

Calgary North Central LRT:
The Centre City Connection
Between the North Central
and Southeast LRT Lines



Prepared for:
City of Calgary

Prepared by:

Stantec Consulting Ltd. in
association with:

Context Research
HR&A
SDG

February 12, 2014

CALGARY NORTH CENTRAL LRT

Table of Contents

1.0	INTRODUCTION	1.1
1.1	BACKGROUND	1.1
1.2	MAE NORTH OF 16 AVENUE	1.1
1.3	GOAL REFINEMENT.....	1.2
2.0	KEY CHALLENGES.....	2.4
2.1	GRADES / EXCAVATION.....	2.4
2.2	BLOCK LENGTHS	2.5
2.3	GEOLOGY	2.5
2.4	BOW RIVER CROSSING	2.6
2.5	WEST SIDE GROWTH	2.6
2.6	ACCESS TO BELT LINE.....	2.6
2.7	8 AVENUE TUNNEL	2.7
2.8	CPR TRACKS.....	2.7
3.0	WORKSHOP PROCESS	3.8
3.1	BACKGROUND	3.8
3.2	WORKSHOP FORMAT	3.8
3.3	PUBLIC TRANSIT 2040 VISION.....	3.9
3.4	CYCLING 2040 VISION.....	3.9
3.5	GOODS MOVEMENT 2040 VISION.....	3.9
3.6	CENTRE CITY PLAN MOBILITY GOALS.....	3.10
3.7	LRT AND TRANSIT SERVING DOWNTOWN COMMUNITIES.....	3.10
4.0	WORKSHOP OUTPUT	4.12
4.1	KEY DESTINATIONS.....	4.12
4.2	GROUP 1	4.13
4.3	GROUP 2	4.14
4.4	GROUP 3	4.15
4.5	GROUP 4	4.16
4.6	GROUP 5	4.17
4.7	SUMMMARY OF OPTIONS.....	4.18
4.8	PREFERRED CORRIDOR.....	4.19
4.9	PREFERRED ALTERNATIVES	4.20
5.0	ROUND 1 OPTIONS.....	5.22
5.1	OPTION 1 TO 10 AVENUE.....	5.22
5.2	OPTIONS 3 & 10 TO 10 AVENUE	5.23
5.3	OPTIONS 4 & 6 TO 17 AVENUE	5.24
5.4	OPTIONS 11 & 12 TO 12 AVENUE.....	5.25
5.5	OPTION 13 TO 17 AVENUE.....	5.26
6.0	ROUND 1 EVALUATION	6.27

CALGARY NORTH CENTRAL LRT

7.0	ROUND 2 OPTIONS	7.28
8.0	ROUND 2 EVALUATION	8.29
9.0	CONCLUSIONS	9.31

LIST OF FIGURES & TABLES

Figure 1 – Key Downtown Challenges	2.4
Figure 2 – Geology in Downtown	2.5
Figure 3 – Key Locations in the Centre City	4.12
Figure 4 – Group 1 Option	4.13
Figure 5 – Group 2 LRT and Streetcar	4.14
Figure 6 – Group 3 (4 Street to 12 Avenue)	4.15
Figure 7 - Group 4 (4 Street to 13/17 Avenue).....	4.16
Figure 8 - Group 5 (4 Street to 13 Avenue)	4.17
Figure 9 - Overlay of Options	4.18
Figure 10 - Preferred Corridor.....	4.19
Figure 11 – Preferred Alignment from Workshop.....	4.20
Figure 12- Option 1	5.22
Figure 13 – OPTIONS 3A, 3B, 3C, 3D AND 10	5.23
Figure 14 – OPTIONS 4A, 4B & 6.....	5.24
Figure 15 – OPTIONS 11, 12A, 12B, 12C, 12D	5.25
Figure 16 – OPTIONS 13A, 13B, 13C & 13D.....	5.26
Table 1 – Round One Evaluation Results	6.27
Table 2 – Round 2 Evaluation Results	8.29

LIST OF APPENDICES

APPENDIX A	A.1
-------------------------	------------

CALGARY NORTH CENTRAL LRT

Introduction
February 12, 2014

1.0 Introduction

1.1 BACKGROUND

The Downtown Analysis is a result of a desire to align two separate LRT projects; the North-Central LRT Line and the Southeast LRT Line / SETWAY. Though nominally always considered to be connected from an operational perspective in order to eliminate the need for a second heavy duty LRV maintenance facility, the lines were being studied separately.

The starting points of the Downtown Analysis were SETWAY and its approved Downtown alignment terminating in the Eau Claire area and the North-Central alignment that assumed shared use of the 7 Avenue transit mall. Earlier tasks of this current North-Central LRT Study considered three possible alternatives to the approved Nose Creek alignment: Centre Street, Edmonton Trail and 4 Street NW. Each of the three alternative alignments, as well the approved alignment, would connect the Downtown to communities in the north, but the level of analysis that had been taken with respect to the Centre City area was limited. As a result of these earlier tasks, Centre Street and Edmonton Trail were brought forward as the preferred alternatives north of 16 Avenue. Following the elimination of the Nose Creek alignment option for the NC LRT, it was apparent that the location for the Downtown connection needed to be revised

The Downtown Analysis task of the Green Line study was established to provide a comprehensive analysis of potential LRT alignment(s) in the Downtown. Efforts have been made to gather detailed input from City staff rather than rely on existing approved alignments that were approved prior to recent work on the Centre City Plan, Centre City Mobility Plan, and East Village Master Plan and before the identification of new growth opportunities and connectivity requirements for the Beltline, approved residential increases in the Eau Claire area, and new cycling initiatives within the Downtown.

1.2 MAE NORTH OF 16 AVENUE

As alluded to above, prior to the Downtown Analysis, the Stantec team developed alternative alignments for the NC LRT line north of 16 Avenue. The alternatives included underground, at-grade, and aerial alignments along 4 Street NW, Centre Street, and Edmonton Trail, as well as an at-grade option along Nose Creek, resulting in 10 alternatives. These alternatives were evaluated through a Multiple Account Evaluation (MAE) process that resulted in the identification of two options, an at-grade option along Centre Street and an at-grade option along Edmonton Trail. It was therefore assumed that the Downtown alignment would connect with one of these two selected alignments, but with the understanding that if a particular Downtown alignment was extremely attractive but did not correspond to an at-grade Centre Street or Edmonton Trail alignment north of 16 Avenue, then this result could be revisited.

CALGARY NORTH CENTRAL LRT

Introduction
February 12, 2014

1.3 GOAL REFINEMENT

The project team identified a number of goals related to a new LRT line in the Downtown area, but during the preliminary corridor identification process, it became clear that these goals needed to be defined in more detail to have a definitive impact on the selection of an alignment. These goals included:

- Creating a north-south LRT movement through the geographic centre of Downtown to complement the existing east-west movements provided by the 7 Avenue LRT line
- Connecting the Downtown with the Beltline area to stimulate development south of Downtown
- Connecting with the 7 Avenue transit mall to provide an opportunity to transfer between rail lines
- Connecting with the planned 8 Avenue tunnel to provide an opportunity to transfer between rail lines
- Connecting to the Stampede grounds
- Connecting to the future High Speed Rail station
- Providing a station in north Downtown (at Eau Claire) per the approved SETWAY alignment

To further refine the goals for LRT in the Downtown, key assumptions or principles were identified in consultation with City staff to guide the analysis. These included:

- The approved SETWAY alignment could be slightly adjusted to connect with the NC LRT to form the Green Line
- At-grade options could and should be explored in the interest of cost savings and stimulating more complete street design in the Downtown
- A direct link (either in the form of a cross platform transfer or interlined service) between the North-Central LRT and SE LRT was expected of any proposed alignment
- The LRT line would not be able to take existing capacity off of the 4 and 5 Avenue Bridges nor would a new vehicular bridge in this area be explored
- While not a specific requirement of the Green Line, the topic of a future Downtown circulator was actually addressed by some of the small groups in the Downtown Analysis workshop (see Chapter 4)
- Initially, separate sets of options were created to align with Centre Street and Edmonton Trail. However, it was decided that the Downtown alignment did not depend on what the alignment was north of 16 Avenue, so this simplified the list of options to some degree.

CALGARY NORTH CENTRAL LRT

Introduction
February 12, 2014

Given that the goals for the Downtown alignment had only been loosely defined, the initial set of options for the Downtown were constrained mainly by a need to serve the Downtown core with one or more stations, provide a strong connection between the NC and SE LRT lines, and avoid an LRT concept that would serve as a circulator as opposed to a Downtown connector. This resulted in a fairly large number of options. These options were evaluated through a preliminary Multiple Account Evaluation (MAE) process, similar to how the options north of 16 Avenue were evaluated (see Chapter 6 and Appendix A).

