disciplines, one week before the main workshop began. The FAST diagram was presented to the main workshop participants to build an understanding of project objectives/goals.

For the Creativity Phase, participants were split into smaller groups in order to generate new ideas and design supplements. For ease of brainstorming, the project was divided into four categories: strategic, community, structures and tunnel boring, and track and civil.

The workshop concluded with an initial assessment of the options, removing those considered infeasible and classifying the remainder as either design suggestions or full options. Participants regrouped to perform a Holistic Value Index (HVI) evaluation on these, then evaluated the viable options to determine which should be taken forward for further analysis and cost estimating.

4. INFORMATION: DRIVING IDEAS (CRITERIA & CONSTRAINTS)

The criteria were reviewed and expanded by the participants to guide them during the latter workshop phases, then weighted prior to evaluating key ideas. The criteria are as follows: Constructability, Public Impact, Environmental Impact, Operations, Accessibility, and Transit Oriented Development. Key constraints were also reviewed, generally revolving around critical locations or stakeholders.

It was noted that while the overall alignment is reasonably fixed, there is room for some adjustments within the corridor, including shifting the line within the TUC. The benefits and drawbacks of various grade separations were also discussed but will ultimately be decided by the City's crossing assessment and approved by City Council. Some other constraints included procurement-readiness timelines, level of service, and LRT speed with respect to safety precautions.

The project goal was to refresh the preliminary engineering performed in 2010 to ensure the City is shovel-ready for the upcoming phase of funding, as expanding the LRT system is key to meeting the City's growing transportation needs, as outlined in the City's "The Way We Move" strategic document.

The workshop goal was to review, refine, and evaluate the current options and to generate and define potential new options and design suggestions before determining those most favourable to project function and goals to carry forward. The workshop also successfully met one of the City's goals, which was to facilitate a large workshop that allowed the City and design team representatives from each of the design disciplines to collaborate and identify design constraints and opportunities as one team.

5. FUNCTION ANALYSIS: FOCUSING IDEAS

The functional analysis exercise can help participants determine the true objectives of the project in order to better guide them in the Evaluation Phase. A FAST diagram (Figure 3 below) was created by a small management project team composed of various design disciplines one week before the start of the main workshop. The diagram was constructed by writing out the functions on sticky notes and arranging them on a whiteboard where we could easily fill in and alter the characteristics of the FAST diagram, such as the in and out-of-scope lines. The works really well for establishing our critical logic path and differentiating it from what is secondary. After this was completed, we then replicated what was on the whiteboard digitally. During the workshop the participants were shown the FAST diagram and explained the way to read it as well as its logic. Feedback was instantaneous, and it was clear that the diagram was successful in demonstrating project constraints to the participants.

