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Calgary North Central LRT

High Level Evaluation Report

October 2013

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High Level Evaluation Report

October 2013

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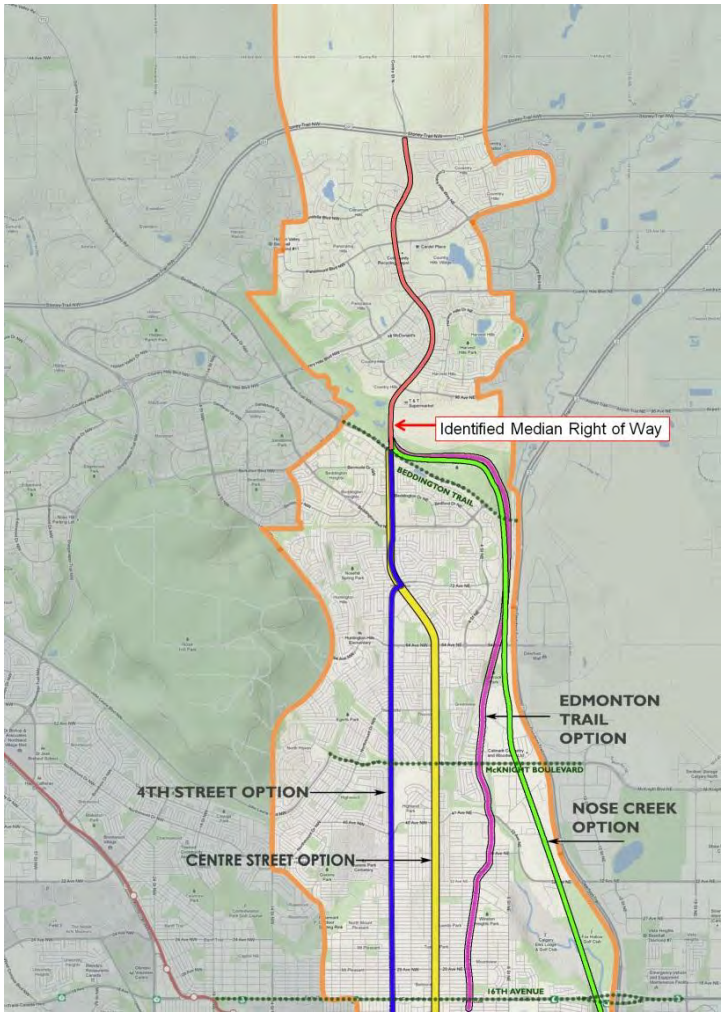
Executive Summary

Overview

1. On behalf of the City of Calgary, Steer Davies Gleave is working with Stantec Consulting Ltd.(Stantec), Context, and HR&A to deliver a concept study for the Calgary North Central LRT project. The study objective is to identify an effective solution for LRT for the North Central communities of Calgary. Tasks include identifying a route alignment and station locations, as well as how the line will integrate into the local community and with existing and planned transit services.
2. The work undertaken for this report is the initial phase of the project, which uses Multiple Account Evaluation (MAE) to evaluate the potential route alignments to the north of 16th Avenue. Another phase of the work will consider the possible alignments to the south of 16th Avenue, and then the project will move towards the detailed technical design phase.
3. The study area for this phase of the project is set out in the adjacent figure. Within the area four potential alignment corridors have been identified – 4th Street, Centre Street, Edmonton Trail and Nose Creek. Three of these corridors had been identified as part of the previous work undertaken, and the fourth (4th Street) was identified as part of the initial public consultation.
4. A Multiple Account Evaluation (MAE) was utilised to reduce a full long list of potential options to a shorter list which will be taken forward for more detailed analysis in the next phase of the study. The work in this phase only considered the section of the alignments north of 16th Avenue.
5. The basis for the MAE work was the project Vision and Objectives. Each helped shape the MAE accounts and criteria used to distinguish between the proposed options. The project Vision is set out below, and has been endorsed by the public and City stakeholders through the consultation process.



A transit service that improves mobility in existing and new communities in North Central Calgary, connecting people and places, and enhancing the quality of life in the City

6. The project Objectives were linked to a series of accounts for the Multiple Account Evaluation, and are set out in the table below. For this stage of the project, high level criteria were developed under each of the project Objectives and those are set out in the following table. The high level criteria were developed to highlight the differences between the various options. The criteria were selected based on data availability and the level of effort required to undertake the evaluation (given the number of potential options identified for this initial assessment).

MAE Accounts	NC LRT Draft Project Objectives
Financial Capacity / Sustainable Corporation	An affordable and cost-effective service- A service that has costs that are achievable, sustainable in the longer term and provide value for money
Community Well-being	A safe, secure and socially inclusive service that improves access to key community destinations and encourages walking and cycling
Prosperous Economy	A service that promotes economic development by improving access to employment, without adversely impacting goods movement
Transportation	A high priority transit service that attracts transit use, walking and cycling as preferred mobility choices for Calgarians and that integrates with, improves customer experience, meets the future demand of, and strengthens the regional and Frequent transit networks
Urban Development / Urban Realm	A service that supports current and future land use and intensification of development along the corridor, integrating with the character of the communities it passes through
Sustainable Environment	A service that facilitates a reduction in GHG emissions while not impacting the City's current natural environment
Deliverability	A service that can be constructed and operated without significant technical issues or constraints

7. Following this initial evaluation, a further more detailed evaluation will take place, as such, this high level MAE is a screening process to reduce the number of options which are taken forward to more detailed design.

NC LRT Project Accounts	High Level MAE Criteria
Financial Capacity / Sustainable Corporation	Capital Cost – high level estimate based on route length and on-street and off-street construction cost estimates per kilometre
Community Well-being	Links to Community destinations – evaluation of the number of community destinations within 400m of the proposed route alignments
Prosperous Economy	Population and Employment catchments – GIS assessment of the population and number of jobs within 400m of each of the alignments
	Improving city competitiveness through access to YYC – Business feedback
Transportation	Ridership – based on an initial catchment analysis
	Transit efficiency / compatibility – consideration of how the proposed alignment / option would link in with the existing regional and Frequent transit networks
	Journey time by segment – consideration of likely journey times for each of the alignments based on the three key geographic segments identified
Urban Development / Urban Realm	TOD Opportunity – qualitative assessment of the level of potential for TOD on each of the alignments, split by the three geographic areas
	Urban Realm– qualitative assessment of the level of potential for urban realm improvements on the alignments, split by the three geographic areas
Sustainable Environment	Route impact on existing natural environment – qualitative assessment on the like impacts during construction and operation, split by geographic area
Deliverability	Constructability - technical constraints – initial constraints identified as part of the corridor scoping exercise and as part of the review of previous work

6. Within the area four potential alignment corridors, 10 individual options were developed. For each of the 10, the high level MAE framework was used to evaluate each one using five-point scoring scales. Where there were multiple criteria for a single account, the average value was taken and included within the evaluation total. Criteria totals were summed across each of the accounts. A summary of the results is presented below.

High Level MAE Report

MAE Accounts	Criteria	Option 1 - 4th Street at grade	Option 2 - 4th Street elevated	Option 3 - 4th Street underground	Option 4 - Centre Street at grade	Option 5 - Centre Street elevated	Option 6 - Centre Street underground	Option 7 - Edmonton Trail at grade	Option 8 - Edmonton Trail elevated	Option 9 - Edmonton Trail underground	Option 10 - Nose Creek at grade
Financial Capacity / Sustainable Corporation	Capital cost	5.0	2.0	1.0	5.0	2.0	1.0	5.0	4.0	2.0	5.0
Community Well-being	Links to community destinations	5.0	4.5	4.0	5.0	4.5	4.0	4.0	3.5	3.0	1.0
Prosperous Economy	Population and Employment	2.5	3.0	3.0	3.5	4.0	4.0	4.5	5.0	5.0	2.3
	Access to YYC	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	2.0
	Overall	**2.3**	**2.5**	**2.5**	**2.8**	**3.0**	**3.0**	**3.8**	**4.0**	**4.0**	**2.1**
Transportation	Ridership (based on catchment)	3.5	3.5	3.5	5.0	5.0	5.0	4.0	4.0	4.0	1.5
	Transit efficiency / compatibility	4.0	2.0	2.0	4.0	2.0	3.0	5.0	4.0	4.0	1.0
	Journey Time by segment	3.0	4.0	4.0	3.0	4.0	4.0	3.0	4.0	4.0	3.5
	Overall	**3.5**	**3.2**	**3.2**	**4.0**	**3.7**	**4.0**	**4.0**	**4.0**	**4.0**	**2.0**
Urban Development / Urban Realm	TOD Opportunity	2.0	2.0	3.0	4.0	4.0	5.0	4.0	4.0	5.0	3.0
	Impact on Urban Realm	2.0	1.0	3.0	4.0	1.0	4.0	4.0	1.0	4.0	3.0
	Overall	**2.0**	**1.5**	**3.0**	**4.0**	**2.5**	**4.5**	**4.0**	**2.5**	**4.5**	**3.0**
Sustainable Environment	Impact on Natural Environment	4.0	4.0	4.0	5.0	5.0	5.0	3.0	3.0	3.0	1.0
Deliverability	Technical constraints	1.0	1.0	1.0	3.0	3.0	3.0	2.0	2.0	2.0	4.0
Overall		**22.8**	**18.7**	**18.7**	**28.8**	**23.7**	**24.5**	**25.8**	**23.0**	**22.5**	**18.1**

7. As demonstrated in the table, the Centre Street and Edmonton Trail options performed better than the 4th Street and Nose Creek alignments. Among the Centre Street and Edmonton Trail options, the at-grade options received the highest scores, and so they are recommended to be taken forward to the detailed design and analysis stage:

   - Option 4 – Centre Street at grade
   - Option 7 – Edmonton Trail at grade

8. The next step for the project is to undertake a more detailed evaluation and design for these two options. It should be noted that this decision means that the 4th Street and Nose Creek options will no longer be considered. Hybrid alternatives of underground and elevated options on the Edmonton Trail and Centre Street alignments will be considered further if during the detailed assessment, there are constraints identified with the at-grade options.

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1 Introduction and Overview

Introduction

1.1 Steer Davies Gleave are working with Stantec, Context, and HR&A to deliver a concept study for the Calgary North Central LRT project on behalf of the City of Calgary. The objective of this study is to identify an effective solution for building LRT to the North Central communities of Calgary.

1.2 The plan will identify an alignment, an LRT technology, station locations, integration into the local communities and finalize a plan for connecting to the wider City of Calgary transit network. The study will identify and quantify the impacts on those who drive, take transit, own businesses, or live near the corridors through a Multiple Account Evaluation (MAE) process. This work is phase one in part of a larger project aimed to ultimately deliver LRT to communities in the North Central area of Calgary.

1.3 Within key City of Calgary documents including the Municipal Development Plan (MDP), Calgary Transportation Plan (CTP) and the RouteAhead, North Central Calgary is identified as the location for a LRT connection to Downtown, although the alignment has not yet been finalised.

1.4 Previous work undertaken in 2006 and 2008 as part of the 'North Central Transit Corridor Review' and the 'South Nose Creek Planning Area Study', identified the Nose Creek alignment as being the best option to serve the expanding communities to the north, providing greater journey time savings for these communities.

1.5 In 2012, the RouteAhead focused on matching transit and land use, supporting activity centres and corridors and supporting intensification of population and employment. This study is being undertaken to not only consider access to Downtown for the expanding and future communities to the north, but also for the existing communities closer to the Downtown. This dual focus brings other alignments into the area into consideration.

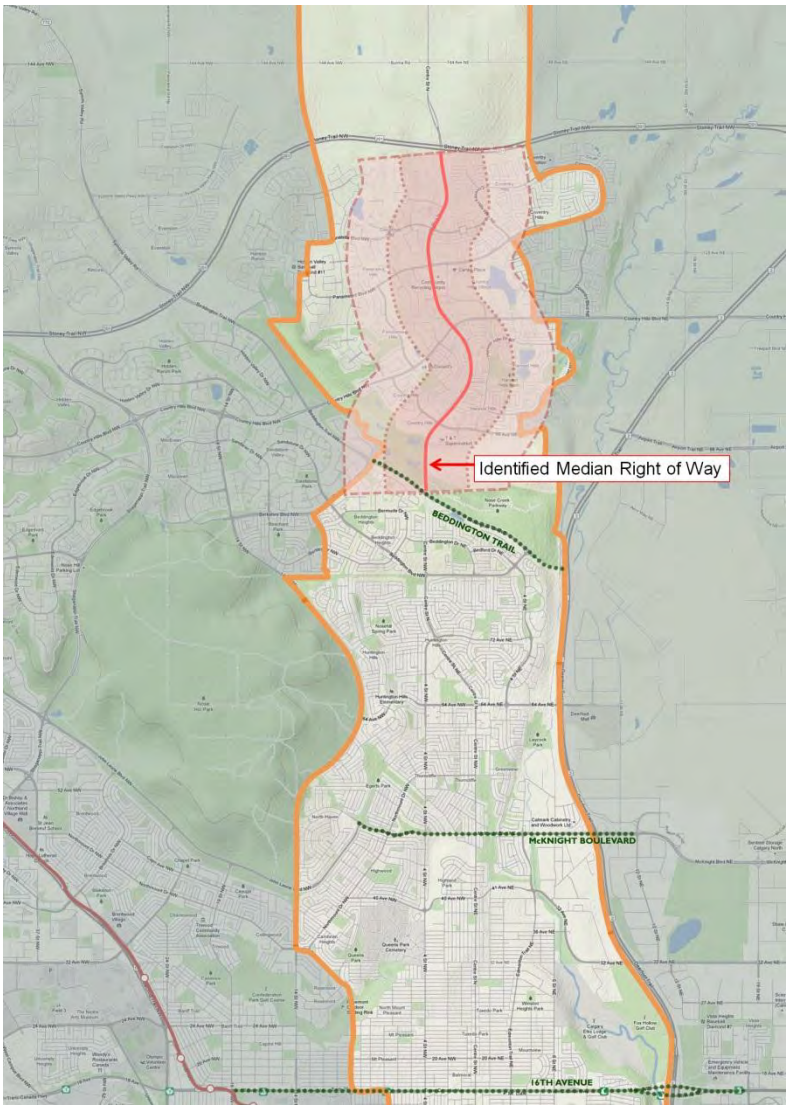
Study Area

1.6 For the purposes of this study, the study area has been defined as set out in figure 1.1 overleaf and has been defined to be consistent with the City of Calgary Transportation Zones used in the regional modelling.