CALGARY NORTH CENTRAL LRT

Key Challenges
February 12, 2014

2.0 Key Challenges

The purpose of this chapter is to highlight some of the key challenges that have been identified regarding the Downtown alignment. Figure 1 depicts items for consideration in the Centre City area of the Green Line.

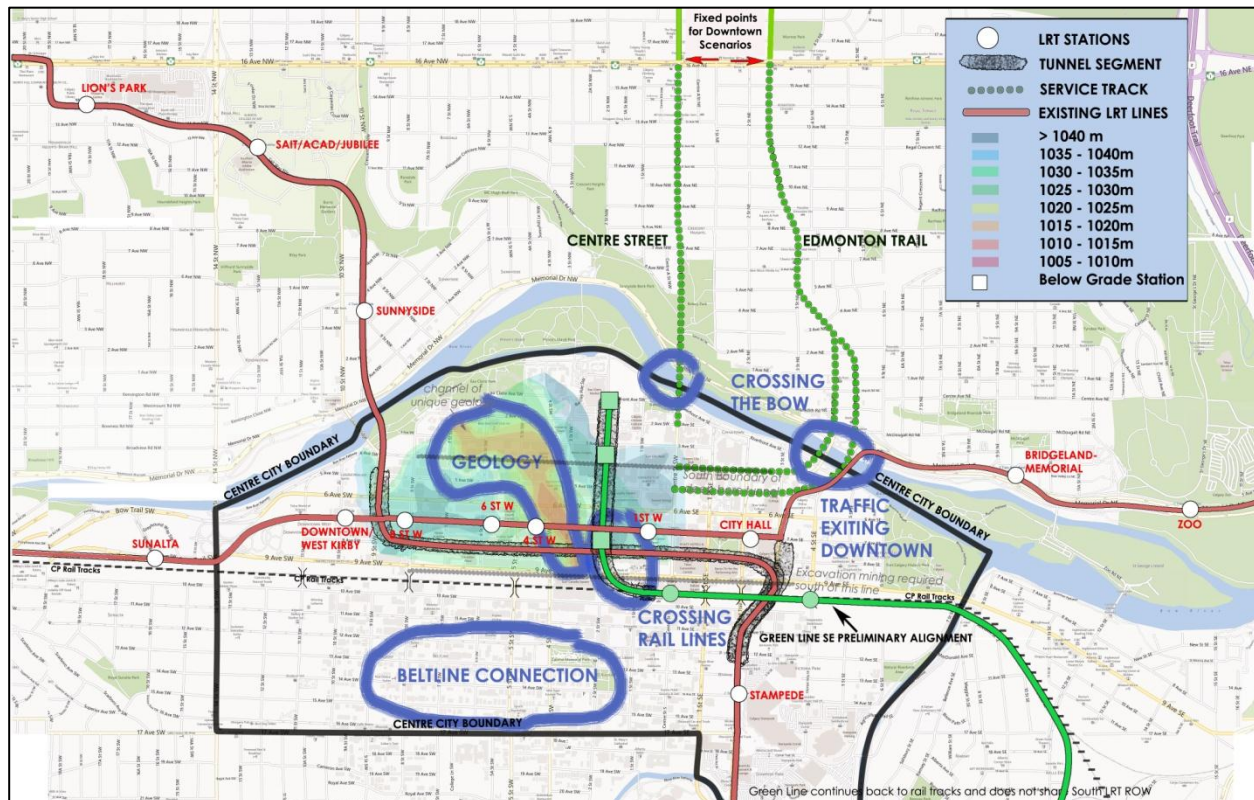


Figure 1 – Key Downtown Considerations

2.1 GRADES / EXCAVATION

The geology within and around the Downtown will require that different excavation techniques be employed at different areas if a tunnel option is pursued for the Green Line. Deep tunnel boring and the sequential excavation method are the two excavation techniques for the downtown area, while cut and cover methods would be required at the approaches of the tunnel entrance and exit.

As for grade issues, attaining sufficient tunnel depth below the Bow River requires sufficient horizontal lengths, particularly on the section north of the Bow, to overcome the elevation of the embankment (and keeping the rail grades below 7%).

CALGARY NORTH CENTRAL LRT

Key Challenges
February 12, 2014

2.2 BLOCK LENGTHS

The Downtown features longer east-west block lengths than north-south lengths which potentially limits station location areas on at-grade options where the length of the train may exceed the physical length of the block. There are techniques to mitigate this, including track signaling and stop protocols that allow door to door stopping within a platform or changing the configuration of the light rail vehicles from train consists of multiple single cars to articulated trains with multiple sections. Other features of the Downtown roadway network that pose a challenge to an at-grade LRT alignment are the high number of non-continuous roads and tight turning radii.

2.3 GEOLOGY

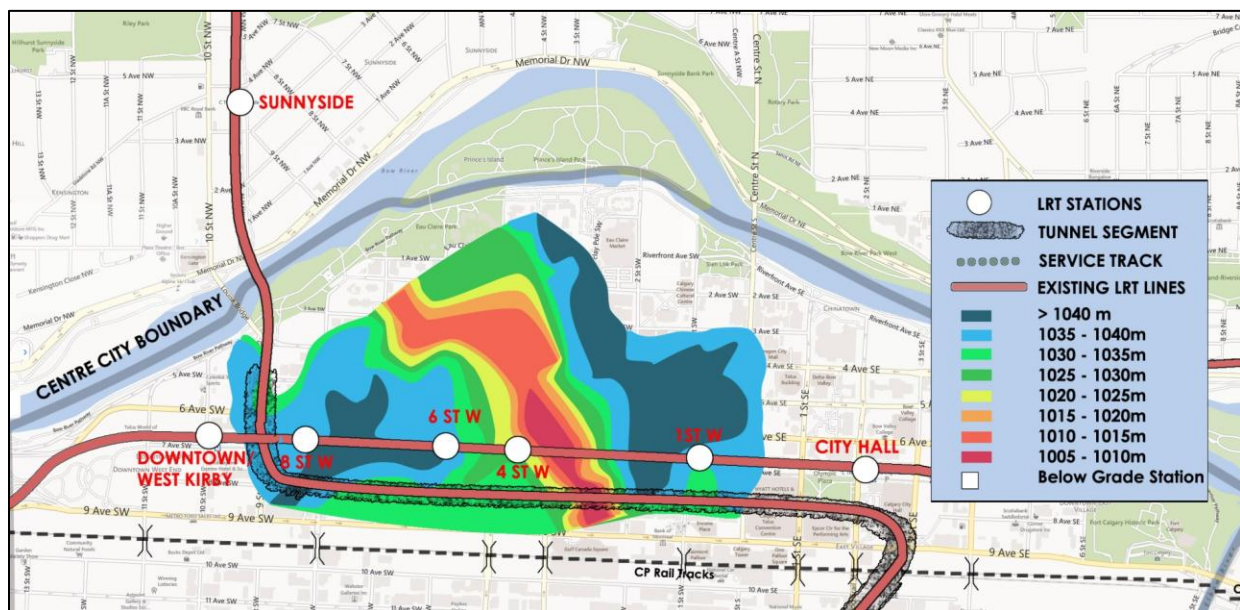


Figure 2 – Geology in Downtown

Downtown Calgary features non-homogenous geology with a glacial channel crossing on a Northwest to Southeast axis. The coloured areas in Figure 2 represent areas of bedrock at different depths. The green areas are the gravel and silt sides of the channel while the yellow and orange areas are different depths of the river bottom. This means that a deep bore tunnel in the areas of red, orange, yellow, and dark green is difficult and costly unless it is sufficiently deep. This geological information summarizes preliminary findings on research done on the downtown geology. It is not supported by borehole analysis and would require further investigation to confirm in later phases of the study.

CALGARY NORTH CENTRAL LRT

Key Challenges
February 12, 2014

If a tunneling method was chosen to be within the bedrock it would impact the surface to platform movements of passengers due to the significant depth. Shallow tunnels through this area can be accommodated but would result in higher costs and risks.

2.4 BOW RIVER CROSSING

Crossing of the Bow River at-grade requires some form of structure. The available options are to:

- Use the Centre Street Bridge and restrict vehicle access as a result
- Attach a new guideway to the Centre Street Bridge
- Construct a new structure in the region of the Centre Street Bridge

There are a number of constraints regarding the location of the bridge and the approaches to the structure both within Downtown and on the north side of the Bow. Prince's Island represents an ecologically sensitive area where intrusions from bridge footings would likely be detrimental. To the east of Centre Street, there is limited opportunity north of the 1 Avenue NE area to put in a bridge where the access within Downtown does not begin to impact the 4 Street/5 Street flyover accesses into Downtown. The area between 1 Street NE and Prince's Island likely represents the best location for a new structured crossing of the Bow by rail.