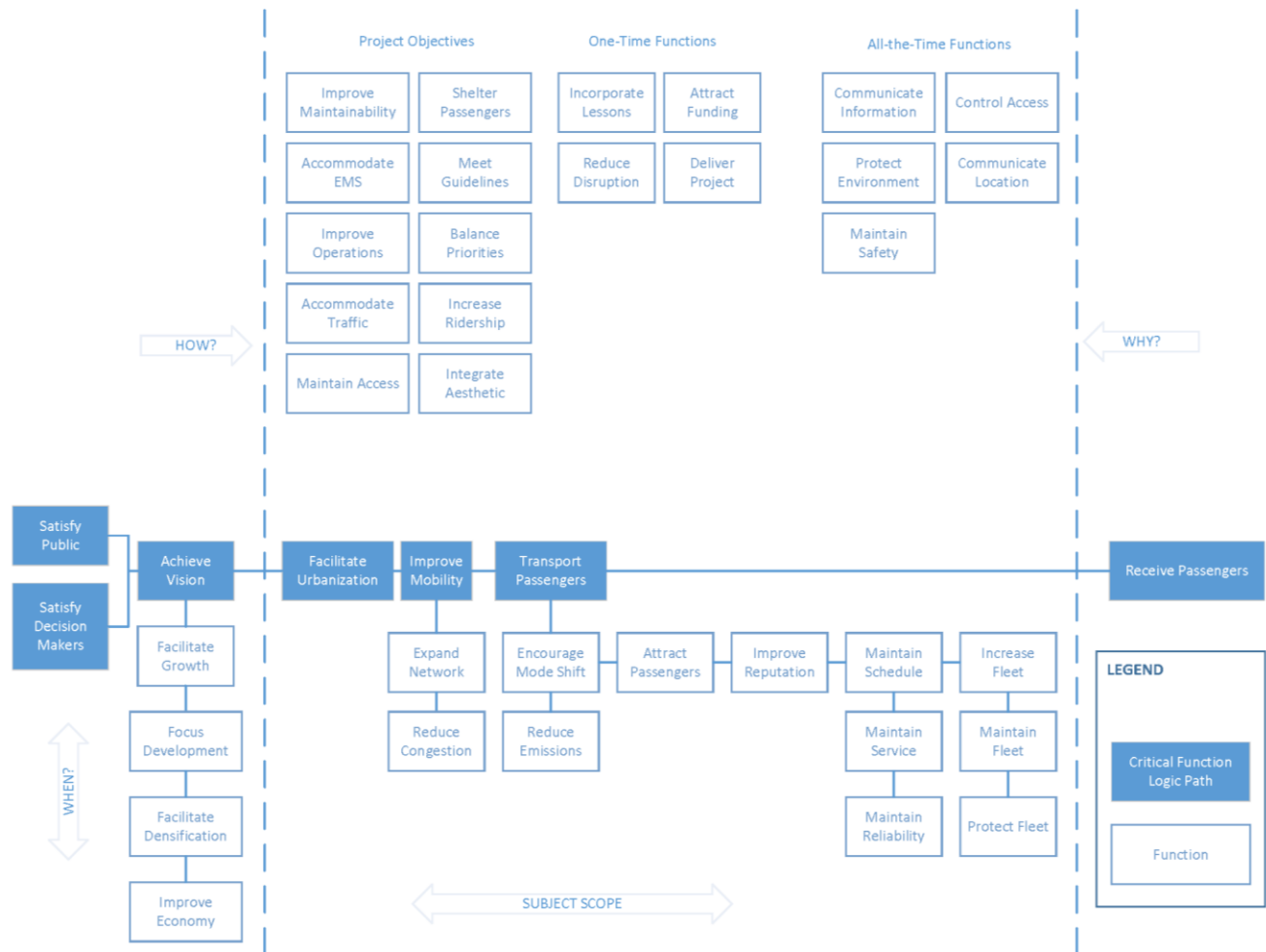


Figure 3 Capital Line LRT South Extension FAST Diagram

6. CREATIVITY: GENERATING IDEAS

Prior to the start of the workshop, the participants were categorised by the design discipline they represented on project. They were then further organised into City or design team participants and arranged into four groups, where each group had at least one representative from the City and the design team for each design discipline.

During the workshop, the groups were put through a critical thinking technique called World Café, which was used to increase the number and the quality of ideas gathered. Each facilitator hosted a topic (defined as: strategic, community, structures/Twin Brooks, and track/civil works) with a group for about half an hour. The participants then rotated to a different facilitator, reviewing the ideas generated by the previous group and expanding on them. This process allowed the participants to get up, move around, and grab refreshments as they proceeded to the next facilitator, something essential to alleviating fatigue. This process was repeated until every group had covered all the topics.

The smaller and more intimate atmosphere was highly effective in achieving continuous and active contribution from every participant. It also succeeded in generating a considerable number of ideas in a shorter than normal amount of time. Reviewing and expanding on the previous group's ideas helped each new group to start thinking about the topic, while reducing the amount of repetition. In total, 216 suggestions were generated.

7. OPTION EVALUATION: FILTERING & EXPANDING IDEAS

The initial evaluation began with filtering the options generated during the Creativity Phase, rejecting infeasible ideas and classifying the remainder as ideas to carry forward for further study or as design suggestions to improve full ideas. Following the smaller breakout sessions, participants came together again to evaluate the options as one large group.

Of the 216 suggestions generated during the creativity phase, 31 were considered full options; the remainder were termed design suggestions or were discarded. Participants evaluated these options using the HVI, a scale ranging from 1.0 to 5.0, with options scoring 3.0 or above kept for further investigation. Of the 31 full options evaluated using the HVI, 21 were carried forward for further investigation.