1.7 Previously three alignments had been identified for review within the study area – Nose Creek, Centre Street and Edmonton Trail. Having looked at the study area and noted feedback from the community outreach events, an additional 4th Street alignment was included in the high level list of options.

1.8 The Study area was checked to ensure that 1000m catchments around each of these alignments were included.

FIGURE 1.1 FIGURE SHOWING EXTENT OF NORTH CENTRAL LRT STUDY AREA



Report Context and Purpose

1.9 This report documents the work undertaken for the high level Multiple Account Evaluation (MAE). The purpose of the work is to consider a number of potential options for the NC LRT project, and reduce these down to a smaller number of options to be taken forward for more detailed analysis. This document sets out the criteria and process undertaken to do this and provides an audit trail to show the rationale behind the final outcomes.

1.10 The outputs of this report will be a reduced set of options to be taken forward to the more detailed analysis phase, as well as documenting the steps that led to that decision being taken.

1.11 The multiple account evaluation for this project is a two-step process and the first step documented in this report is the high level evaluation. The second step will take place once further detailed analysis has been undertaken on the shortlisted options and will include a more detailed MAE with a broader range of criteria being evaluated for each option.

Report Structure

1.12 This report includes the following chapters and these are supported by a number of appendices:

- Executive Summary
- Chapter 1: Introduction and Overview
- Chapter 2: Project Vision and Objectives
- Chapter 3: Multiple Account Evaluation
- Chapter 4: Option Development
- Chapter 5: Financial Capacity / Sustainable Corporation
- Chapter 6: Community Well-being
- Chapter 7: Prosperous Economy
- Chapter 8: Transportation
- Chapter 9: Urban Development / Urban Realm
- Chapter 10: Sustainable Environment
- Chapter 11: Deliverability
- Chapter 12: Summary and Conclusions

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Marseille Lowfloor LRT

2 Project Vision and Objectives

Purpose of Project Vision and Objectives

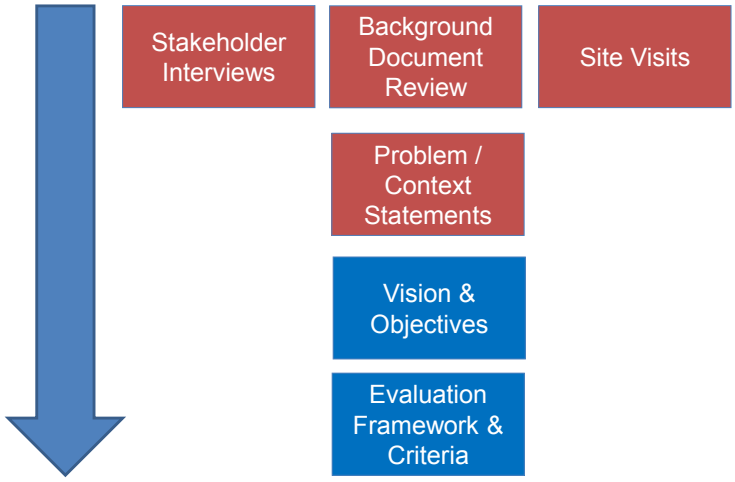
2.1 Setting an appropriate Vision and objectives for the project in the early stages of the work is crucial for ensuring project success.

2.2 It allows any issues or decisions that need to be made, to be evaluated on the basis of the established Vision and objectives. It has also been found to assist in the project evaluation if the evaluation accounts align with the project objectives, making it easier to assess if the project objectives have been met.

Development of Project Vision and Objectives

2.3 The figure below shows the typical inputs needed to develop Vision and objectives for a project. It is important to capture the knowledge, understanding and needs of the local residents and stakeholders, and recognise this through the Vision and objectives that are developed.

FIGURE 2.1 TYPICAL PROCESS FOR GENERATING VISION AND OBJECTIVES



Project Vision

2.4 The Vision for the project should explain the overall aim or purpose of the project, and provide a 'big-picture' focus. It should be referred to as the project progresses to inform priorities and decision making. It was developed in consultation with the client, and validated with internal and external stakeholders for the project.

2.5 The draft project Vision was developed at a team working session and then refined following input from the Project Steering Committee. City policy documents and stakeholder inputs were considered during the Vision development.

2.6 Following the input received from the consultation process, a number of changes were made and the revised project vision is set out below. In this vision statement, the goals of improved mobility, enhanced quality of life and connecting people and places are recognized. To be successful, the study must identify a transit service for existing and new communities in North Central Calgary that will achieve these outcomes.

- ***A transit service that improves mobility in existing and new communities in North Central Calgary, connecting people and places, and enhancing the quality of life in the City***

Project Objectives

2.7 Project objectives provide further detail over and above the project vision and clarify how the alternatives will be measured/compared against each other. Flowing from the Vision Statement, the supporting objectives help to inform the detailed evaluation criteria and explain, justify and prioritise trade-offs between options.

2.8 Each objective is then supported by detailed criteria that will be used to measure and assess the relative performance of the options and it is important to consider how the objectives will be used to evaluate options, during the development process.

2.9 When developing project objectives, it is important to consider the results that can be achieved given the available time, resources and project scope. As well as being key to option evaluation, it is also important that the objectives align with current City policy and priorities.

2.10 The City of Calgary has a number of existing documents and policies that set out different priorities for the City, including those areas against which the project should be evaluated. Ideally the objectives for the NC LRT project would align and be consistent with these. Policy documents that were reviewed during the development of the objectives included the 2020 Sustainability direction, Calgary 'Triple Bottom Line', the Transportation Infrastructure Investment Plan, imagineCalgary, the Municipal Development Plan, Calgary Transportation Plan and the RouteAhead.

2.11 Taking into account all of the inputs discussed above, and incorporating minor revisions to take account of feedback received from stakeholders and the public; the project objectives are set out below:

- An affordable and cost-effective service - A service that has costs that are achievable, sustainable in the longer term and provide value for money
- A safe, secure and socially inclusive service that improves access to key community destinations and encourages walking & cycling
- A service that promotes economic development by improving access to employment, without adversely impacting goods movement
- A high priority transit service that promotes transit use, walking and cycling as preferred mobility choices for Calgarians that integrates with, improves customer experience. meets the future demand of, and strengthens the regional and Frequent transit networks

- A service that supports current and future land use and intensification of development along the corridor, integrating with the character of the communities it passes through
- A service that facilitates a reduction in GHG emissions while not impacting the City's current natural environment
- A service that can be constructed and operated without significant technical issues or constraints

Community Objectives

2.12 Through the stakeholder consultation process, we received a number of comments wanting to expand the Vision to be more specific around certain issues, and although the feeling was that these issues had been covered in either the Vision or the objectives, it was decided that it would be helpful for the project and the consultation process if an additional set of 'Community Principles' were developed for the project.

2.13 These Community Principles sit between the Vision and objectives and aim to expand on some of the points in the Vision without having to create a very detailed and complex Vision statement. The Community principles developed are set out below.

2.14 North Central LRT should:

- Enhance connectivity between people and places, connecting to all modes of transportation in the community;
- Contribute positively to community development and revitalization;
- Be the affordable transportation mode;
- Be accessible for people to get to, board and use;
- Contribute to the character and cohesion of the community through integrated design with no barriers to accessibility;
- Contribute to an efficient traffic management system that promotes the right transportation choice, and reduces congestion and travel times;
- Contribute to the vitality of businesses in the community by promoting business development and access;
- Enhance the environment by contributing to reducing GHGs, protecting natural areas and urban beautification;
- Create a positive transportation experience - safe, accessible, efficient; and
- Contribute to complete streets including landscaping and urban form, and pedestrian and cycling systems.

2.15 As the project progresses, the Vision, objectives and Community principles should be reviewed against the project progress to ensure that all work is focused in meeting the goals that have been identified.

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3 Multiple Account Evaluation Methodology

Overview

3.1 This project is using a Multiple Account Evaluation (MAE) approach in order to identify the benefits and impacts of a number of options through a mixture of qualitative and quantitative measures across a range of different areas or 'accounts'.

3.2 The MAE framework developed, will be used to:

- Consider the broader impacts of projects beyond financial/cost to include qualitative impacts/benefits;
- Show the trade-off among often conflicting objectives; and
- Assess the alternatives against the project objectives examining the direct and broader public policy impacts.

3.3 It should be remembered that evaluation is not a single step process, and the framework and methodology needs to be scalable and consistent. These accounts will be covered in the two-stage evaluation process - an initial high level MAE screening will be undertaken using readily available data (as documented in this report), and this will be followed by a more detailed MAE once outputs from the majority of the project workstreams have been completed.

3.4 The accounts selected are aimed to cover a broader range of issues than a simple monetised cost benefit analysis and aim to try and capture more of the qualitative benefits and impacts of the options and document these, and the decisions taken on the basis of these clearly and transparently.

Development of Accounts

3.5 The Multiple Account Evaluation accounts were developed by the project team and validated through a round of public and wider stakeholder consultation. Initial accounts were based on City of Calgary policy documentation including the Calgary 'Triple Bottom Line', the Municipal Development Plan (MDP), the Calgary Transportation Plan (CTP), imagineCalgary, the RouteAhead and the 2020 Sustainability direction.

3.6 Closely aligning the accounts with the policy documentation, helps not only to provide weight to the objectives identified, but can also help to gather data which can be used to validate progress against the stated policies.

3.7 In reality, the accounts were developed in parallel with the project objectives, to ensure an integrated and joined-up approach. The accounts selected for the MAE are set out in the table below, along with the corresponding project objective.

TABLE 1 MAE ACCOUNTS SET AGAINST PROJECT OBJECTIVES

MAE Accounts	NC LRT Draft Project Objectives
Financial Capacity / Sustainable Corporation	An affordable and cost-effective service- A service that has costs that are achievable, sustainable in the longer term and provide value for money
Community Well-being	A safe, secure and socially inclusive service that improves access to key community destinations and encourages walking and cycling
Prosperous Economy	A service that promotes economic development by improving access to employment, without adversely impacting goods movement
Transportation	A high priority transit service that attracts transit use, walking and cycling as preferred mobility choices for Calgarians and that integrates with, improves customer experience, meets the future demand of, and strengthens the regional and Frequent transit networks
Urban Development / Urban Realm	A service that supports current and future land use and intensification of development along the corridor, integrating with the character of the communities it passes through
Sustainable Environment	A service that facilitates a reduction in GHG emissions while not impacting the City's current natural environment
Deliverability	A service that can be constructed and operated without significant technical issues or constraints

MAE Criteria

3.8 Once the project accounts and objectives have been agreed, it is necessary to develop the criteria under each of the accounts that will be used to assess the impacts and benefits relating to that account. It is possible to have a huge number of criteria against each of the accounts that would be time-consuming to establish and document, however one of the key things with selecting the criteria, is to ensure that the results will vary across the different options. It is this variation that will allow the options to be differentiated and screening / reduction in the number of options to go forward to allow a more detailed assessment to be made.

3.9 As set out previously, this project will employ a two-step evaluation process, using two different sets of criteria. The criteria utilised in the initial high-level evaluation will be driven by time constraints and data availability, and as such will be quite limited, but enough to distinguish between the options.

3.10 Once the number of options has been reduced, more detailed analysis will be undertaken and the outputs from this work will help to inform a more detailed MAE which will include a greater number and wider range of criteria under each of the accounts. Information on the criteria selected for both the high level and detailed evaluations are set out below.

3.11 In both the high level and detailed MAE evaluation, the option is compared against a Business as Usual (BAU) scenario. For the high level evaluation, the BAU scenario has been set as the present day. For the detailed evaluation, the BAU for comparison will be decided on before the evaluation commences.

High Level MAE Criteria

3.12 As discussed previously it is planned to undertake a two stage MAE process to inform the decision making process. The early evaluation will be undertaken using readily available data and the results of this evaluation may reduce the number of options that are taken forward to the detailed MAE process.