In addition, a tunnel under the Bow River is an option in this Downtown Analysis.

2.5 WEST SIDE GROWTH

Significant high-density residential development is underway in the West End, a neighbourhood west of Downtown. It is already served by the Blue Line at 7 Avenue SW, at the southern edge of the neighbourhood. Additional transit service, such as an infill Blue Line station or streetcar service to the rest of Centre City, may be of value for improving mobility for current and future residents. Given that the West End is and will be primarily residential, there may be few origins and destinations between the West End and the North-Central communities. In addition, serving the West End before connecting to Downtown may increase trip times for riders originating in North-Central communities.

2.6 ACCESS TO BELT LINE

The Beltline is a mixed-use neighbourhood and regional entertainment destination. 17 Avenue is the heart of the corridor featuring shops, offices, restaurants, and bars. It does not have LRT access, but has thrived because of its relative proximity to Downtown and its urban character of walkable streets and public realm. The experience of other cities like New York, Portland, and Boston demonstrates that connecting Downtown-adjacent neighbourhoods by transit enhances the competitive profile of the Downtown by connecting workers and visitors to a vibrant destination in a seamless way. The Beltline's ability to perform this function for the City of Calgary would be improved with a direct and frequent north-south

CALGARY NORTH CENTRAL LRT

Key Challenges
February 12, 2014

rail link to Downtown. Moreover, the significant real estate value that could be created by new transit service in the Beltline could be leveraged as part of a value capture strategy to fund the transit investment.

2.7 8 AVENUE TUNNEL

The 8 Avenue Tunnel has been shown on all options based on the presumption that this infrastructure will exist concurrently with the Green Line at some future date. The South LRT to Northwest LRT alignment will utilize 8 Avenue thus reducing the total volume of LRT vehicles along 7 Avenue and allowing for expansion of service on the Northeast-West LRT alignment, if required. Station locations have not yet been identified.

2.8 CPR TRACKS

Most of the options considered a tunnel to get between the areas north and south of the CPR tracks. In some cases, the LRT uses a vehicle underpass, but this is possible only with significant impacts to vehicle movements.

CALGARY NORTH CENTRAL LRT

Workshop Process
February 12, 2014

3.0 Workshop Process

3.1 BACKGROUND

Since April 2013, Stantec and the NC LRT project team have been working to identify a preferred route alignment for the NC LRT. Planning and engagement was initially focused on the study area north of 16 Avenue NE. More recently, the project team began to evaluate the options for the NC LRT alignment in the Downtown area, known as the 'Centre City'.

The City has established a vision for the Centre City that has been used to guide land-use decisions and to provide the broader context for planning for development, the economy and communities in the Downtown. With respect to mobility and transit, however, the Centre City Plan provides only high-level values and goals.

On October 31, 2013, the City's NC LRT Steering Committee met to review progress on the alignment study. The Steering Committee noted that the NC LRT contributes to the overall future vision for The City and discussed the need to more clearly define The City's goals for the Downtown including how LRT should serve the Beltline and Downtown residents. The Steering Committee directed the project team to conduct a workshop with City staff to address the role of, and alignment for the NC LRT in the Centre City.

The workshop was an opportunity to provide a cross section of Calgary staff with an overview of the issues and challenges that were pivotal in creating the preliminary options. The creation of the options highlighted the need to provide constraints in order to begin the process of reducing the options to a few key corridors. Stantec provided staff with a number of issues that required debate and direction within the Centre City zone.

3.2 WORKSHOP FORMAT

The December workshop was planned as a half-day session with representation from the NC LRT Technical Advisory Committee. The purpose of the workshop was to:

1. Establish the City's planning context for the NC LRT in the Downtown area, with particular reference to the Beltline and the area west of Centre Street, north of the CPR tracks to the Bow River; and,
2. Identify how the NC LRT should connect into and through the Downtown to form the Green Line.

The workshop began with a review of initial alignment concepts for the Centre City to help set the stage for a discussion of more detailed planning concepts. This was followed by a presentation on the Centre City Plan for the Downtown, and a presentation and discussion of economic development opportunities that could be served by improved mobility and LRT. Once the planning context for LRT in the Downtown was established, participants worked in breakout groups to identify the goals for mass transit in the

CALGARY NORTH CENTRAL LRT

Workshop Process
February 12, 2014

Centre City and provide direction on the future of transit mobility in the Beltline and the Downtown west of Centre Street.

Following the discussion of initial alignments and the planning framework for the Downtown, participants were asked to comment on the goals for mass transit in the Downtown for 2040. To help guide the discussion, participants were asked to describe how the mobility experience in the Downtown would be different in 25 – 30 years, and what role mass transit will play in a City of the future. Participants were encouraged to take the perspective of different modes (e.g., cycling, pedestrians, transit users, goods movement, etc.) or to comment more generally on the experience and goals.

Key themes emerging from this discussion included limitations on the use of, and capacity for automobiles in the Downtown core, and establishing mobility priorities for pedestrians, public transit, cycling and goods movement. The following narrative, taken from participants' comments, describes the mobility experience from the perspectives of public transit cycling, and goods movement.

3.3 PUBLIC TRANSIT 2040 VISION

Public transit is the prioritized way to get into and around the Centre City. A transit-oriented lifestyle, complemented by ride share programs (Car2Go, bikeshare), and an improved pedestrian network have helped to reduce congestion in the Downtown area. People move quickly and efficiently into the Centre City from outlying communities. Within the Downtown, LRT and other forms of public transit connect people seamlessly to desirable locations, for example, to the East Village, Inglewood and Downtown West where densities have substantially increased. The LRT system is underground, and is a safe, warm and convenient way to get around the City.

3.4 CYCLING 2040 VISION

Cycling will be a preferred transportation mode in the Centre City, providing a fast, efficient, safe and friendly way to about the City. A much broader cycling network will improve mobility in the Downtown with dedicated lanes and infrastructure to ease demand for mass transit, as well as storage and security at park and ride facilities and major hubs. The cycle network will be fully integrated with mass transit to provide a seamless and efficient commute both within the Downtown and for commuters to Downtown.

An initial cycle track is being built in the Downtown along 1 Street SE from the Bow River, and future cycle tracks are being considered along other alignments as part of this cycling initiative.

3.5 GOODS MOVEMENT 2040 VISION

A vibrant economy functions within the Centre City providing employment and a diverse range of facilities and services that support those who live and work in the Downtown core. A substantial increase in the number of people living and working in the Downtown means a corresponding increase in the transport of goods to supply stores and businesses and to make deliveries to residents. The Stampede area is a major economic driver in the community, for special events as well as a major business district.

CALGARY NORTH CENTRAL LRT

Workshop Process
February 12, 2014

Traffic congestion, technology and concerns about safety and livability have led to major changes in how goods move within and through the City. Dangerous goods are not permitted to move through the City either by rail or transport. Regulations now permit deliveries in designated hours and in laneways to minimize traffic impacts in the Downtown. Technology also allows smaller parcels to be delivered using drones, and an underground automated courier system is connected to the underground mass transit system.

3.6 CENTRE CITY PLAN MOBILITY GOALS

Specific policies in the Centre City Plan that provide guidance to planning transit and LRT in the Downtown include the following:

- Establish a target modal split between public transit and other movement modes into the Downtown.
- Transit systems must be expanded and enhanced to provide more and better transit services for residents, employees and visitors.
- Make transit the first choice for people accessing and moving around the Centre City in the longer term.
- Increase the frequency and capacity of CTrain services.
- Complete and develop the future transit network within and beyond the Centre City to accommodate growth, which includes improved transit service connectivity between Centre City neighbourhoods, particularly Beltline and the Downtown, including consideration of one or more loops.
- Support the use of BRT to and from the Centre City as an interim solution before new LRT routes are constructed. Optimize transit connectivity between the commercial core and neighbourhoods north and south of the core. This should include considerations of transit technology alternatives including buses, LRT and streetcars and their ability to meet service requirements and to enhance community development.

Combining the elements of the vision for mobility identified by participants at the workshop with the Centre City mobility policies could result in an updated set of goals/objectives to guide planning for public transit and mass transit in the Centre City.

3.7 LRT AND TRANSIT SERVING DOWNTOWN COMMUNITIES

Working in small groups, participants were asked to first consider if and how mobility should be improved in the Beltline and the Downtown west of Centre Street and south of 9 Avenue. The Beltline includes the communities of Connaught and Victoria Park. It is bounded by 9 Avenue SW to the north, 17

CALGARY NORTH CENTRAL LRT

Workshop Process
February 12, 2014

Avenue SW to the south, 14 Street S.W and the Elbow River to the east. Participants were then asked to consider the role of LRT in meeting future needs for mobility and connectivity.