7.1 Project-Wide

Some project-wide landscaping topics discussed include using lighting to improve safety and walkability as per the SUI goals; the advantages and disadvantages of higher tree density along the alignment; collaborating with the Edmonton Arts Council to integrate public art into the alignment in a way that meets both safety and maintenance standards; public consultation to validate the artworks being used; and finally the opportunity to improve the aesthetics for the general project area.

The project-wide design suggestions discussed included the use of a catenary system to increase clearance; the advantages and disadvantages of various signalling systems; the advantages and disadvantages of operating speed options; grade separations and utilizing art and landscaping at elevation changes; a variety of ways to reduce noise impact; and station amenities and incentives to support active modes of transportation and reduce the number of vehicles.

Other topics discussed were Traction Power Substation (TPSS) aesthetics and locations to minimize impact while maintaining ideal power distribution through out the LRT alignment. Some safety-related design suggestions were the use of Crime Prevention Through Environmental Design principles, emergency phones and lights at pedestrian crossings, improved sightlines, safety cameras, and sidewalks at grade.

In terms of landscaping, some design suggestions follow: the strategic use of lighting, solar powered stations, streetscaping, encouraging community contribution via murals or urban gardens along the alignment, and tree-planting along medians to maximize buffering where needed while reducing impediments to regular maintenance and operations. General landscaping suggestions centred around the experience of the riders and the local residents, and balancing aesthetic needs with practical and safety needs. Connectivity-related suggestions included improved and integrated pedestrian and bicycle infrastructure, as well as allowing bicycles on the LRT during peak times.

7.2 23 Avenue Crossing

Discussions around the 23 Avenue Crossing included relocating all TPSS onto accessible City-owned land in the area; various drainage options; and the advantages and disadvantages of using a bridge or a tunnel to grade separate the major 23 Avenue and 111 Street intersection.

Some additional design suggestions debated were roadway adjustments; modifications to underpass construction; implementing the recommendations for a City-wide Flood Mitigation Study; and a potential increase in tunnel slope.

7.3 Twin Brooks Neighbourhood

Topics in the Twin Brooks area included the feasibility of a Twin Brooks Station, including location alternatives and the possibility of pre-designating a space for a future station should the community desires change, with additional studies needed to determine the cost. Another topic discussed was the feasibility of at-grade crossings versus grade separation, including costs, traffic and neighbourhood impact, safety, and aesthetics, with a recommendation for further public consultation and traffic modelling. Also included in the discussion were street connections and their impact on local and through traffic, and the potential need for an overpass, which would require provincial funding and delay procurement readiness. TPSS locations were also talked about, along with the various options' impact on cost,

schedule, operations, and maintenance.

Some general design suggestions for the area included adjustments to turning lanes; improving active transportation infrastructure; using various methodologies to reduce both environmental and local impact of the station; incorporating a residential parking program following public consultation; and emergency access options.

7.4 AHD & TUC

Several geometrically analyzed alternative alignments for crossing AHD were explored for feasibility, operability, and overall cost, as shown in **Error! Reference source not found.** below. The future 135 Street interchange is shown in red on the westernmost portion of the figure for context and effect on the options put forward.