3.13 This potential high level screening allows effort to be focussed on the most likely options, as it is key to the MAE process that all options are evaluated on a similar basis. To take too many options forward to the detailed MAE would limit the time and budget available to look at each of the options in as much depth as possible.

3.14 Taking into consideration the data that is readily available (or can be obtained within the required budget and timescales), the data sources below have been identified as being feasible for use in the initial evaluation process. For clarity, the criteria have been set out against each of the different evaluation accounts.

TABLE 2 PROPOSED HIGH LEVEL MAE CRITERIA

NC LRT Project Accounts	High Level MAE Criteria
Financial Capacity / Sustainable Corporation	Capital Cost – high level estimate based on route length and on-street and off-street construction cost estimates per kilometre
Community Well-being	Links to Community destinations – evaluation of the number of community destinations within 400m of the proposed route alignments
Prosperous Economy	Population and Employment catchments – GIS assessment of the population and number of jobs within 800m of each of the alignments
	Improving city competitiveness through access to YYC – Business feedback
Transportation	Ridership – based on an initial catchment analysis
	Transit efficiency / compatibility – consideration of how the proposed alignment / option would link in with the existing regional and Frequent transit networks
	Journey time by segment – consideration of likely journey times for each of the alignments based on the three key geographic segments identified
Urban Development / Urban Realm	TOD Opportunity – qualitative assessment of the level of potential for TOD on each of the alignments
	Urban Realm– qualitative assessment of the level of potential for urban realm improvements on the alignments

NC LRT Project Accounts	High Level MAE Criteria
Sustainable Environment	Route impact on existing natural environment – qualitative assessment on the likely impacts during construction and operation
Deliverability	Constructability - technical constraints – initial constraints identified as part of the corridor scoping exercise and as part of the review of previous work

Detailed MAE Criteria

3.15 The high level evaluation process is very much limited by time and data availability factors, and as such the criteria against which the options are evaluated at this stage are limited. This issue will be addressed when the detailed MAE takes place.

3.16 The detailed evaluation will not take place until much later in the project, and as such, is not documented in this report. It was felt however that it would be useful to set out the proposed detailed evaluation criteria at this point to show the potential extended scope of the criteria that will be considered going forward.

TABLE 3.3 DETAILED MAE CRITERIA

MAE Accounts	Detailed MAE Criteria (to be confirmed)
Financial Capacity / Sustainable Corporation	Capital cost Benefit Cost Ratio Operating and Maintenance costs Cost per new rider Cost per passenger km Phasing possibilities Impact on existing City assets e.g. land
Community Well-being	Low income population served Links to Community destinations Impact on community cohesion Safety Emergency access Preservation of community heritage User Centred Design/Accessibility Integration of / provision of facilities for walking & cycling
Prosperous Economy	Employment & population catchments Construction effects (employment & GDP) Access to YYC Impact on Goods movement

MAE Accounts	Detailed MAE Criteria (to be confirmed)
Transportation	Route ridership Changes in journey time (auto & transit) Reliability Matches projected capacity needs Enhancing transportation choices and experience Impact of displaced traffic and demand on parallel routes Impact on parking
Urban Development / Urban Realm	Land use diversity & residential mix Land use integration (MACs within 200m) Land use / TOD potential Land acquisition impacts Contributes to 'complete streets' / improved streetscape
Sustainable Environment	Vehicle kilometers travelled / GHG calculation Route impact on existing natural environment Potential for Brownfield development Impact on parks and open spaces Noise Impacts Impact on water/aquatic environment
Deliverability	Constructability - technical constraints Acceptability Funding and affordability Policy support

3.17 In applying the framework, no explicit weightings are given to the different accounts. Individual decision makers / agencies will consider the implications and understand the potential effect of implicitly or explicitly applying different weightings.

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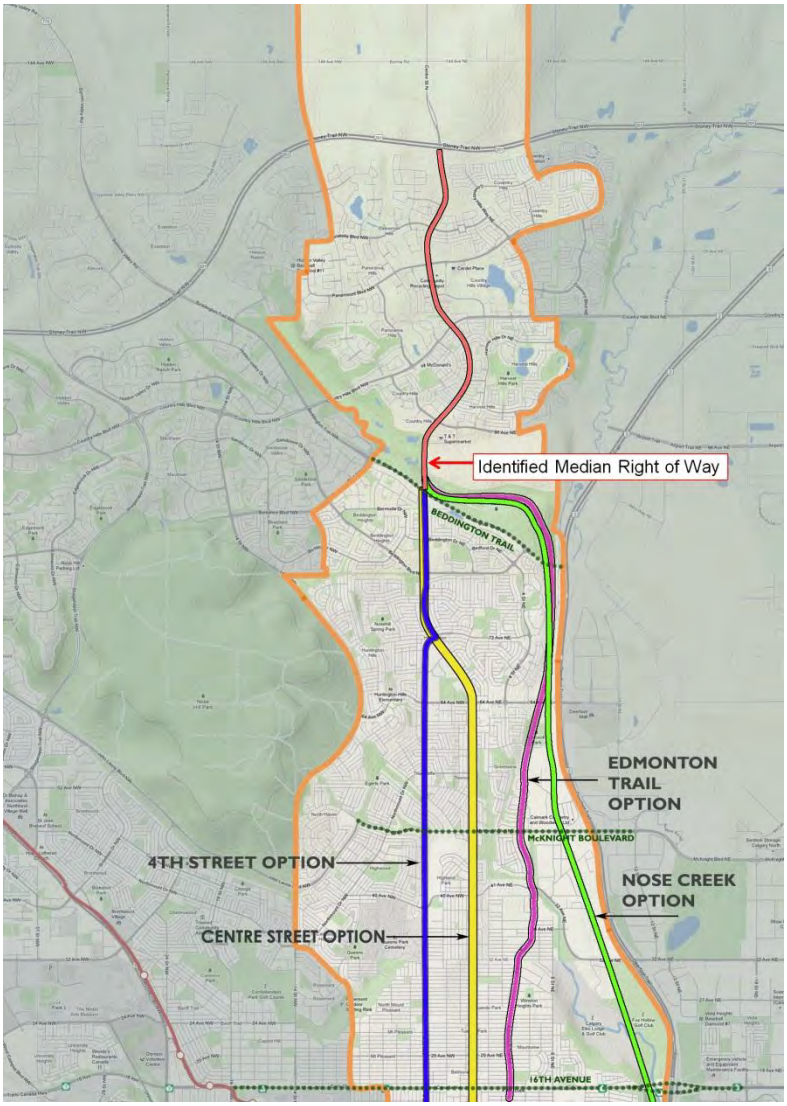
TriMet Max LRT, Oregon

4 Option Development

Study Area Overview

4.1 As set out in the report introduction, the study area for this phase of the project (preliminary MAE to the north of 16th Avenue) has been defined as set out in the figure below, and four main route options have been identified. Based on these four horizontal alignments, and three vertical alignments, a series of options to be evaluated have been established.

FIGURE 4.1 STUDY AREA MAP WITH 4 ROUTE CORRIDORS



Geographic Split of Alignments

4.2 Rather than summarise the characteristics of an alignment over the entire route length, it was decided to split the evaluation into different route sections, split as follows:

- North of Beddington Trail;
- McKnight Boulevard to Beddington Trail;
- 16th Avenue to McKnight Boulevard; and
- Downtown to 16th Avenue.

North of Beddington Trail

4.3 At this point all of the alignments are identical as there is a planned alignment reserved along the median. This section will not be considered as part of the high level evaluation as it will not allow differentiation between the current options.

McKnight Boulevard to Beddington Trail

4.4 Between McKnight Boulevard and 72nd Avenue, the four route options are completely separate. Between 72nd Avenue and Beddington Trail, the 4th Street alignment and the Centre Street alignment are both assumed to run on Centre Street. Between Beddington Boulevard NE and Beddington Trail, both the Edmonton Trail and Nose Creek alignments are assumed to run on Beddington Trail.

16th Avenue to McKnight Boulevard

4.5 Between 16th Avenue and McKnight Boulevard, the four route options are completely separate. In this section the Edmonton Trail and Centre Street options are the most constrained they are along their route length.

Downtown to 16th Avenue

4.6 There are a significant number of options for how each of the alignments would connect into the Downtown and whether or not they would or could connect into the other existing and planned LRT times. Many of these options are dependent on the technology used e.g. low floor or high floor LRT, as well as constraints on the existing connections to Downtown and plans for additional Downtown connections.

4.7 To fully understand the possibilities, significant additional detailed work would need to be undertaken, and it is felt that this effort would be more useful once the number of options had been reduced both in terms of alignments and the technologies that would be used. Any known issues that are specific to the options will identified under the Deliverability criteria.

4.8 It is acknowledged that connecting to Downtown will be a very important part of the study going forward, but that with the information currently available, considering the Downtown connection will not assist in significantly reducing the number of options at this high level evaluation stage.

Option Scope

4.9 Having considered the study area, four general alignments were identified:

- 4th Street;
- Centre Street;
- Edmonton Trail; and
- Nose Creek.

4.10 It should be noted at this point it is considered that each of the options would predominantly be situated along the specified alignment, but it does not rule out the possibility that at some point in the future, some deviation off the alignment may be required. For example the Centre Street alignment may route along Edmonton Trail for a short section if capacity issues are identified through the detailed design work.

4.11 As well as considering the horizontal alignment, vertical alignments were also considered. Note that for the Nose Creek route, only a single vertical alignment was considered. Each of the options set out below are described as being either 'at grade', 'elevated' or 'underground'. While at this stage detailed technology is not part of the work, in general terms the three options are described below.

At-Grade System

4.12 This system runs at street level and is assumed to be either high or low floor LRT. At this point the level of segregation between the traffic and the LRT has not been determined. Examples of at-grade systems are given below.

4.13 Generally at-grade systems, depending on the design, can provide good accessibility with no requirement to utilise steps. The difference between segregated and unsegregated systems is mainly the level of separation from general traffic movements and the level of priority that can be given. Higher levels of segregation can lead to quicker and more reliable journey times.

FIGURE 4.2 AT-GRADE LOW FLOOR 'URBAN-STYLE' LRT

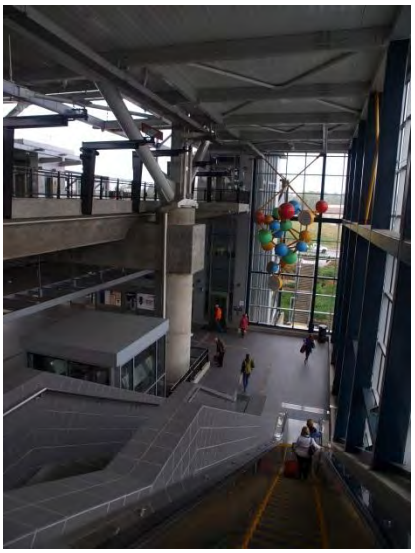
FIGURE 4.3 HIGH FLOOR LRT – AS CURRENT CALGARY SYSTEM

Elevated System

4.14 A system based on a principle of elevation can provide fast reliable journey times, and can be completely automated, such as the Skytrain system in Vancouver, British Columbia. Access can be more difficult and the need for significant structures to support the elevated system can create barriers within the community and create voids underneath, which can be difficult to develop.

FIGURE 4.4 ELEVATED SYSTEM IN VANCOUVER BC

FIGURE 4.5 LINK LRT SYSTEM IN SEATTLE WASHINGTON



Underground System

4.15 Systems that run completely underground, generally can provide a very high capacity (rather than other systems that run underground for short sections to avoid constraints at specific locations.) Construction impacts can be significant and access, as well and the perception of safety and security can be issues.

FIGURE 4.6 EXAMPLE OF AN UNDERGROUND SYSTEM IN VANCOUVER BC

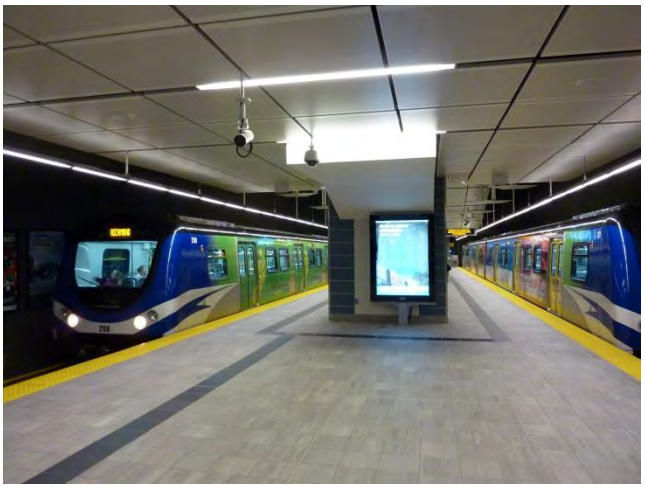
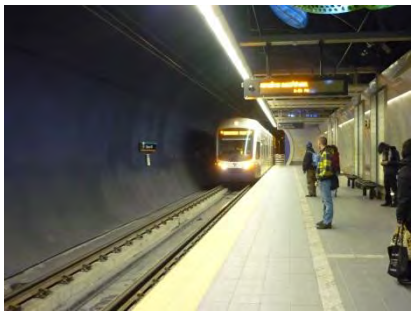


FIGURE 4.7 EXAMPLE OF UNDERGROUND SYSTEM IN SEATTLE WASHINGTON



Options for High Level MAE

4.16 Detailed diagrams for each of the identified alignments, including vertical profiles can be found in Appendix A.

4th Street Alignment

4.17 In the sector from 16th Avenue N to McKnight Boulevard the 4th Street alignment runs along 4th Street NW. In the sector between McKnight Boulevard and Beddington Trail the alignment continues along 4th Street NW until merging with Centre Street, which it follows until the end of the sector. The alignment continues past Beddington Trail along Harvest Hills Boulevard N until its terminus north of Country Hills Boulevard.