Workshop participants agreed that improvements to mobility are important in the Centre City to support both residential growth and businesses. Participants agreed that at least two levels of transit service are required. At the local level, a 'circulator' system to improve local mobility and to serve attractions is required. A slower moving streetcar system or 'electro-bus' connecting to mass transit was provided as an example. Mass transit provides a higher level service, moving large numbers of people into and out of the Centre City throughout the day.

Participants generally agreed that the NC LRT should extend west along 3 or 4 Avenue into the Downtown, connecting to high density development at the Eau Claire site, before turning south near 4 Street to connect into the Downtown business district. The LRT line would then extend south across the CPR tracks to 11 or 12 Avenue to form an east-west connector to the Southeast LRT line, forming the Green Line. Key LRT hubs along this alignment would include Eau Claire Estates, Devonian Gardens, Railtown and Stampede, where the connection to the Southeast LRT takes place.

Participants were divided as to whether the alignment should be at-grade or underground. Concerns about undergrounding included the risks from flooding, safety and the potential loss of vibrancy associated with people and activity at street level. Support for undergrounding future LRT alignments was based on reducing traffic conflicts, achieving the speed and efficiency of underground systems (e.g., Vancouver's Canada Line was cited as an example) and reducing the costs and impacts associated with acquiring rights of way.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.0 Workshop Output

The output from the workshop will be considered along with a multiple account evaluation of all options, however, given the cross section of City of Calgary staff providing input; the output has a key role in finalizing or narrowing the alignment options through the Centre City.

4.1 KEY DESTINATIONS

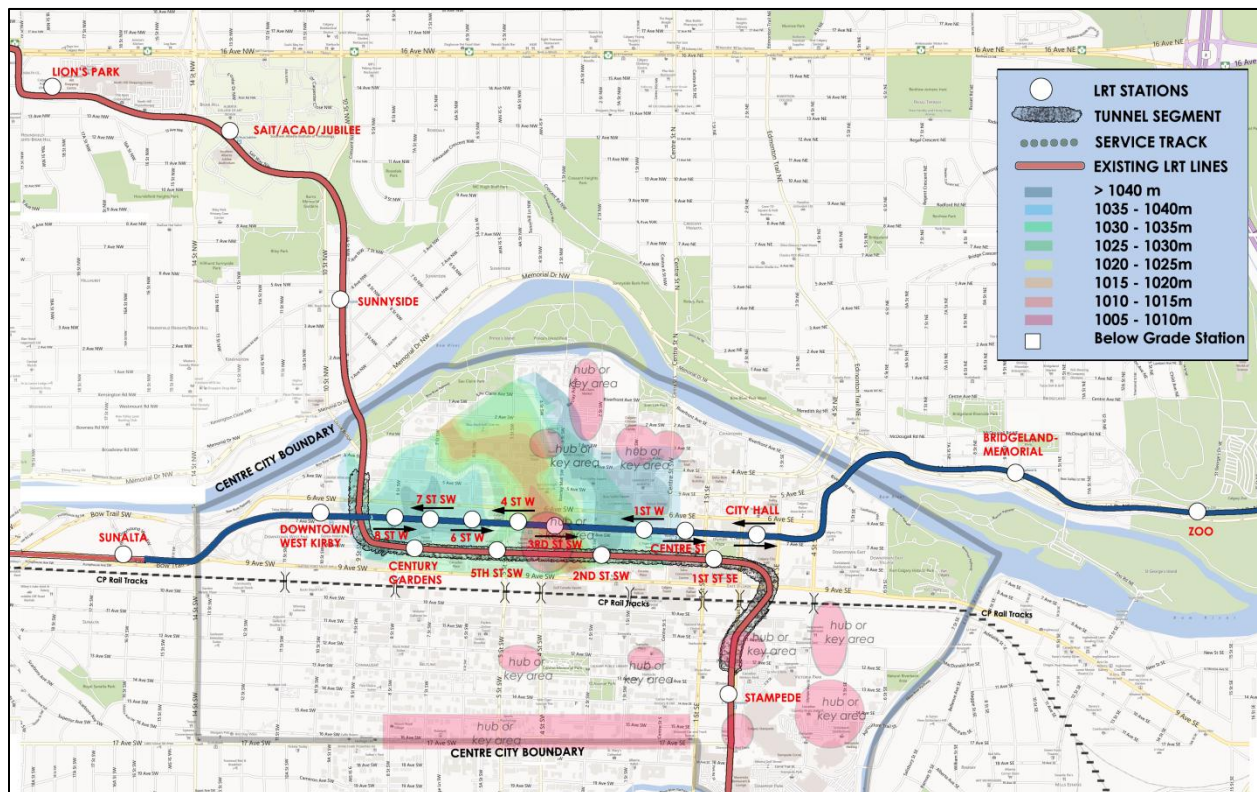


Figure 3 – Key Locations in the Centre City

One of the main points of discussion prior to the creation of options was the need to identify the key locations, transfer issues, iconic locations and rationale for various movements through Downtown.

The Beltline and connectivity to the Downtown were important themes south of the rail tracks with locations along 17 Avenue and 12 Avenue for development potential while Stampede and connection to the future High Speed Rail were connection points.

Within Downtown, Eau Claire has development potential along with significant residential growth along with Chinatown and the need to connect the two LRT lines in an iconic form.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

The notion of an iconic transit structure within the Downtown that is centrally located and provides a destination for transportation modes such as New York's Grand Central Terminal or London's Victoria Station was brought forward by all groups in the workshop.

4.2 GROUP 1

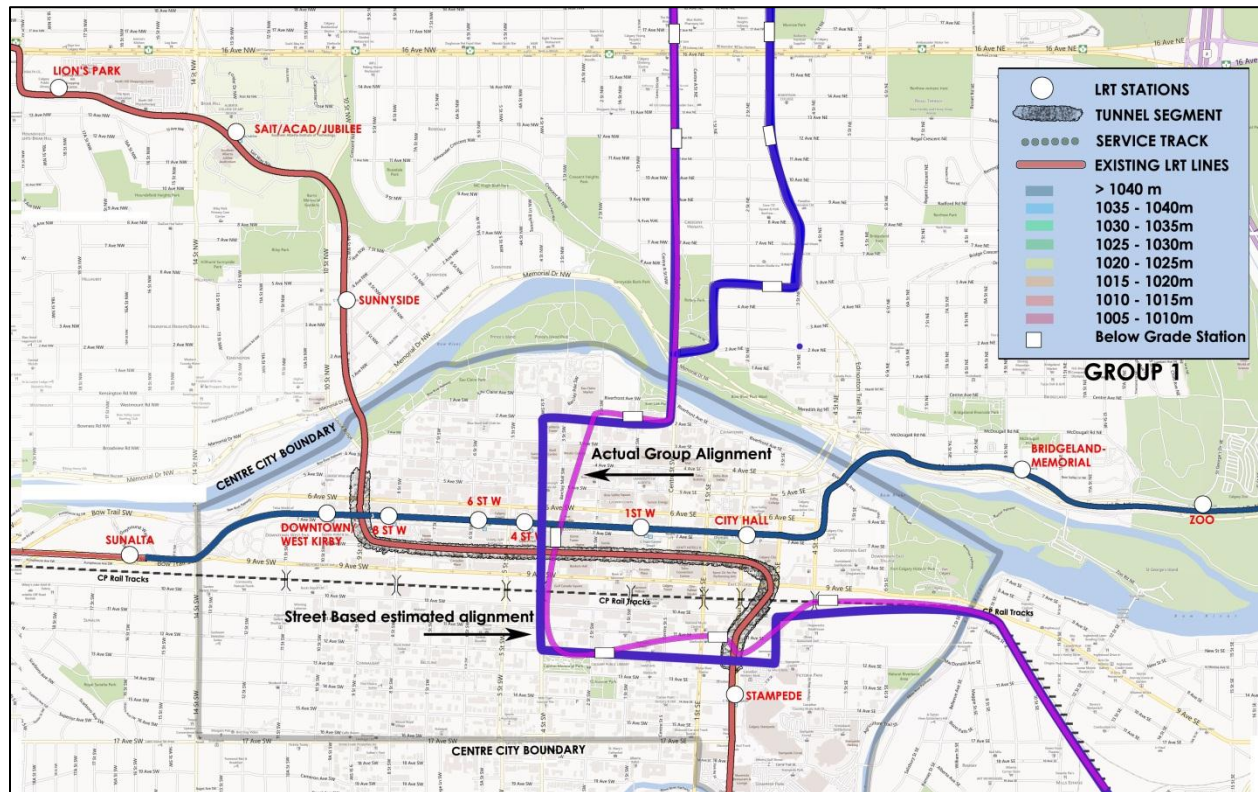


Figure 4 – Group 1 Option

Group 1 created an alignment along Centre Street, turning west on 2 Avenue then south on 3 Street SW to 13 Avenue. The line then runs along 13 Avenue to McLeod Trail where it heads northeast to meet up with the high speed rail terminal. This alignment was not restricted to exact roads.