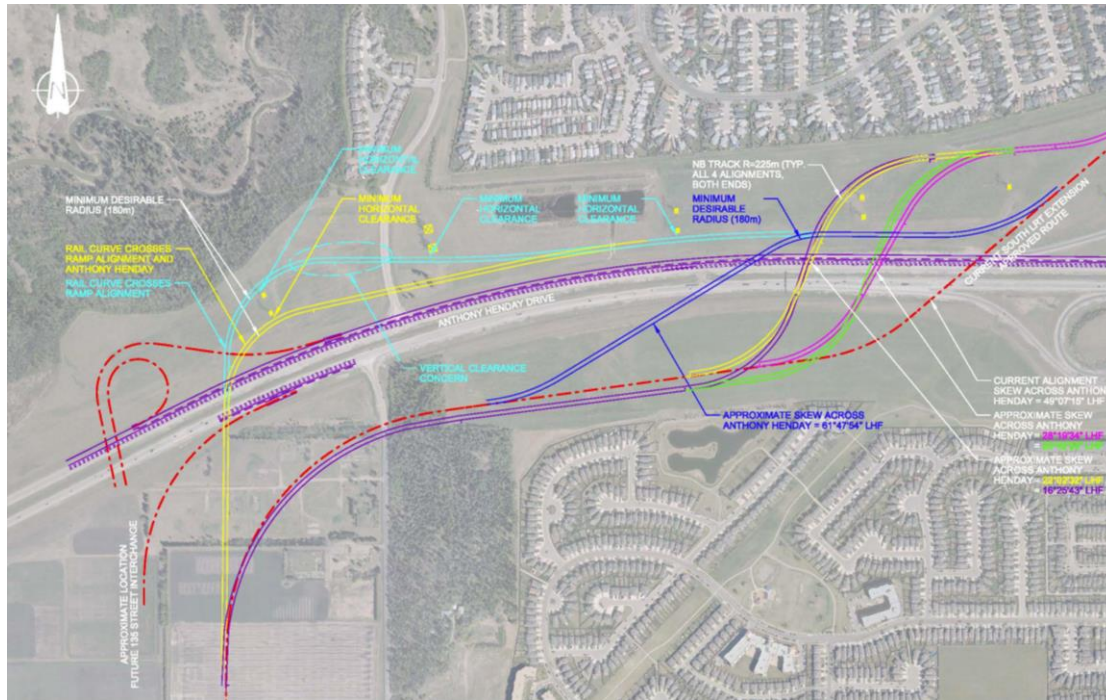


Figure 4 AHD bridge alternate alignment options

Some key findings were noted, including impacts on interchanges, bridge length, alignment conflicts, and technical implications. Discussion topics included bridge design, utilities interference, LRT clearance options, and potential TPSS location in bridge abutment.

7.5 OMF & U of A Lands

Options for the OMF included the timing of construction and the location of the OMF, as well as the HVI and costs associated with each option. Some of the concerns mentioned were expansion flexibility, reclamation and remediation costs, stakeholder input, funding timing, and potential for cost escalation. Additional design suggestions included landscaping as buffer and screening, along with various drainage strategies, some of which would require further study.

7.6 Eilerslie Station & Heritage Valley

Discussion topics included potential grade separation at Eilerslie Road and subsequent SUI impacts; the feasibility of elevating the station (see Figure 5 Potential Eilerslie Stacked Station RenderingFigure 5) vis-à-vis integrating the LRT with buses, thus reducing potential for pedestrian conflicts, and implementation of SUI principles; and the possible integration of a TPSS into the elevated guideway (see Figure 6). Some general design suggestions revolved around the timing of the Heritage Valley P&R and general

coordination to improve pedestrian experience and safety.



Figure 5 Potential Ellerslie Stacked Station Rendering



Figure 6 Potential TPSS Under the Elevated Guideway

8. CONCLUSION

The Capital Line South LRT Extension VE workshop sessions resulted in a successful FAST diagram that was produced ahead of the main workshop session by a small management group, before being further verified during the main workshop setting. Following this order saved a significant amount of time while still achieving a greater understanding of project functions and goals/objectives by the full workshop participants.

The City's goal of holding a 50-person VE workshop was successfully met by dividing the participants into smaller, strategically prearranged groups who then went through the World Café critical thinking

technique. This allowed us to condense the amount of in-workshop time and generate a significant number of ideas that ultimately increased the functionality of the current project.

Overall, 216 ideas and design suggestions were collected, 21 of which were carried forward for further analysis as main options, and 185 design suggestions were added to the current design. After combining the ideas generated, the total value saved was \$194M. While some options presented a higher cost, they significantly increased the overall value/function of the project and improved the client's project goals.

8.1 Next Steps

The final results of the workshop were presented to the City, and each of the options for the project's geographic areas to be carried forward was detailed and compared to the baseline design. All of the criteria were defined in order to reach a common understanding of their meaning for the project. We then proceeded with an Analytical Hierarchy Process to rank the options for each area, and to rank them against the baseline option. The output of this process was a rating score indicating a recommended option for each area. The design team is currently working through and validating the design suggestions and options carried forward, bringing greater insight and understanding to the AHP ranking process.