4.18 The alignment runs through a predominantly low density residential area. Between 16th Avenue and McKnight Boulevard the alignment will serves older inner city communities, while the sector between McKnight Boulevard and Beddington Trail would serve low density residential areas. The sector between Beddington Trail and the terminus would serve newer suburban developments. While the communities surrounding the alignment on the east and west are primarily composed of single family dwellings, there are some activity centres including light retail, such as strip malls, gas stations, and community destinations such as schools, and parks in close proximity to the alignment. The area surrounding the third segment is primarily residential with some commercial use.

4.19 4th Street NW is primarily a two lane residential street with the majority of its intersections un-signalized, however some segments do feature medians. This leaves limited room for expansion and development. A potential conflict is Queen's Park Cemetery at 32nd Avenue and 4th Street NW, which lies adjacent to the proposed route.

4.20 Three potential options have been considered for this alignment:

- Option 1 – 4th Street – Option A at grade
- Option 2 – 4th Street – Option B elevated
- Option 3 – 4th Street – Option C underground

Centre Street Alignment

4.21 For the sectors between 16th Avenue N to McKnight Boulevard and McKnight Boulevard to Beddington Trail, this alignment runs along Centre Street. In the sector between Beddington Trail and the terminus this alignment continues along Harvest Hills Boulevard.

4.22 The first portion of the route runs through an area with mixed land use. From 16th Avenue to 25th Avenue the alignment runs through a mixed use area with some multifamily and commercial land uses. North of 25th Avenue, the adjacent land use becomes less dense and more residential, however there are still light commercial uses close to the alignment. Along with commercial uses, there are many activity centres adjacent to and near the alignment including schools/libraries, parks, and places of worship. Throughout the second segment, the land use is primarily residential and low density with some commercial uses and activity centres.

4.23 The majority of the alignment is a two lane road that runs through mixed use areas. While some segments of the alignment feature medians and wider lanes, there are portions that run through more residential areas that may present challenges for transit development. The narrow right of way may present challenges during design and construction. There are also a large number of businesses along the alignment that may be impacted during construction.

4.24 Three potential options have been considered for this alignment:

- Option 4 – Centre Street – Option A at grade
- Option 5 - Centre Street – Option B elevated
- Option 6 – Centre Street – Option C underground

Edmonton Trail Alignment

4.25 From 16h Avenue N to McKnight Boulevard the route follows Edmonton Trail NE. In the sector between McKnight Boulevard and Beddington Trail the alignment moves along 4th Street NE. After passing Beddington Trail, the alignment moves west through the Nose Creek Parkway before joining Harvest Hills Boulevard and terminating north of Country Hills Boulevard.

4.26 The first part of the route runs through a primarily residential area with some light commercial land uses and activity centres. North of 32nd Avenue NE Edmonton Trail NE is primarily a mix of commercial and industrial until 41 Avenue NE. The route is also bordered by the Nose Creek Parkway. The portion of the alignment running along 4th Street NE is primarily Residential. The second segment runs through the Nose Creek Parkway before terminating in a primarily residential suburban area.

4.27 The majority of the alignment runs through two lane residential streets. A potential conflict occurs in segment two when the alignment runs through the Nose Creek Parkway. Additionally, the route from 32nd Avenue NE to 41st Avenue NE is a higher traffic area than the rest of the alignment and may cause conflicts.

4.28 Three potential options have been considered for this alignment:

- Option 7 – Edmonton Trail – Option A at grade
- Option 8 - Edmonton Trail – Option B elevated
- Option 9 – Edmonton Trail – Option C underground

Nose Creek Alignment

4.29 The Nose Creek alignment follows the Nose Creek Parkway from 16th Avenue N until Beddington Trail. After Beddington Trail the alignment cuts west through the north portion of the Nose Creek Parkway and joins Harvest Hills Boulevard, which it follows north before terminating north of Country Hills Boulevard.

4.30 The majority of segment one runs adjacent to park space and light commercial and industrial land uses. North of 32nd Avenue NE there is residential use west of the alignment and continued light industrial east of the alignment. Segment two runs through a primarily suburban area with light residential land uses.

4.31 As the Nose Creek Alignment is largely grade separated only an 'at-grade' option has been identified for this alignment:

- Option 10 – Nose Creek – Option A at grade

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5 Financial Capacity / Sustainable Corporation Account

Objective

- An affordable and cost-effective service - A service that has costs that are achievable, sustainable in the longer term and provide value for money

High Level MAE Criteria

- Capital Cost – high level estimate based on route length and on-street and off-street construction cost estimates per kilometre. It should be noted that costs have only been calculated from 16th Avenue north and exclude fleet and depot costs.

Development of High Level Cost Data

5.1 For this high level analysis, capital costs were developed for each option based on:

- Road work;
- Track and civil work;
- Systems (signalling, power, overhead catenary, U/G duct));
- Structures;
- Utilities;
- Land acquisitions; and
- Station and facilities.

5.2 Further information on these elements of civil construction works and their impact on the capital costs of the 10 LRT options are presented in Appendix B.

5.3 Knowledge and experience from past projects, such as the NE LRT extension from McKnight-Westwinds to Saddletowne, was used to identify unit costs for each work category.

Option Costings

5.4 High level cost analysis was conducted based on the above categories from 16th Avenue to the northern terminus for each alignment option. This process determined cost estimates based on a number of design and planning assumptions that are further outlined in Appendix B.

5.5 When comparing between options within one alignment, underground options invoke the greatest costs, while elevated options offer the middle price, and at grade options are the lowest. Specific requirements for each alignment that cause differences in capital costs between the options are discussed below.

4th Street Alignment

5.6 For the 4th Street Alignment, road widening and re-defining is required in most areas between Downtown and Beddington Trail, to accommodate the future LRT.

Residential land acquisitions and house expropriation will have to be organized to make this required space available, since at some locations there is only a 20m road width.

Centre Street Alignment

5.7 When considering the LRT sharing the road width with vehicles, as like the 4th Street Alignment, road widening and re-defining will take place in most areas between downtown and Beddington Trail. Again, residential land acquisitions and house expropriation will have to be completed. For utilities, a main concern in the route segment of McKnight Boulevard and Beddington Trail is the presence of several main storm pipes, as great as 1800mm x 1800mm ducts. Again, the unit cost for this has been factored to compensate.

Edmonton Trail Alignment

5.8 Edmonton Trail alignment, unlike the previous two alignments, will only have road widening and re-defining occurring in most areas between Downtown and Beaver Dam Road.

5.9 When considering acquisitions and expropriation, a mix of residential and commercial properties will be required. For utilities, the only minor concern is a 1200mm concrete storm pipe; once more the unit cost has been factored but it is not as significant as the previous alignments.

Nose Creek Alignment

5.10 One advantage that the Nose Creek Alignment has over the other three is the fact that only a dedicated right-of-way needs to be built, rather than having to widen roads to make room for the LRT. Therefore, acquiring industrial land is all that needs to be completed. Another noteworthy advantage is that there are no foreseen major utility conflicts, which reduces the price for this option.

Financial Capacity/ Sustainable Corporation Summary

5.11 All options were scored based on their estimated capital costs. Projects scored higher based on a greater degree of affordability, while more costly options scored lower. The scores and price estimates for each option are summarized in Table 5.1.

5.12 All at grade options were estimated to be in a similar price bracket of less than $500 million and were scored equally at 5. The Edmonton Trail elevated option was scored a 4, while the 4th Street and Centre Street elevated options received a score of 2. The Edmonton Trail underground option also received a score of 2. Finally, the remaining 4th Street and Centre Street underground options received a score of 1.

5.13 The Edmonton Trail underground and elevated options were less costly than their 4th Street and Centre Street counter parts due in part to lower structural and roadwork costs. At the northern end of the Edmonton Trail alignment, where it runs along the Nose Creek alignment, it is assumed to run at-grade.

TABLE 5.1 FINANCIAL CAPACITY / SUSTAINABLE CORPORATION SUMMARY

Option	Description - Value millions ($)	Assessment
Option 1 – 4th Street Option A at grade	415	5
Option 2 – 4th Street Option B elevated	1200	2
Option 3 – 4th Street Option C underground	1830	1
Option 4 – Centre Street Option A at grade	415	5
Option 5 - Centre Street Option B elevated	1220	2
Option 6 – Centre Street Option C underground	1855	1
Option 7 – Edmonton Trail Option A at grade	415	5
Option 8 - Edmonton Trail Option B elevated	860	4
Option 9 – Edmonton Trail Option C underground	1210	2
Option 10 – Nose Creek Option A at grade	355	5

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6 Community Well-Being Account

Objective

- A safe, secure and socially inclusive service that improves access to key community destinations and encourages walking and cycling

High Level MAE Criteria

- Links to Community destinations – evaluation of the number of community destinations within 400m and 800m of the proposed route alignments

Identification of 'Community Destinations'

6.1 In order to utilise a consistent data source for all alignments, the City of Calgary information database was used as the data source for all of the evaluations.

6.2 The community destinations identified for the evaluation were:

- Schools;
- Recreation facilities;
- Places of Worship;
- Community centres; and
- Child care facilities.

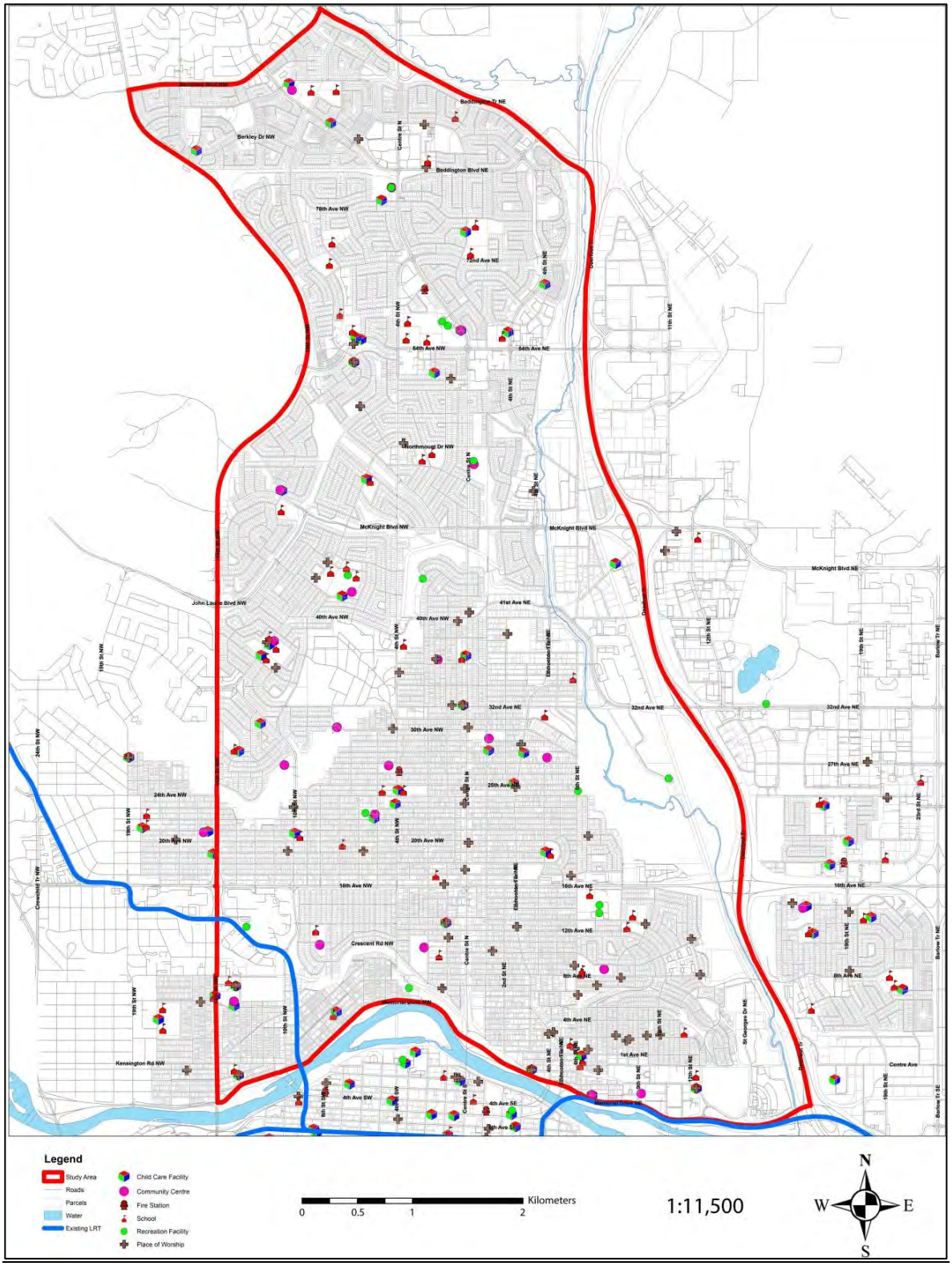
Option Analysis

6.3 The City of Calgary GIS database was used to identify key community destinations within 400m and 800m of the identified alignments. The 400m and 800m distances were selected as these are considered the standard walk distances to access transit and generally reflect a 5 or 10 minute walk. These values are also consistent with those used for the RouteAhead. In reality this time and distance should be based on actual station locations, but as the locations have not yet been determined, a simple buffer around the alignment has been used for this stage of evaluation.