The group noted the need for hubs between 7 and 8 Avenues and another around 13 Avenue as well as the connection to Stampede and the high speed rail area (which also allows for a connection to East Village via the 4 Street SE underpass).

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.3 GROUP 2

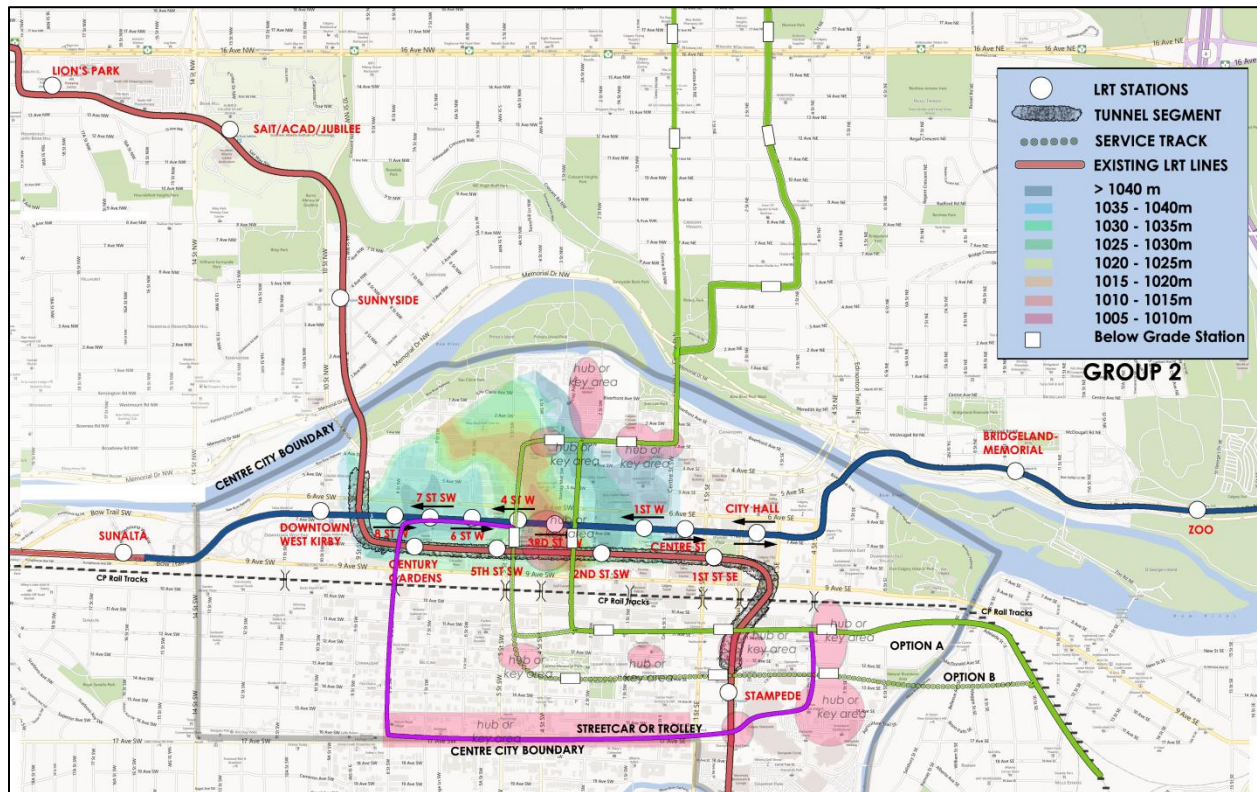


Figure 5 – Group 2 LRT and Streetcar

Group 2 chose an alignment along Centre Street turning west on 3 Avenue SW. There were two options for heading south - either 3 Street SW or 5 Street SW. The eastern movement in the Beltline was either at 11 Avenue or 13 Avenue connecting to a hub between the high speed rail station and the Stampede grounds.

Within Downtown there was a second major transit hub connecting all LRT lines. The group also considered how to serve the remainder of the Beltline area and created a trolley or streetcar route that linked the two hubs via the Stampede grounds, 17 Avenue and 8 Street SW.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.4 GROUP 3

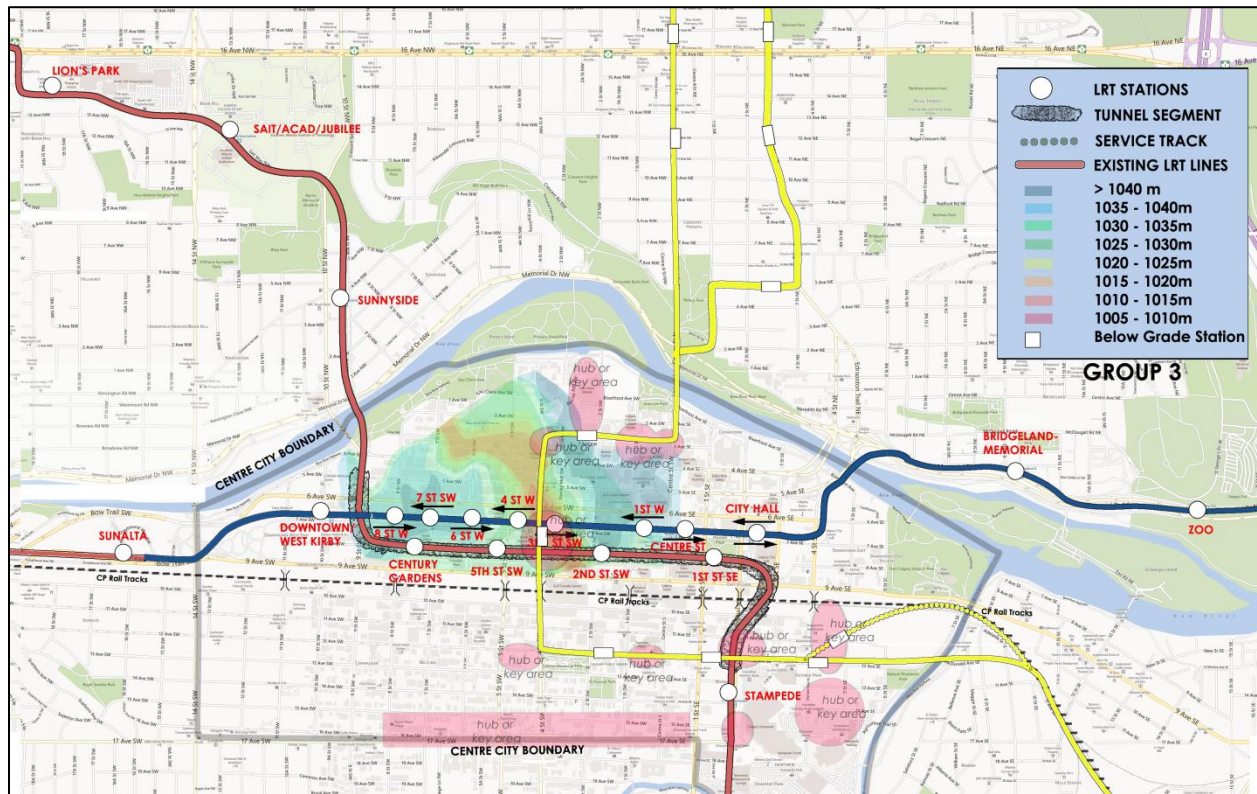


Figure 6 – Group 3 (4 Street to 12 Avenue)

Group 3 utilized Centre Street, 3 Avenue SW, 4 Street SW to 12 Avenue through the Downtown then eastward via 12 Avenue to 4 Street SE. At 4th Street SE, the alignment has two options with the primary routing continuing on 12 Avenue across the Elbow River to the rail tracks while a second option swings north from the Stampede grounds to the high speed rail terminal.