6.4 Figures are presented in Appendix C showing each of the alignments with a 400m and 800m buffer, along with the community destinations. The figure below gives an overview of the study area and the community destinations within it, and was presented at the community open house events.

6.5 While there may be some debate as to whether many of the people accessing community destinations would use LRT, the perceived importance of proximity of LRT to community facilities was highlighted during the public Open House events.

FIGURE 6.1 OVERVIEW OF COMMUNITY DESTINATIONS WITHIN THE STUDY AREA



4th Street Alignment

6.6 The 4th Street Alignment runs through a primarily residential area with access to a variety of community activity centers. Along the alignment there are a number of key community destinations including James Fowler High School, the Mount Pleasant Community Sportsplex, and the North Mount Pleasant Arts Centre.

6.7 4th Street has a high number of community destinations within 400m and the highest within 800m. It also has generally the highest numbers in each of the separate categories.

6.8 The assessment for the 4th Street alignment covers the following options:

- Option 1 – 4th Street – Option A at grade
- Option 2 – 4th Street – Option B elevated
- Option 3 – 4th Street – Option C underground

TABLE 6.1 COMMUNITY DESTINATIONS ALONG 4TH STREET ALIGNMENT

Community Destination	Within 400m	Within 800m
Recreation Facilities	6	11
Schools	17	35
Places of Worship	16	39
Child Care facilities	23	38
Community Centres	5	10
Total	67	133

Centre Street Alignment

6.9 The Centre Street corridor presents many opportunities to integrate transit with community destinations. As a corridor that runs through a combination of older communities with mixed land uses and newer suburbs, there is a diverse set of community destinations within the catchment area of the Centre Street Alignment. Activity centres that this alignment would serve include the Thornhill Recreation Centre, James Fowler High School, a Calgary Public Library Branch, and the Centre Street Church.

6.10 Centre Street has the highest overall number of community destinations within 400m and a high number within 800m. It also has a high number of destinations in each of the categories.

6.11 The assessment for the Centre Street alignment covers the following options:

- Option 4 – Centre Street – Option A at grade
- Option 5 - Centre Street – Option B elevated
- Option 6 – Centre Street – Option C underground

TABLE 6.2 COMMUNITY DESTINATIONS ALONG CENTRE STREET ALIGNMENT

Community Destination	Within 400m	Within 800m
Recreation Facilities	6	9
Schools	13	30
Places of Worship	27	41
Child Care facilities	21	38
Community Centres	6	8
Total	73	126

Edmonton Trail Alignment

6.12 The Edmonton Trail alignment facilitates access to fewer community destinations than the Centre Street Alignment due to portions of the alignment that run through light industrial, park, and residential areas. However, the alignment still provides access to a number of destinations including the Centre Street Church, and Georges P. Vanier School.

6.13 Edmonton Trail has a significant overall number of community destinations within both 400 and 800m. It also has a moderate number of destinations in each of the categories, including the greatest number of places of worship.

6.14 The assessment for the Edmonton Trail alignment covers the following options:

- Option 7 – Edmonton Trail – Option A at grade
- Option 8 - Edmonton Trail – Option B elevated
- Option 9 – Edmonton Trail – Option C underground

TABLE 6.3 COMMUNITY DESTINATIONS ALONG EDMONTON TRAIL ALIGNMENT

Community Destination	Within 400m	Within 800m
Recreation Facilities	3	8
Schools	10	19
Places of Worship	19	46
Child Care facilities	22	33
Community Centres	3	6
Total	57	112

Nose Creek Alignment

6.15 The Nose Creek alignment follows the Nose Creek Parkway which is situated primarily in a park area between roadways and light industrial land uses. As a result, this

alignment has far fewer community destinations than the other alternatives. Community destinations along this alignment include the Fox Hollow Public Golf Course.

6.16 Nose Creek has the lowest number of community destinations within both 400 and 800m. It also has the lowest number of destinations in each of the categories.

6.17 The assessment for the Nose Creek alignment covers Option 10 – Nose Creek – Option A at grade. Only an 'at-grade' option has been identified for this alignment.

TABLE 6.4 COMMUNITY DESTINATIONS ALONG NOSE CREEK ALIGNMENT

Community Destination	Within 400m	Within 800m
Recreation Facilities	3	3
Schools	4	16
Places of Worship	11	29
Child Care facilities	16	26
Community Centres	2	3
Total	36	77

Community Well Being Account Summary

6.18 An initial score was assigned to each of the four alignments, based on the number of community amenities within a 5 and 10 minute walk catchment. This score was then refined based on consideration of the differences between the at-grade, elevated and underground options.

6.19 It was considered an at-grade system provided the best access, including the potential for more frequent station spacing. As the elevated and underground systems both require a change in elevation, there is a quantifiable penalty for these modes in terms of access time and ease. The alignment / technology combinations were scored using these principles and the outputs are set out in the table below.

TABLE 6.5 COMMUNITY WELL-BEING ACCOUNT SUMMARY

Option	Assessment
Option 1 – 4th Street Option A at grade	5
Option 2 – 4th Street Option B elevated	4.5
Option 3 – 4th Street Option C underground	4
Option 4 – Centre Street Option A at grade	5
Option 5 - Centre Street Option B elevated	4.5
Option 6 – Centre Street Option C underground	4
Option 7 – Edmonton Trail Option A at grade	4
Option 8 - Edmonton Trail Option B elevated	3.5
Option 9 – Edmonton Trail Option C underground	3
Option 10 – Nose Creek Option A at grade	1

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LINK LRT, Seattle

7 Prosperous Economy Account

Objective

- A service that promotes economic development by improving access to employment, without adversely impacting goods movement

High Level MAE Criteria

- Employment catchments – GIS assessment of the number of jobs within 400m and 800m of each of the alignments
- Improving city competitiveness through access to YYC – Business feedback

Development of Employment Catchments

7.1 Employment catchments are related to prosperous economy as the greater the number of jobs and employees that can be linked, the greater the economic potential.

7.2 The data for the employment analysis was based on the data used for the transport model. It was considered important to not focus solely on the present day situation, but also to look ahead to the planned employment forecasts for future years. On this basis, numbers were generated for 2039 and 2076.

Option Analysis

7.3 Employment numbers were calculated for areaswithin 400m and 800m of the identified alignments. The 400m and 800m distances were selected as these are considered the standard walk distances to access transit and generally reflect a 5 or 10 minute walk. These values are also consistent with those used for the RouteAhead. These buffer areas are represented by maps contained in Appendix D. In reality this time and distance should be based on actual station locations, but as the locations have not yet been determined, a simple buffer around the alignment has been used for this stage of evaluation.

4th Street Alignment

7.4 The 4th Street alignment runs through a primarily residential area that features low employment. The key employment centres in the corridor include a light retail centre in the Thorncliffe community, James Fowler High School, and the Beddington Towne Centre.

7.5 The assessment for the 4th Street alignment covers the following options:

- Option 1 – 4th Street – Option A at grade
- Option 2 – 4th Street – Option B elevated
- Option 3 – 4th Street – Option C underground

TABLE 7.1 EMPLOYMENT ALONG 4TH STREET ALIGNMENT

	2039	2076
Employment Downtown	135,000	138,600
Employment 16th to McKnight	5,900	6,400
Employment McKnight to Beddington	5,300	8,000
Employment North of Beddington	7,000	8,000
Total Employment	153,200	161,000

Centre Street Alignment

7.6 The Centre Street corridor features light employment throughout due to mixed zoning along Centre Street, some light commercial centres, and community institutions located along the corridor. Key employment centres within the corridor include the James Fowler High School, a mixed light industrial and commercial area between 32nd and 41st Avenue NE, large shopping areas such as the Beddington Towne Centre, and supermarkets like Canada Safeway and Superstore.

7.7 The assessment for the Centre Street alignment covers the following options:

- Option 4 – Centre Street – Option A at grade
- Option 5 - Centre Street – Option B elevated
- Option 6 – Centre Street – Option C underground

TABLE 7.2 EMPLOYMENT ALONG CENTRE STREET ALIGNMENT

	2039	2076
Employment Downtown	139,300	143,300
Employment 16th to McKnight	10,300	11,600
Employment McKnight to Beddington	6,600	7,100
Employment North of Beddington	7,000	8,000
Total Employment	163,200	170,000

Edmonton Trail Alignment

7.8 The Edmonton Trail alignment features similar levels of employment to the Centre Street alignment, however it serves more light industrial areas. In the future the alignment will directly serve the Aurora Business Park in the north end of the alignment near the Nose Creek Parkway. Edmonton Trail serves many employment

centres including a mixed light industrial and commercial area between 32nd and 41st Avenue NE. Like all alignments, it also serves the Country Hills Town Centre.

7.9 The assessment for the Edmonton Trail alignment covers the following options:

- Option 7 – Edmonton Trail – Option A at grade
- Option 8 - Edmonton Trail – Option B elevated
- Option 9 – Edmonton Trail – Option C underground

TABLE 7.3 EMPLOYMENT ALONG EDMONTON TRAIL ALIGNMENT

	2039	2076
Employment Downtown	151,300	156,200
Employment 16th to McKnight	13,900	17,300
Employment McKnight to Beddington	11,900	14,200
Employment North of Beddington	9,600	10,800
Total Employment	186,700	198,500

Nose Creek Alignment

7.10 The Nose Creek alignment follows Nose Creek which consists mainly of natural areas that have not yet been developed, however in the future the alignment will serve the Aurora Business Park. Like all alignments, it also serves the Country Hills Towne Centre near the northern terminus.

7.11 The assessment for the Nose Creek alignment covers Option 10 – Nose Creek – Option A at grade.

TABLE 7.4 EMPLOYMENT ALONG NOSE CREEK ALIGNMENT

	2039	2076
Employment Downtown	106,800	114,600
Employment 16th to McKnight	14,400	17,700
Employment McKnight to Beddington	13,200	15,700
Employment North of Beddington	9,600	10,800
Total Employment	144,000	158,800

Summary of Employment Catchment Analysis

7.12 Of the four alignments considered, in both 2039 and 2076, Edmonton Trail would provide the greatest access to employment. The alignment provides access to the future Aurora Business park, while also granting access to a large portion of downtown and light industrial and commercial employment throughout the north central corridor

of the city. The Centre Street alignment offers the second greatest levels of employment in both comparison years, but does not provide direct access to the Aurora Business park. 4th Street performs third overall in both analysis years due to its access to downtown and some employment – however it is still located in a largely residential area so it does not have the same employment gains as Edmonton Trail or Centre Street. Nose Creek serves the lowest levels of employment, however it does reach future developments along its corridor, the Aurora business park, and parts of downtown.

Consideration of Access to Calgary International Airport (YYC)

7.13 An important element in driving forward a prosperous economy is having good connections to the airport. The alignment should maximize opportunities for an airport connection (for example either via a direct connection or a people mover linking the NCLRT to the airport).

7.14 An airport connection to Downtown Calgary would not only alleviate traffic congestion and generate ridership, but would enhance Calgary's competitiveness as a place to live and do business. These benefits would be maximized with the most efficient route minimizing the time, distance and number of transfers to the airport from Downtown.

7.15 It is possible that the most economically advantageous way of providing a connection to the airport may be off the North East line rather than the North Central line. There are also potential plans to develop an intermodal hub at Airport Trail, which could connect a people mover, the LRT and a high speed rail service to Edmonton.

7.16 Airport access via rail transit often generates significant ridership and economic development benefits. It provides a fast alternative for business travelers to downtown, enhancing a downtown's competitiveness as a prime location for businesses. Further, it provides a reliable and high-quality connection for airport workers.

Option Analysis

4th Street Alignment

7.17 The 4th Street alignment runs with the Centre Street alignment at this point of the route, making it jointly the furthest geographically from the airport. It is considered that it would be unfeasible for a direct extension of this alignment to be built to the airport. It is also considered that due to the distances involved, it is unlikely that a separate 'people-mover' type system would be built between a station on this alignment and the airport, or a dedicated shuttle bus established.

7.18 It is therefore assessed that opportunities to access Calgary International Airport from the 4th Street alignment would be limited. A connection to the NE LRT may be more advantageous.

7.19 The assessment for the 4th Street alignment covers the following options:

- Option 1 – 4th Street – Option A at grade

- Option 2 – 4th Street – Option B elevated
- Option 3 – 4th Street – Option C underground

Centre Street Alignment

7.20 The Centre Street and 4th Street alignments use a common path north of 72nd Avenue, making it jointly the furthest geographically from the airport. It is considered that it would be unfeasible for a direct extension of this alignment to be built to the airport. It is also considered that due to the distances involved, it is unlikely that a separate 'people-mover' type system would be built between a station on this alignment and the airport, or a dedicated shuttle bus established.

7.21 It is therefore assessed that opportunities to access Calgary International Airport from the Centre Street alignment would be more limited than a other options such access via the Edmonton Trail alignment, Nose Creek alignment, or NE LRT.

7.22 The assessment for the Centre Street alignment covers the following options:

- Option 4 – Centre Street – Option A at grade
- Option 5 - Centre Street – Option B elevated
- Option 6 – Centre Street – Option C underground

Edmonton Trail Alignment

7.23 The Edmonton Trail alignment runs with the Nose Creek alignment at this point of the route. This joint alignment is the closest to the airport. However it is still considered that a direct extension of this alignment to the airport is unfeasible. Due to the shorter distances involved, it is possible that a separate 'people-mover' type system would be built between a station on this alignment and the airport. A second alternative is a dedicated shuttle bus service. At the southern end of the alignment, the Edmonton Trail route would likely take a more direct route to the City Centre than the Nose Creek alignment, making this the preferred option.

7.24 It is therefore assessed that opportunities to access Calgary International Airport from the Edmonton Trail alignment would be moderate to good.

7.25 The assessment for the Edmonton Trail alignment covers the following options:

- Option 7 – Edmonton Trail – Option A at grade
- Option 8 - Edmonton Trail – Option B elevated
- Option 9 – Edmonton Trail – Option C underground

Nose Creek Alignment

7.26 The Nose Creek alignment runs with the Edmonton Trail alignment at this point of the route, making it the joint closest to the airport. However it is still considered that it would be unfeasible for a direct extension of this alignment to be built to the airport. It is considered that due to the distances involved, it is possible that a separate 'people-mover' type system would be built between a station on this alignment and the airport, or a dedicated shuttle bus established. The Nose Creek alignment runs the

closest to the airport when it diverges from the Edmonton Trail alignment and would likely provide the shortest journey time connection for the section of the route north of 16th Avenue. South of this, the connection to Downtown would be less direct than for the Edmonton Trail alignment.

7.27 It is therefore assessed that opportunities to access Calgary International Airport from the Nose Creek alignment would be moderate to good.

7.28 The assessment for the Nose Creek alignment covers Option 10 – Nose Creek – Option A at grade.

Prosperous Economy Account Summary

7.29 Of the four alignments, the Edmonton Trail alignment would provide the best connection to the airport, based on its airport proximity at the northern end of the alignment and its direct routing at the southern end of the alignment. The Nose Creek alignment also has good proximity to the airport, but its alignment to the south offers a less direct connection to Downtown. It is unlikely that either the 4th Street alignment or the Centre Street alignment would be connected to the airport due to their physical separation at the northern end of the alignment.

TABLE 7.5 PROSPEROUS ECONOMY ACCOUNT SUMMARY

Option	Employment	Access to YYC	Overall
Option 1 – 4th Street Option A at grade	2.5	2.0	2.3
Option 2 – 4th Street Option B elevated	3.0	2.0	2.5
Option 3 – 4th Street Option C underground	3.0	2.0	2.5
Option 4 – Centre Street Option A at grade	3.5	2.0	2.8
Option 5 - Centre Street Option B elevated	4.0	2.0	3.0
Option 6 – Centre Street Option C underground	4.0	2.0	3.0
Option 7 – Edmonton Trail Option A at grade	4.5	3.0	3.8
Option 8 - Edmonton Trail Option B elevated	5.0	3.0	4.0
Option 9 – Edmonton Trail Option C underground	5.0	3.0	4.0
Option 10 – Nose Creek Option A at grade	2.3	2.0	2.1

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8 Transportation Account

Objective

- A high priority transit service that attracts transit use, walking and cycling as preferred mobility choices for Calgarians and that integrates with, improves customer experience on, meets the future demand of, and strengthens the regional and Frequent transit networks

High Level MAE Criteria

- Ridership – based on an initial catchment analysis
- Transit efficiency / compatibility – consideration of how the proposed alignment / option would link in with the existing regional and Frequent transit networks
- Journey time by segment – consideration of likely journey times for each of the alignments from 16th Avenue north.

Development of Ridership Catchment

8.1 Originally the High Level MAE Ridership assessment was going to be undertaken utilising outputs from the City of Calgary Regional Transportation Model. An alternative ridership evaluation method based on catchment analysis was proposed when it became apparent that we would not be able to obtain the required outputs in time to undertake the high level analysis work. Outputs from the model will be used for the detailed MAE evaluation later in the project.

8.2 The ridership catchment analysis makes use of a method used previously by the City of Calgary to undertake high level ridership estimates for the RouteAhead. The method uses the model input data for the population within an 800m buffer zone around the route alignment, combining it with an assumed transit generation rate to produce ridership numbers. Maps outlining these buffer areas for each alignment are contained in Appendix E. Standard factors are used to generate all day, peak period and peak direction numbers. An uplift factor was also calculated to include a proxy for park and ride demand.

8.3 Data was available for the years 2006, 2039 and 2076, and analysis was also undertaken at a sector level to understand the potential for ridership generation by route section and year. Further detail on this disaggregated assessment is presented in Appendix F, and the output from the summary assessment is set out below.

Option Ridership Catchment

4th Street Options

8.4 The population identified as being within an 800m radius of the 4th Street alignment was 74,200 in 2039 and 105,200 in 2076. The growth in population between the years is around 30,000 people or approximately 40%. Applying the ridership methodology

including the uplift for park and ride trips, resulted in a forecast daily ridership of 25,600 and 36,400 in 2039 and 2076 respectively.

Centre Street Options

8.5 The population identified as being within an 800m radius of the Centre Street alignment was 80,300 in 2039 and 119,400 in 2076. The growth in population between the years is around 40,000 or nearly 50%. Applying the ridership methodology including the uplift for park and ride trips, resulted in a forecast daily ridership of 27,800 and 41,300 in 2039 and 2076 respectively.

Edmonton Trail Options

8.6 The population identified as being within an 800m radius of the Edmonton Trail alignment was 76,200 in 2039 and 115,400 in 2076. Again the growth in population between the years is around 40,000 or around 50%. Applying the ridership methodology including the uplift for park and ride trips, resulted in a forecast daily ridership of 26,300 and 39,900 in 2039 and 2076 respectively.

Nose Creek Options

8.7 The population identified as being within an 800m radius of the Nose Creek alignment was 63,600 in 2039 and 84,200 in 2076. The growth in population between the years is around 20,000 or 30%. Applying the ridership methodology including the uplift for park and ride trips, resulted in a forecast daily ridership of 22,000 and 29,100 in 2039 and 2076 respectively.

TABLE 8.1 SUMMARY OF RIDERSHIP AND ACCOUNT SCORING

Option	2039 Daily Ridership	2076 Daily Ridership	Scoring	Scoring	Summary
Option 1 – 4th Street Option A at grade	25,600	36,400	4	3	3.5
Option 2 – 4th Street Option B elevated	25,600	36,400	4	3	3.5
Option 3 – 4th Street Option C underground	25,600	36,400	4	3	3.5
Option 4 – Centre Street Option A at grade	27,800	41,300	5	5	5.0
Option 5 - Centre Street Option B elevated	27,800	41,300	5	5	5.0
Option 6 – Centre Street Option C underground	27,800	41,300	5	5	5.0

Option	2039 Daily Ridership	2076 Daily Ridership	Scoring	Scoring	Summary
Option 7 – Edmonton Trail Option A at grade	26,300	39,900	4	4	4.0
Option 8 - Edmonton Trail Option B elevated	26,300	39,900	4	4	4.0
Option 9 – Edmonton Trail Option C underground	26,300	39,900	4	4	4.0
Option 10 – Nose Creek Option A at grade	22,000	29,100	2	1	1.5

Development of Journey Time Analysis

8.8 LRT journey times from the northern terminus to 16th Avenue were calculated using current LRV performance attributes. The LRT assumed priority crossings at every intersection, meaning there was no delay in the journey times due to waiting at traffic signals for motor vehicle and pedestrian crossing movements. Journey times for the options were also examined based on each alignment and whether the configuration was at-grade or elevated/underground. The Journey time model is outlined in Appendix G.

Summary of Journey Time Analysis

8.9 The journey time model was applied to each option to develop a journey time estimate. Options that provide a quicker journey were given a higher score, while a longer journey time received a lower score. These estimate sand accompanying scoring are shown in Table 8.2.

TABLE 8.2 LRT OPTIONS JOURNEY TIME ESTIMATES AND ANALYSIS

Option	Journey Time (mins)	Scoring
Option 1 – 4th Street Option A at grade	18.6	3
Option 2 – 4th Street Option B elevated	16	4
Option 3 – 4th Street Option C underground	16	4
Option 4 – Centre Street Option A at grade	18.8	3
Option 5 - Centre Street Option B elevated	16.1	4
Option 6 – Centre Street Option C underground	16.1	4

Option	Journey Time (mins)	Scoring
Option 7 – Edmonton Trail Option A at grade	19.1	3
Option 8 - Edmonton Trail Option B elevated	17.3	4
Option 9 – Edmonton Trail Option C underground	17.3	4
Option 10 – Nose Creek Option A at grade	15.5	3.5

8.10 Nose Creek receives a lower score as, unlike the other options, the 16th Avenue to downtown leg of its alignment is not assumed to be similar. For this leg of the alignment, Nose Creek will incur significant run time penalties and will therefore lose the benefits it gains in this analysis. It has therefore received a lower score.

Development of Transit Compatibility / Efficiency Analysis

8.11 Seven qualities were selected that would help describe the performance of the options in regards to transit compatibility / efficiency. These include:

- Ease of Transfer
- Transfer Environment
- Operational Savings
- Transit Service Delay Reduction
- Support of the Primary Transit Network Concept
- New Coverage
- Candidate Sites for a Maintenance Facility

8.12 It was decided to weight all of these criteria the same, such that they would all have a maximum value of 5 and a minimum value of 0. Each option was divided into three segments: 16th Avenue to McKnight, McKnight to Beddington Trail, and Beddington Trail and points North. Each segment of each option was then evaluated against the criteria. Full details of the assessments undertaken for these seven criteria can be found in Appendix H. A high level summary is presented below.

TABLE 8.3 SUMMARY OF TRANSIT EFFICIENCY / COMPATIBILITY ASSESSMENT

Option	Total Points - 16th to McKnight	Total Points - McKnight to Beddington Trail	Total Points - Beddington Trail and Points North	Point Average
4th Street - Option A - At Grade	17	17	20	18
4th Street - Option B – Elevated	13	13	16	14

Option	Total Points - 16th to McKnight	Total Points - McKnight to Beddington Trail	Total Points - Beddington Trail and Points North	Point Average
4th Street - Option C – Underground	13	13	16	14
Centre Street - Option A - At Grade	17	17	20	18
Centre Street - Option B – Elevated	15	15	16	15.3
Centre Street - Option C – Underground	18	18	16	17.3
Edmonton Trail - Option A - At Grade	21	21	25	22.3
Edmonton Trail - Option B – Elevated	17	17	21	18.3
Edmonton Trail - Option C - Underground	17	17	21	18.3
Nose Creek - Option A - At Grade	4	9	25	12.7

8.13 Of the alignment options, Edmonton Trail - Option A - At Grade appears to score the best for the following reasons:

- It passes by areas that are candidates for a maintenance facility, as opposed to options along Centre Street and 4th Street
- It would be able to serve the Aurora Business Park, as opposed to options along Centre Street and 4th Street
- It progresses the Primary Transit Network concept more dramatically than the other alignments by introducing premium transit service to a street that is included in the Primary Transit Network plan but does not currently have a BRT service.
- It provides at grade transfers, unlike the Elevated and Underground Options.

8.14 Edmonton Trail - Option A - At Grade has a high score despite having lower operational savings compared to Centre Street - Option A - At Grade.

8.15 Of the alignment options, the Nose Creek alignment performs the worst. This is due to the following reasons:

- It requires more physically demanding transfers and transfers in undeveloped areas in the 16th to McKnight and McKnight to Beddington Trail segments.
- It does not create significant operational savings compared to the other options, in large part because it would not be able to replace many bus services.

8.16 The Nose Creek alignment options scores the worst despite being able to offer candidate maintenance facility sites and new coverage, unlike the 4th Street and Centre Street Options.

8.17 The points for the transit compatibility / efficiency criteria were converted to a 1 to 5 point ranking for the full transportation account summary.

Transportation Account Summary

8.18 The overall scoring for the Transportation account was calculated by averaging the scoring over the three categories – Ridership, Journey Time and Transit Efficiency. The results are presented below.