The group focused on redevelopment potential and connectivity through hubs with a north-south movement through the geographic centre of Downtown to connect the Beltline area.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.5 GROUP 4

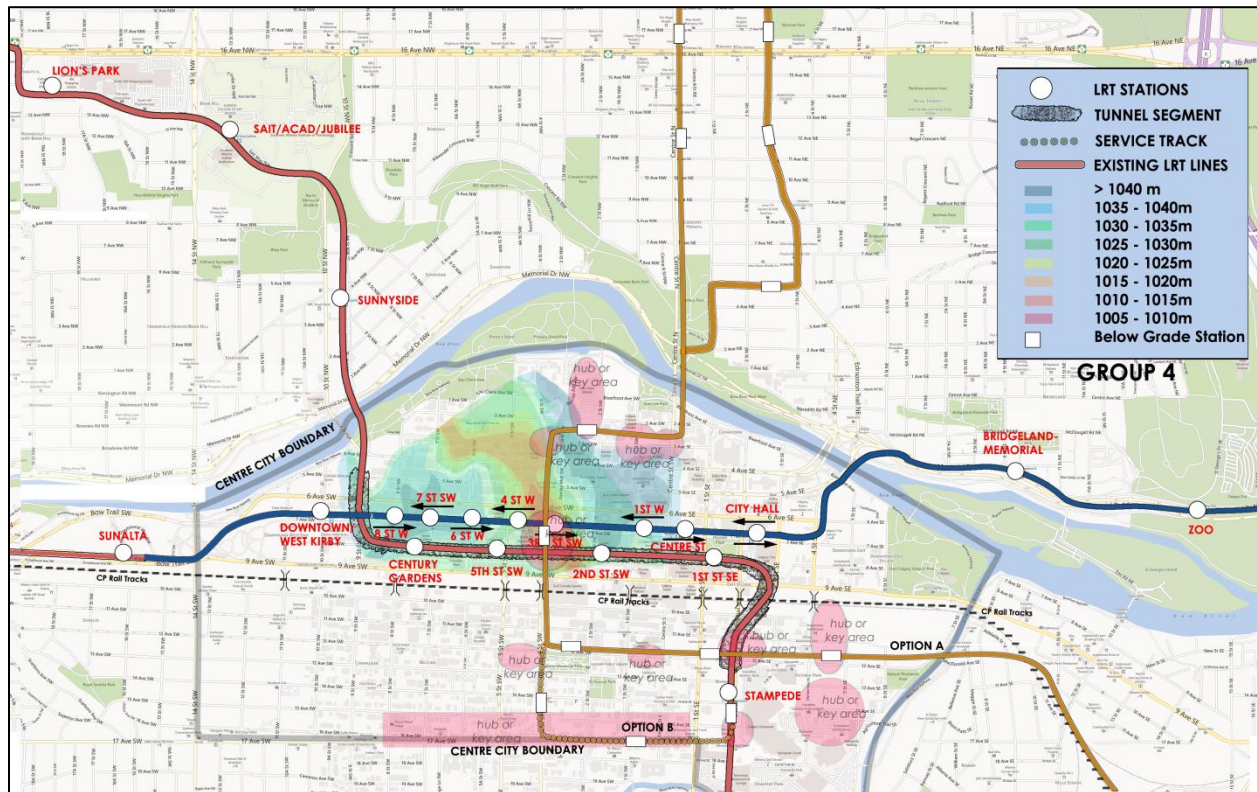


Figure 7 - Group 4 (4 Street to 13/17 Avenue)

Group 4 focused on the notion of bisecting Downtown and creating hubs within the Downtown and in the Stampede grounds/high speed rail area. The primary alignment is via Centre Street to 3 Avenue then south via 4 Street SW to 13 Avenue SW then eastward to the CPR rail corridor.

An alternative alignment went south to 17 Avenue then east to either connect to the SLRT line or connect to the CPR corridor south of the Stampede Grounds. The Downtown hub between 7 and 8 Avenues was highlighted as was a second at the northwest corner of the Stampede grounds.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.6 GROUP 5

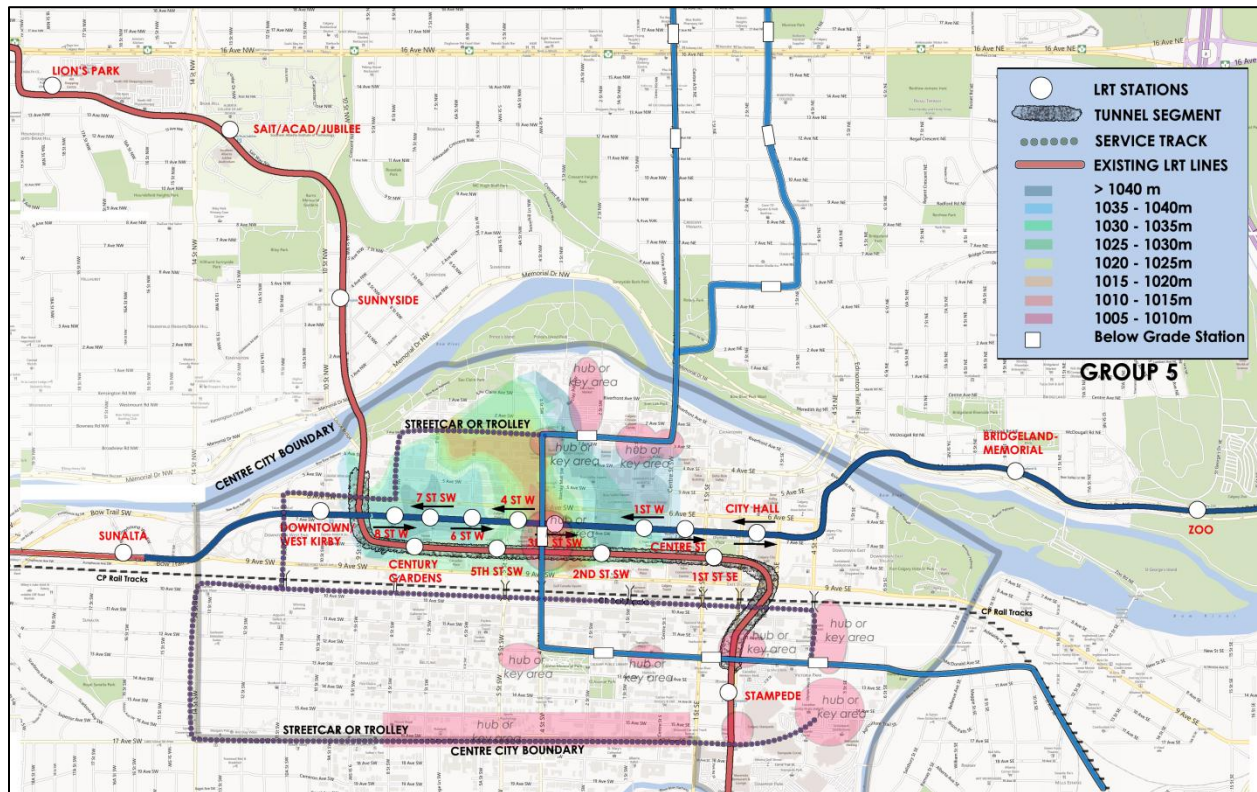


Figure 8 - Group 5 (4 Street to 13 Avenue)

Group 5 mapped out all potential high density zones within the Downtown, the office core and the major traffic streets to avoid. The result was an alignment along Centre Street, 3 Avenue SW, 4 Street SW and 12 Avenue SW/SE through to the CPR corridor.

Similar to other groups, the concept of a Downtown circulator was brought forward as an option to complete the connection between Downtown and the Beltline with two possible lines along 17 and 10 Avenues connecting through to East Village via 4 Avenue.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.7 SUMMARY OF OPTIONS

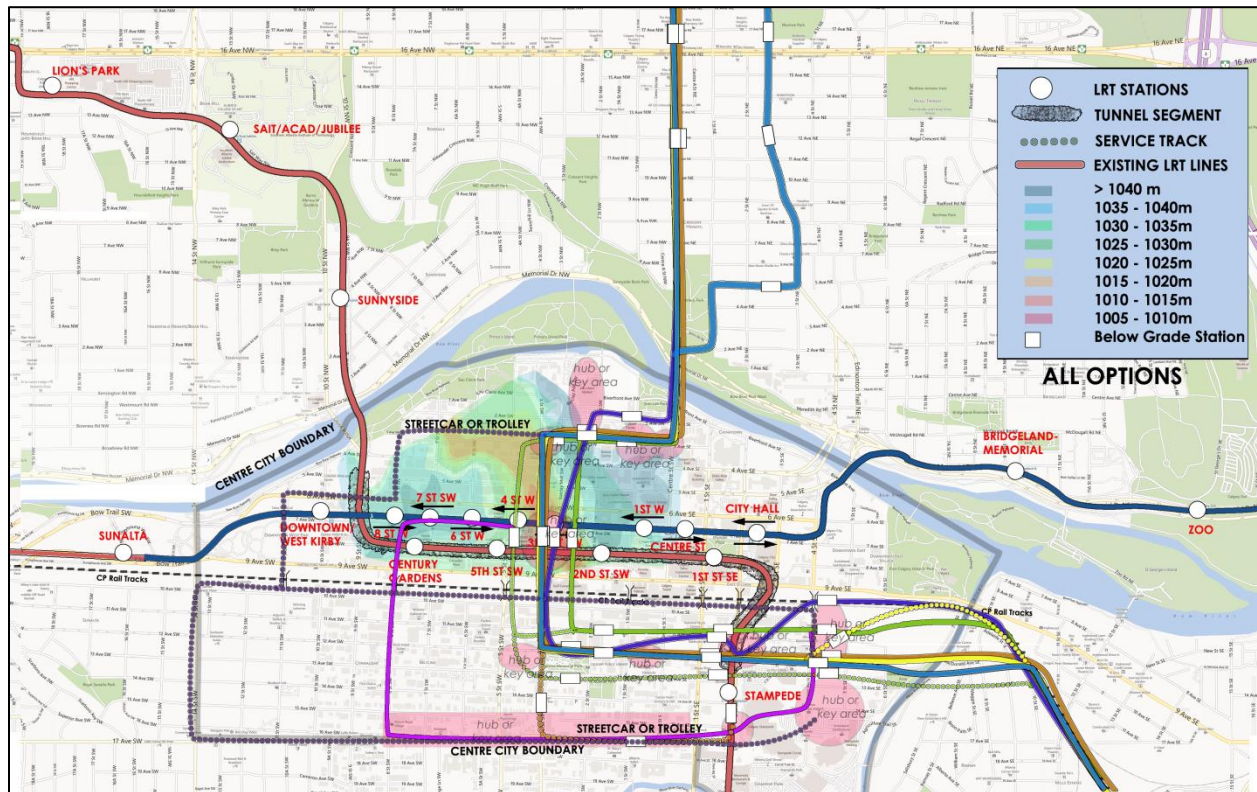


Figure 9 - Overlay of Options

As a collective, there was excellent discussion about the main issues within the Centre City and the ability to influence future land use through transit. When the alignments were overlaid, there was a high level of congruency over the preferred area of Downtown to serve as well as the degree of extension south into the Beltline area.

The notion of serving 17 Avenue with LRT was deferred to the potential to provide extended coverage using a streetcar or trolley type service that connects to the LRT at a few key hubs. The notion of an iconic transit hub in the Downtown was universal.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.8 PREFERRED CORRIDOR

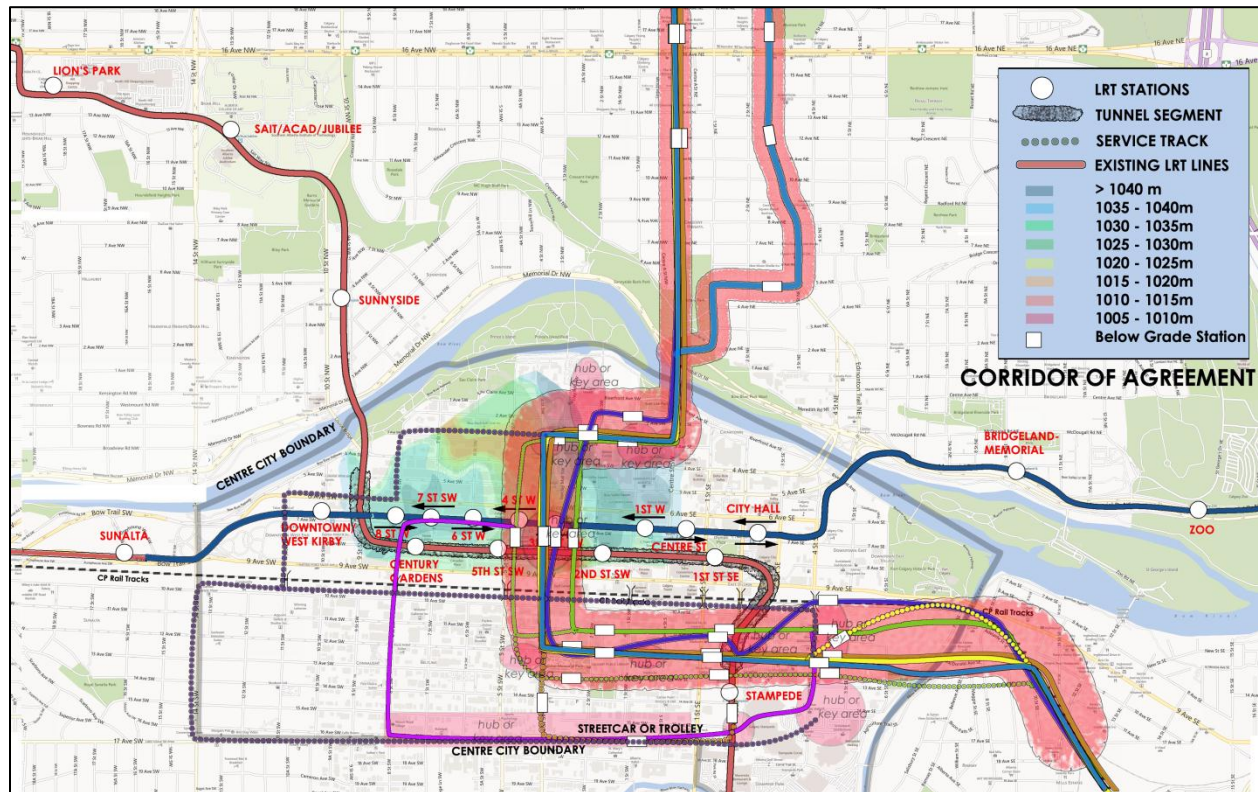


Figure 10 - Preferred Corridor

The first step in using the results of the workshop to identify a preferred alignment was to identify a corridor which had a high level of agreement among the workshop attendees. The preliminary evaluation results (see Chapter 6) identified options that were consistent with this preferred corridor (though this was not shared with the participants in order to reduce any influence).

The preferred corridor was Centre Street or Edmonton Trail from 16 Avenue to 2 Avenue SW. The corridor was then bounded by 2 Avenue and 4 Avenue SW. Through Downtown on a north south axis, the corridor was bounded by 3 Street and 5 Street SW then in the Beltline area from 10 Avenue to 13 Avenue.

This general corridor is shown in Figure 10.

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

4.9 PREFERRED ALTERNATIVES

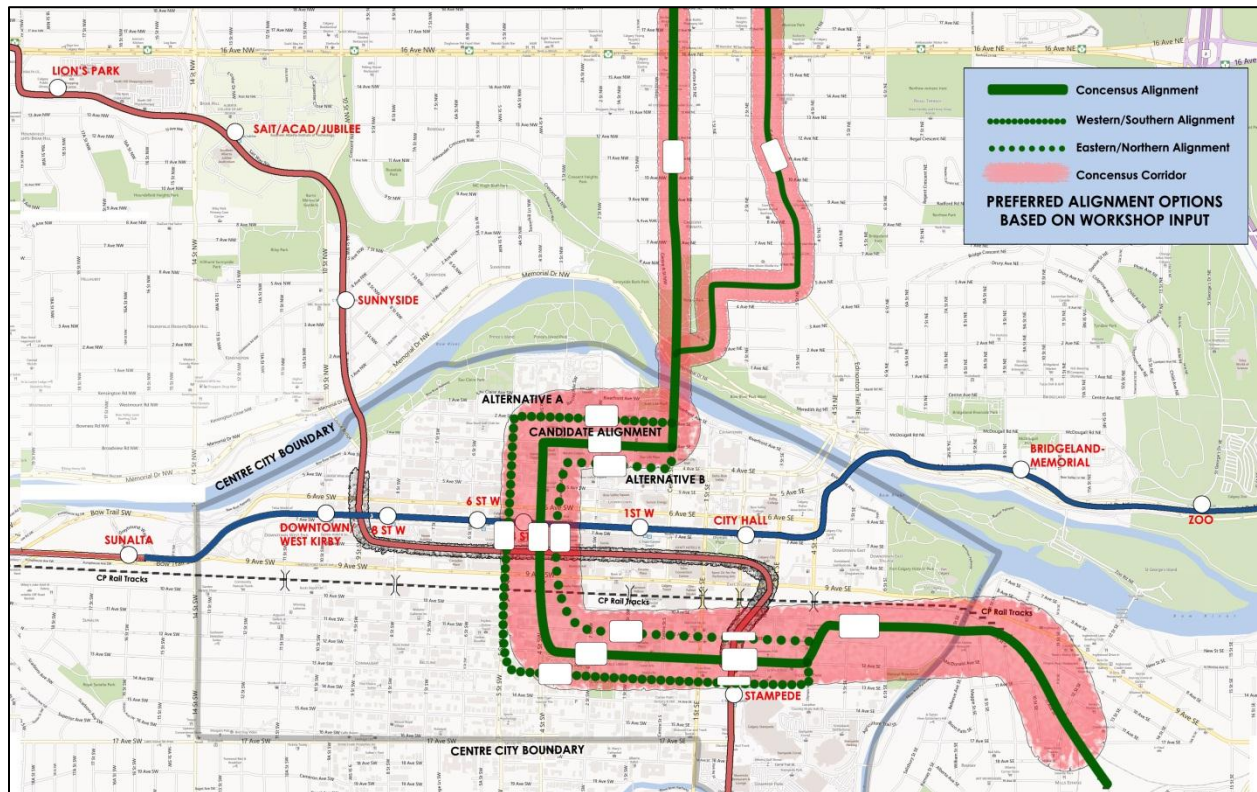


Figure 11 – Preferred Alignment from Workshop

In Figure 11, a preferred alignment is developed based on the preferred corridor. The preferred alignment travels via Centre Street, 3 Avenue SW, 4 Street SW, 12 Avenue SW/SE, 4 Street SE, 11 Avenue SE to the CPR corridor. There are two alternative corridors that flank this corridor to show that there are multiple alignments that are consistent with the preferred corridor.