TABLE 8.4 TRANSPORTATION ACCOUNT SUMMARY

Option	Capacity / Ridership	Journey Time Score	Transit Efficiency	Assessment
Option 1 – 4th Street Option A at grade	3.5	3	4	3.5
Option 2 – 4th Street Option B elevated	3.5	4	2	3.2
Option 3 – 4th Street Option C underground	3.5	4	2	3.2
Option 4 – Centre Street Option A at grade	5	3	4	4.0
Option 5 - Centre Street Option B elevated	5	4	2	3.7
Option 6 – Centre Street Option C underground	5	4	3	4.0
Option 7 – Edmonton Trail Option A at grade	4	3	5	4.0
Option 8 - Edmonton Trail Option B elevated	4	4	4	4.0
Option 9 – Edmonton Trail Option C underground	4	4	4	4.0
Option 10 – Nose Creek Option A at grade	1.5	3.5	1	2.0

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9 Urban Development / Urban Realm Account

Objective

- A service that supports current and future land use and intensification of development along the corridor, integrating with the character of the communities it passes through

High Level MAE Criteria

- TOD Opportunity – qualitative assessment of the level of potential for Transit Oriented Development (TOD) on each of the alignments
- Urban Realm– qualitative assessment of the level of potential for urban realm improvements on the alignments

Development of TOD Opportunity Assessment

9.1 TOD around LRT stations is gaining in popularity. In the past, TOD experienced slow absorption in Calgary, notably at Bridgeland Station where the recent recession and stringent design guidelines slowed the project. Increasingly, developers view LRT as a significant attribute, principally for the convenient Downtown connection for daily commuting.

9.2 The North Central Corridor has experienced less development pressure than other areas of the City. Most of the new product in North Central Calgary has consisted of lower density condominiums concentrated closer to Downtown around the base of Edmonton Trail (e.g. Exul, Next, and Arcadia at Crescent Heights). These projects benefit from sheer proximity to Downtown and other locational attributes, such as impressive views. Areas north of 16th Avenue in particular have attracted little new development in recent decades.

9.3 During outreach undertaken with Developers, detailed further in Appendix H they have questioned the feasibility of TOD in North Central Calgary, even with the advent of LRT service. Developers have several concerns about the North Central Corridor: The corridor lacks in-place amenities, infrastructure, and has few destinations.

- The corridor features small, fragmented parcels and lacks large redevelopment sites.
- The economics of redevelopment are challenging. In order to justify the cost of demolishing existing income-generating property (e.g. an aging retail strip center or office building), a TOD would need significant density to recoup costs and lost income. Constructing 3-4 storey stick-frame condominiums in the same manner as those currently being developed in the corridor would not provide a sufficient return on investment. Higher densities would require concrete and possibly steel-frame construction, which also may not be viable due to insufficient rent potential.

- Opportunities to accommodate residential and commercial demand remain in areas perceived as more attractive, including the Beltline, Mission, and Kensington, among others, that have in-place amenities and proximity to Downtown. Some developers would continue to look to these areas to develop projects before considering North Central Calgary.

9.4 The Aurora Business Park is a major new development opportunity that should be considered in alignment planning. The Office of Land Servicing and Housing (OLSH) is managing the development of the City-owned Aurora Business Park, which at build-out is proposed to be a significant office, retail, and industrial development occupying 329 acres of land just north of Beddington Trail.

9.5 When considering the impact on TOD of whether the station is underground, elevated or at grade, it was determined that an underground system would be marginally better for TOD opportunities. It is perceived that an underground system is likely to be faster, and would potentially provide the opportunity to build higher density development above the stations. This preference has been reflected in the scoring.

Option Analysis

4th Street Alignments

9.6 The Municipal Development Plan identifies 4th Street NW as a neighbourhood corridor planned for less development intensity than an urban corridor. This policy guidance suggests TOD on 4th Street would not align with City objectives.

9.7 4th Street NW features small lots and fractured ownership, making land assembly for TOD challenging.

Centre Street Alignments

9.8 The Municipal Development Plan identifies Centre Street as an urban corridor, a policy designation that endorses future redevelopment in the corridor.

9.9 Centre Street's alignment provides parcels oriented to the front of the street and is a major commercial thoroughfare with access to Beddington Towne Centre. Retail is a critical amenity for residents and workers in TOD corridors, and the existing commercial character of Centre Street offers a foundation for fostering multifamily residential development.

9.10 Centre Street's significant grade change immediately after crossing the river limits development opportunities close to Downtown.

9.11 A Centre Street alignment approaching the Aurora Business Park from the west, would place the station in a less valuable location that is a more distant walk from much of the site's planned office development.

Edmonton Trail Alignments

9.12 The Municipal Development Plan identifies Edmonton Trail as an urban corridor a policy designation that endorses future redevelopment in the corridor. Edmonton Trail

does not feature a significant grade change crossing the river from Downtown, enhancing the potential for future development in the downtown-adjacent Crescent Heights neighborhood.

9.13 An Edmonton Trail alignment would approach the Aurora Business Park from the east, in accordance with the Park's master plan. This approach would enable a station near the center of the development in close proximity to planned office development, enhancing the Park's value. .

9.14 Edmonton Trail exhibits fractured ownership with fewer parcels oriented towards the front of the Street than Centre street, making land assembly for mid-rise redevelopment more challenging.

Nose Creek Alignment

9.15 Physical constraints hinder the ability for a Nose Creek alignment to catalyze TOD within the North Central Communities study area.

9.16 A Nose Creek alignment may provide a high-quality Downtown connection from underutilized industrial areas on the eastern end of North Central and the areas north of Beddington Trail. However, such a growth paradigm would not accord with the City's current development policies.

9.17 A Nose Creek alignment would approach the Aurora Business Park from the east, in accordance with the Park's master plan. This approach would enable a station near the center of the development in close proximity to planned office development, enhancing the Park's value.

Development of Urban Realm Opportunities

9.18 The introduction of rapid transit and the revision of major traffic movements along a route provide an opportunity for improving the overall urban realm of the transit corridor. Different horizontal and vertical alignments, as well as transit modes and their design, can have a different effect on the urban realm – particularly where integrated, streetscape design and planning is included in the designs and costs.

9.19 New rapid transit stops will become people generators providing the impetus to create a new vibrant pedestrian-focused urban realm. There are also opportunities to use the stop locations as hubs around which development and the urban form is centred. This can improve the environment for local residents and businesses, and provide better conditions for pedestrians, cyclists, and public transit users. An enhanced urban realm also can improve the potential for redevelopment of existing areas and new development in underdeveloped areas.

9.20 As an input to the Urban Development / Urban Realm Account of the high level Multiple Account Evaluation (MAE), a qualitative assessment has been be undertaken of the potential urban design/urban realm impacts for each of the identified options.

9.21 The assessment considered the following factors in evaluating the potential urban realm impacts for each alternative:

- Scale of street –
  - Sidewalk widths and improved road crossings for pedestrians;
  - Impact on general traffic movements;
- Streetscape improvements;
  - Provision of hard and soft landscaping (including grass track and landscaping);
- Community identity/cohesion through improved connectivity and removal of any barriers; and
- Potential impact on property.

At Grade Options

9.22 LRT at grade provides significant potential to improve both the scale of the street, provide improved crossing opportunities for pedestrians and also make significant improvements to the streetscape. There can be an opportunity to provide different track finishes such as grass track guideway which provides a 'softer' guideway design that is more compatible with urban design principles.

9.23 At grade solutions in more constrained rights of way, do tend to have a detrimental impact on traffic flow, although this can be less of an issue in a grid based network where alternative routings may not add significant time to a journey forced to use an alternative route. In constrained rights of way, there is also the potential for impacts on neighbouring properties.

9.24 In addition, in-street platforms can provide a focus for urban design and pedestrian connectivity. The areas around station locations can become activity centres (if they weren't already), and help to improve urban vibrancy.

Elevated Options

9.25 These alternatives have the potential to create a barrier within the community, and create 'dead space' underneath the elevated sections, if this space is not designed appropriately.

9.26 Depending on the footprint of the support structures, space for general traffic and / or pedestrians may be reduced. Access to the elevated stations may also require a reasonable sized footprint and further reduce space for pedestrians and general traffic, however there is the potential for the station accesses to result in localized improved urban realm.

Underground Options

9.27 These alternatives have limited impact on urban design integration primarily due to their underground nature and limited interaction with the streetscape. However, depending on station access final location and architectural quality, the station could result in improved urban realm on the corner(s) with entrances. The station buildings and their entrance areas (once defined) would provide opportunities for localized urban realm improvements.

9.28 It is likely that any underground system built in North Central Calgary would utilize 'cut and cover' tunnel construction methods. This assumption is based on the likely depth of the tunnels and the high costs associated with using bored tunnels. This method would likely require the full reconstruction of the street in order to build the tunnel and so provides an opportunity for improvements to the urban realm once the right of way is reinstated. Due to the lack of interaction with the streetscape, the impact on general traffic movements and pedestrian movements is minimal in these options.

Summary of Urban Development / Urban Realm Account

4th Street Alignments

9.29 The 4th Street at grade option is considered to have potential for improving the urban development / urban realm on the route, however the current residential nature of the corridor would limit these opportunities. The narrow right of way on 4th Street would likely result in significant traffic and property impacts.

9.30 For the 4th Street elevated option, while there is potential for improving the urban realm, is most likely to have the largest detrimental impact if not implemented carefully as it may generate a significant community barrier. Depending on the footprint of the support structures, space for general traffic and / or pedestrians may be reduced. The narrow right of way on 4th Street would likely result in significant traffic and property impacts and a large elevated structure would significantly impact on the character of the area.

9.31 For a 4th Street underground option, the lack of interaction with the streetscape is limited and so the impact on general traffic movements and pedestrian movements should be limited and the potential for negative impacts is reduced. There is potential to improve the urban realm around the station locations, once they have been confirmed, however the residential nature of the 4th Street corridor will limit this potential. Due to the likely 'cut and cover' method for constructing the tunnel, there is an opportunity to improve the urban realm, when reconstructing the street.

Centre Street Alignments

9.32 The Centre Street at grade option is considered to have potential for improving the urban development / urban realm on the route. While the Centre Street alignment is constrained at various points, the mixed land use provides significant opportunity for improving the urban realm and general streetscape of this alignment, without significantly impacting on the character. Also the requirement to relocate the utilities will provide an opportunity to improve the streetscape when the roadway is rebuilt.

9.33 For the Centre Street elevated option, while there is potential for improving the urban realm, is most likely to have the largest detrimental impact if not implemented carefully as it may generate a significant community barrier. Depending on the footprint of the support structures, space for general traffic and / or pedestrians may be reduced. The impact of an elevated structure along this alignment is less than in a predominantly residential neighbourhood.

9.34 Due to the lack of interaction with the streetscape, the Centre Street underground option should have limited impact on general traffic movements and pedestrian movements and so the potential for negative impacts is reduced. There is potential to improve the urban realm around the station locations, once they have been confirmed, and the mixed use nature of this corridor should assist in maximising the potential at these specific locations. Due to the likely 'cut and cover' method for constructing the tunnel, there is an opportunity to improve the urban realm, when reconstructing the street.

Edmonton Trail Alignments

9.35 The Edmonton Trail at grade option is considered to have potential for improving the urban development / urban realm on the route. While the Edmonton Trail alignment is constrained at various points, the mixed land use provides significant opportunity for improving the urban realm and general streetscape of this alignment, without significantly impacting on the character. Also the requirement to relocate the utilities will provide an opportunity to improve the streetscape when the roadway is reinstated.

9.36 For the Edmonton Trail elevated option, while there is potential for improving the urban realm, is most likely to have the largest detrimental impact if not implemented carefully as it may generate a significant community barrier. Depending on the footprint of the support structures, space for general traffic and / or pedestrians may be reduced. The impact of an elevated structure along this alignment is less than in a predominantly residential neighbourhood.

9.37 Due to the lack of interaction with the streetscape, for the Edmonton Trail underground option, the impact on general traffic movements and pedestrian movements should be limited and so the potential for negative impacts is reduced. There is potential to improve the urban realm around the station locations, once they have been confirmed, and the mixed use nature of this corridor should assist in maximising the potential at these specific locations. Due to the likely 'cut and cover' method for constructing the tunnel, there is an opportunity to improve the urban realm, when reconstructing the street.

Nose Creek Alignment

9.38 While the at grade options are considered to have the greatest potential for improving the urban development and urban realm along the route, this is not the case along the Nose Creek alignment where there is very little urban development in the corridor and limited potential to create any due to the natural topography and geography. If however the potential for TOD along this corridor is realised, there might be a limited opportunity for improvement to urban realm.

Conclusions

9.39 The outputs of this account are summarised below and the account scoring was generated by averaging the scores from the TOD opportunity assessment and the Urban Realm potential assessment.

TABLE 9.1 URBAN DEVELOPMENT / URBAN REALM ACCOUNT SUMMARY

Option	TOD Opportunity	Urban Realm Potential	Overall
Option 1 – 4th Street Option A at grade	2	2	2
Option 2 – 4th Street Option B elevated	2	1	1.5
Option 3 – 4th Street Option C underground	3	3	3
Option 4 – Centre Street Option A at grade	4	4	4
Option 5 - Centre Street Option B elevated	4	1	2.5
Option 6 – Centre Street Option C underground	5	4	4.5
Option 7 – Edmonton Trail Option A at grade	4	4	4
Option 8 - Edmonton Trail Option B elevated	4	1	2.5
Option 9 – Edmonton Trail Option C underground	5	4	4.5
Option 10 – Nose Creek Option A at grade	3	3	3

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10 Sustainable Environment Account

Objective

- A service that facilitates a reduction in GHG emissions while not impacting the City's current natural environment

High Level MAE Criteria

- Route impact on existing natural environment – qualitative assessment on the like impacts during construction and operation, split by geographic area

Development of Environmental Impacts

10.1 A high level environmental comparison for all four alignments was undertaken on a qualitative comparison basis. The type of development along the corridor was considered, including potential risks posed by existing businesses along the alignments. Also considered were the impacts on the natural environments including existing parks and amenities adjacent to the proposed alignments.

10.2 Existing and past developments, such as gas stations and dry cleaners, that cause ground contamination are included in this evaluation as they incur a higher cost in environmental mitigation measures.

Option Analysis

4th Street Alignments

10.3 The 4th Street alignment is predominantly located along residential areas. This has lower traffic volumes overall (car, truck, and transit vehicles) as it is not a major corridor. Calgary Transit does not operate BRT along this corridor, but does operate regular transit services that have lower transit volumes than busier corridors. The possible impacts for this alignment are briefly outlined below:

- Possible increase in noise pollution with LRT, as transit does not run down 4th Street and typically lower vehicular volume exists along 4th Street;
- Risk due to existing dry cleaners north of McKnight Boulevard;
- Risk due to existing gas stations located north of McKnight Boulevard; and
- Some risk with the impact to parks by altering landscape (specifically any tree removal).

10.4 The assessment for the 4th Street alignment covers the following options:

- Option 1 – 4th Street – Option A at grade
- Option 2 – 4th Street – Option B elevated
- Option 3 – 4th Street – Option C underground

Centre Street Alignments

10.5 The Centre Street alignment is predominantly located along retail / residential areas. With high traffic volumes of personal vehicles, buses, and bus rapid transit (BRT) along the corridor, the change in the environmental impact with the installation of LRT is expected to produce positive benefits. These possible impacts for this alignment are briefly outlined below:

- Expected reduction in noise pollution due to expected reduced traffic volumes along the corridor;
- Risk due to presence of existing dry cleaners in the section between 16 Avenue to McKnight Boulevard;
- Risk due to existing gas stations along the entire alignment(with 4 stations located at the McKnight intersection);
- Some risk with the impact to parks by altering landscape (specifically any tree removal); and
- Some historic contamination with rail ties near 16 Avenue (will require more detailed historic review).

10.6 The assessment for the Centre Street alignment covers the following options:

- Option 4 – Centre Street – Option A at grade
- Option 5 - Centre Street – Option B elevated
- Option 6 – Centre Street – Option C underground

Edmonton Trail Alignments

10.7 The Edmonton Trail alignment would have similar potential environmental impacts as previously noted for the Centre street alignments. However, this alignment runs fairly close to Nose Creek between 32 Avenue to McKnight Boulevard , and also at Laycock Park as the City is currently undergoing rehabilitation in the area for Nose Creek. The possible impacts for this alignment are briefly outlined below:

- Construction constraints due to proximity to Nose Creek between 32 Avenue and McKnight Boulevard, and at Laycock Park;
- Environmental sensitivity due to presence of fish in Nose Creek;
- Low risk to Nose Creek north of Beddington Trail due to elevation and drainage change near the Aurora Business Park;
- Expected reduction in noise pollution due to expected reduced traffic volumes along the corridor;
- Risk due to existing gas stations along the entire alignment;
- Some risk with the impact to parks by altering landscape (specifically any tree removal); and
- Some historic contamination with rail ties near 16 Avenue (will require more detailed historic review).

10.8 The assessment for the Edmonton Trail alignment covers the following options:

- Option 7 – Edmonton Trail – Option A at grade

- Option 8 - Edmonton Trail – Option B elevated
- Option 9 – Edmonton Trail – Option C underground

Nose Creek Alignment

10.9 Different from the previous alignments, the Nose Creek alignment is located within a predominantly industrial area and would have lower risk associated than residential areas as there no gas stations or dry cleaners located in close proximity to the alignment. However, the presence of this alignment directly within the Nose Creek floodplain makes this alignment the most environmentally sensitive option. The possible impacts for this alignment are briefly outlined below:

- Constriction constraints due to location within the Nose Creek floodplain along the entire length of the alignment;
- Low risk to Nose Creek north of Beddington Trail due to elevation and drainage change near the Aurora Business Park;
- Significant environmental sensitivity with risk of changing hydrology of Nose Creek, altering the Creek flow, and impacting existing fish populations within the Creek;
- Nose pollution to residential / industrial areas will be minimal due to already high noise pollution with Deerfoot Trail and the existing CP Rail line; and
- Some contamination with presence of rail ties.

Summary

10.10 In general the alignments of Centre Street and 4th Street are of lesser relative environmental risk as they are both located adjacent to residential areas and near possibly high risk retail such as service centers and dry cleaners. 4th Street has been scored lower than Centre Street due to its residential nature. The Edmonton Trail and Nose Creek alignments both have high risk areas due to their proximity to Nose Creek, with the Edmonton Trail alignment only having issues at the northern end of the alignment.

TABLE 10.1 SUSTAINABLE ENVIRONMENT ACCOUNT SUMMARY

Option	Assessment
Option 1 – 4th Street Option A at grade	4
Option 2 – 4th Street Option B elevated	4
Option 3 – 4th Street Option C underground	4
Option 4 – Centre Street Option A at grade	5
Option 5 - Centre Street Option B elevated	5
Option 6 – Centre Street Option C underground	5
Option 7 – Edmonton Trail Option A at grade	3

Option	Assessment
Option 8 - Edmonton Trail Option B elevated	3
Option 9 – Edmonton Trail Option C underground	3
Option 10 – Nose Creek Option A at grade	1

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Nice LRT

11 Deliverability Account

Objective

- A service that can be constructed and operated without significant technical issues or constraints

High Level MAE Criteria

- Constructability - technical constraints – initial constraints identified as part of the corridor scoping exercise and as part of the review of previous work

Development of Potential Constraints on Deliverability

11.1 Constraints on deliverability are related to constructability and technical aspects such as road widths and utilities, as well as construction issues and impacts such as traffic and emergency services. These factors are summarized in Appendix J.

11.2 Alignment options were given a route score based on a 1-5 scale and are tabulated in the Table 11.1 and 11.2.

TABLE 11.1 CONSTRUCTABILITY & TECHNICAL CONSTRAINTS

#	Consideration	4th Street	Centre Street	Edmonton Trail	Nose Creek
1	Road Right of Way width	2	2	2	4
2	Underground utilities	2	2	3	5
3	Aboveground utilities	3	3	3	5
4	Road Gradient	3	4	3	3
5	Geotechnical	3	3	3	3
6	Major road intersection	3	3	3	4
7	Major obstruction	3	3	3	2
	TOTAL SCORE	19	20	20	26

TABLE 11.2 CONSTRUCTION ISSUES & IMPACTS

#	Consideration	4th Street	Centre Street	Edmonton Trail	Nose Creek
1	Vehicular traffic	2	3	3	5
2	Pedestrian traffic	2	3	2	4
3	Adjoining property ingress/egress	3	3	2	4
4	Major commercial	3	3	2	5
5	Bus Transit Park and Ride site	3	3	4	4
6	New structures needed	4	4	4	1
	TOTAL SCORE	17	19	17	23

Option Analysis

4th Street Alignment

11.3 The 4th street options received the overall lowest score due to a combination of factors. The alignment features narrow road right of ways, which may impact construction of all potential options. This alignment also features greater potential for disruption to underground utilities than other alignments.

11.4 Vehicular and pedestrian traffic will both face high impacts due to construction on all proposed options. The 4th Street Alignment is expected to have minor impacts on existing structures and will likely require few additional new structures during construction.

Centre Street Alignment

11.5 The Centre Street options feature the second highest deliverability score due to a road gradient that is more manageable when compared to the other options. However, the alignment also has a narrow road right of way throughout that may impact construction. Construction has a high potential to impact underground utilities.

11.6 The Centre Street Alignment is expected to have minor impacts on existing structures and will likely require few additional new structures during construction.

Edmonton Trail

11.7 The Edmonton Trail Alignment scored in third place in the deliverability account due to road right of way width issues, which may cause potential construction impacts.

11.8 Pedestrian traffic, along with ingress and egress to adjoining properties are likely to be significantly impacted by construction of options on this alignment. However, Bus Park and Ride facilities do not face major impacts due to construction. The Edmonton Trail Alignment is expected to have minor impacts on existing structures and will likely require few additional new structures during construction.

Nose Creek Alignment

11.9 The Nose Creek Option received the greatest evaluation in the deliverability category due to few major impacts to utilities and road intersections. The alignment only faces minor constraints due to road right of way width.

Summary

11.10 The final deliverability score for each option is summarized in table 11.3. In general the Nose Creek option achieves the highest deliverability score as it does not interface with developed urban area. Of the alignments that interact with developed urban areas, the Centre Street alignment achieves the highest score.

TABLE 11.3 DELIVERABILITY ACCOUNT SUMMARY

Option	Assessment
Option 1 – 4th Street Option A at grade	1
Option 2 – 4th Street Option B elevated	1
Option 3 – 4th Street Option C underground	1
Option 4 – Centre Street Option A at grade	3
Option 5 - Centre Street Option B elevated	3
Option 6 – Centre Street Option C underground	3
Option 7 – Edmonton Trail Option A at grade	2
Option 8 - Edmonton Trail Option B elevated	2
Option 9 – Edmonton Trail Option C underground	2
Option 10 – Nose Creek Option A at grade	4

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Summary of Outputs from all Accounts

12.1 The table below sets out the scoring under each of the accounts for each of the 10 assessed options. As described previously, where multiple criteria are assessed under a single account, a straight average of these values is taken so that the overall score for the account remains on a scale of 1 to 5.

TABLE 12.1 HIGH LEVEL MAE SCORING SUMMARY

MAE Accounts	Criteria	Option 1 - 4th Street at grade	Option 2 - 4th Street elevated	Option 3 - 4th Street underground	Option 4 - Centre Street at grade	Option 5 - Centre Street elevated	Option 6 - Centre Street underground	Option 7 - Edmonton Trail at grade	Option 8 - Edmonton Trail elevated	Option 9 - Edmonton Trail underground	Option 10 - Nose Creek at grade
Financial Capacity	Capital cost	5.0	2.0	1.0	5.0	2.0	1.0	5.0	4.0	2.0	5.0
Community Well-being	Links to community destinations	5.0	4.5	4.0	5.0	4.5	4.0	4.0	3.5	3.0	1.0
Prosperous Economy	Population and Employment	2.5	3.0	3.0	3.5	4.0	4.0	4.5	5.0	5.0	2.3
	Access to YYC	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	2.0
	Overall	**2.3**	**2.5**	**2.5**	**2.8**	**3.0**	**3.0**	**3.8**	**4.0**	**4.0**	**2.1**
Transportation	Ridership	3.5	3.5	3.5	5.0	5.0	5.0	4.0	4.0	4.0	1.5
	Transit efficiency / compatibility	4.0	2.0	2.0	4.0	2.0	3.0	5.0	4.0	4.0	1.0
	Journey Time by segment	3.0	4.0	4.0	3.0	4.0	4.0	3.0	4.0	4.0	3.5
	Overall	**3.5**	**3.2**	**3.2**	**4.0**	**3.7**	**4.0**	**4.0**	**4.0**	**4.0**	**2.0**
Urban Development / Urban Realm	TOD Opportunity	2.0	2.0	3.0	4.0	4.0	5.0	4.0	4.0	5.0	3.0
	Urban Realm	2.0	1.0	3.0	4.0	1.0	4.0	4.0	1.0	4.0	3.0
	Overall	**2.0**	**1.5**	**3.0**	**4.0**	**2.5**	**4.5**	**4.0**	**2.5**	**4.5**	**3.0**
Sustainable Environment	Impact on Natural Environment	4.0	4.0	4.0	5.0	5.0	5.0	3.0	3.0	3.0	1.0
Deliverability	Technical constraints	1.0	1.0	1.0	3.0	3.0	3.0	2.0	2.0	2.0	4.0
Overall		**22.8**	**18.7**	**18.7**	**28.8**	**23.7**	**24.5**	**25.8**	**23.0**	**22.5**	**18.1**

12.2 In applying the framework, no explicit weightings are given to the different accounts. Individual decision makers / agencies will consider the implications and understand the potential effect of implicitly or explicitly applying different weightings.

Conclusions

12.3 It can be seen from the scoring that of the four alignments assessed, Nose Creek and 4th Street score considerably lower than either Centre Street or Edmonton Trail. On this basis it has been recommended that these options are not considered further in the technical analysis.

12.4 **For the Centre Street and Edmonton Trail alignments, the at-grade option scores highest for these options and so it has been recommended that these two options be taken forward as the priorities for analysis**. The Centre Street underground option is the third highest scoring, however due to the significant costs for this option, it is felt that the at-grade options should be considered in advance of undertaking further technical analysis of this option.

12.5 Note that the selection of the two at-grade options as the priority for technical analysis does not rule out the possibility that underground or elevated sections will be considered along the two alignments. This decision will be taken where the technical analysis highlights constraints or issues that an elevated or underground solution may solve. It may also be possible that the technical analysis will lead to the development of a hybrid Edmonton Trail / Centre Street route option.

Next Steps

12.6 As well as undertaking more detailed analysis on the at-grade options for Centre Street and Edmonton Trail, detailed consideration will now also be given to the route section from Downtown to the south of 16th Avenue, which has been excluded from the evaluation to date.