The preferred alignment would feature a tunnel segment through the Downtown to avoid operation impacts on the LRT and rail lines.

There would be stations:

- On 3 Avenue in the 2/3 Street area to serve Chinatown and Eau Claire
- On 4 Street below grade between 7/8 Avenue to allow connections to the South, North East, North West and West LRT lines
- On 12 Avenue SW near 2 Street to serve the Beltline

CALGARY NORTH CENTRAL LRT

Workshop Output
February 12, 2014

- On 12 Avenue SW at McLeod Trail for Stampede Station connections and Stampede grounds
- At the High Speed Rail station for connections and links to the East Village

CALGARY NORTH CENTRAL LRT

Round 1 Options
February 12, 2014

5.0 Round 1 Options

While the Workshop described in Chapter 4 focused on the development of a preferred alignment and involved City staff, the Stantec team performed a separate exercise in which a broad range of options were developed, refined, and evaluated. As a result of considering the minimum requirements and the desirable outcomes of the Downtown alignment, the team developed 18 options for an initial evaluation.

Round 1 Options were evaluated in accordance with transportation criteria that would make up the eventual Transportation Account of the Downtown Analysis MAE. Round 1 Options were developed based on the assumption that the Downtown area routing could be evaluated independently from the routing north of 16 Avenue.

Given new information and demands on the Green Line, the approved SETWAY alignment in the downtown was modified in all of the options.

5.1 OPTION 1 TO 10 AVENUE

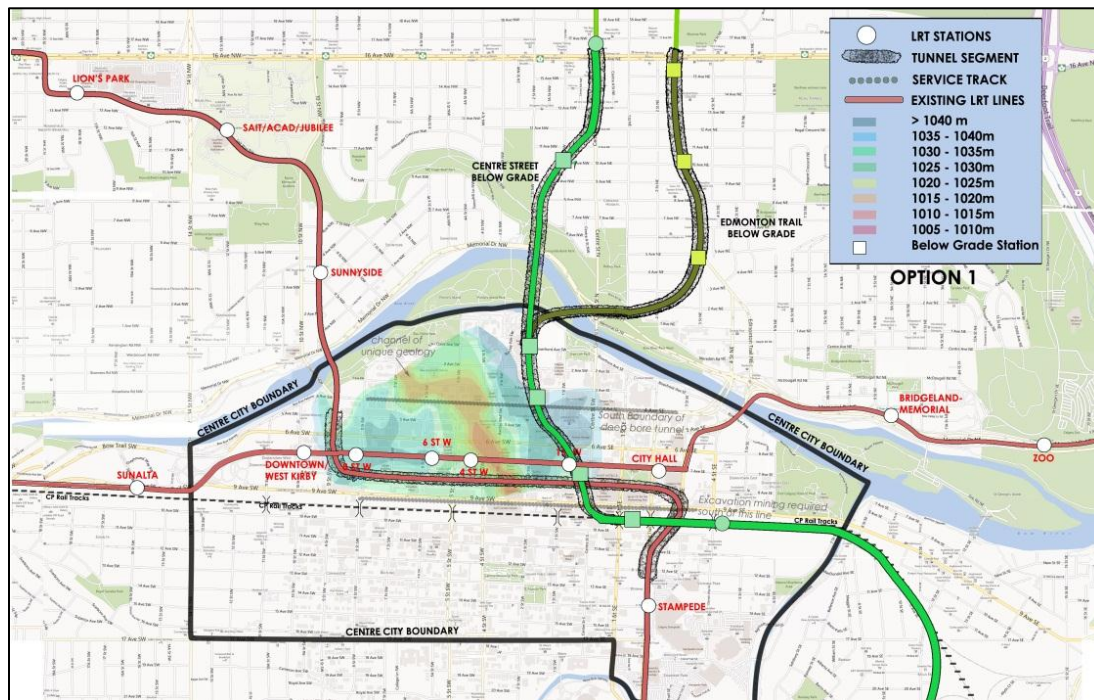


Figure 12- Option 1

CALGARY NORTH CENTRAL LRT

Round 1 Options
February 12, 2014

Option 1 features below grade services from 16 Avenue. Moving south, the alignment turns slightly to the west until it lines up with 2 Street SW around Eau Claire, from which it proceeds southeast (in order to avoid the challenging geology until it joins the SE portion of the Green Line).

The Edmonton Trail option tunnels towards the Centre Street Bridge area where it joins the alignment to the SE.

These options eliminate any issues with surface traffic.

An additional area of concern was the depth required below the Bow River and the distance required to come to surface.

5.2 OPTIONS 3 & 10 TO 10 AVENUE

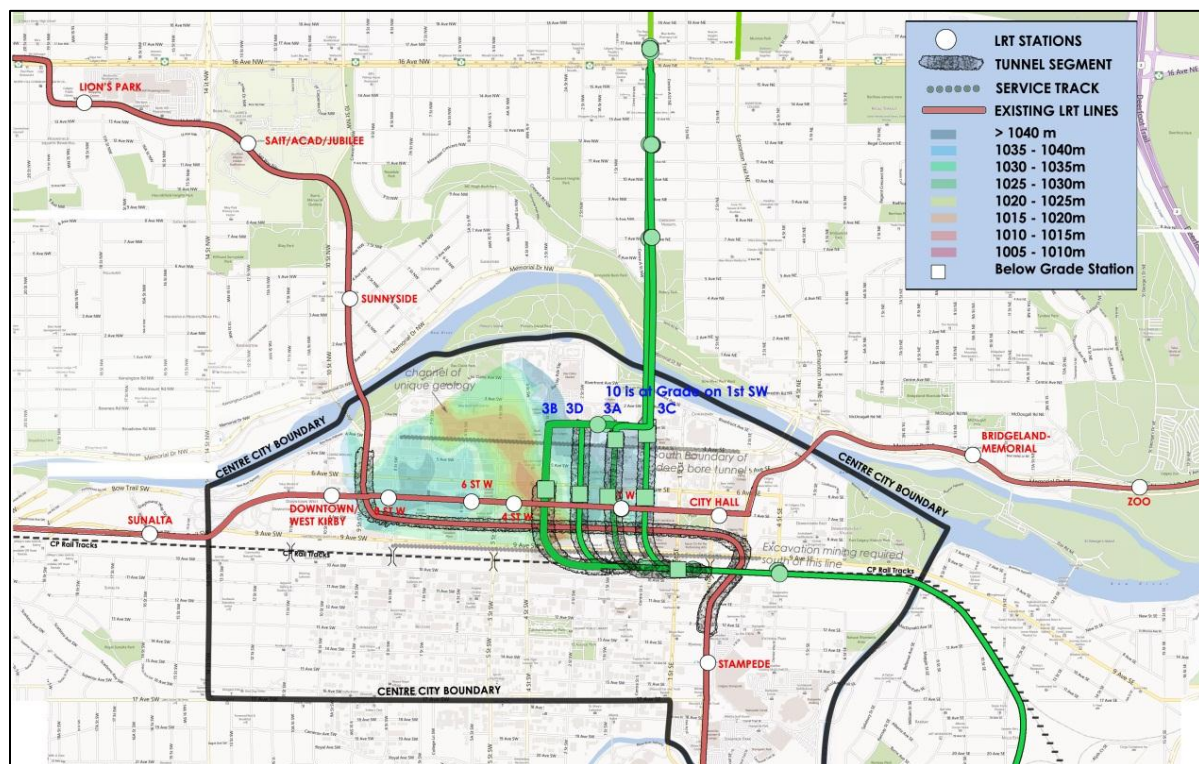


Figure 13 – OPTIONS 3A, 3B, 3C, 3D AND 10

After crossing the Bow River, the options turn south along 3 Street, 2 Street, 1 Street or Centre Street to join the SE alignment. All options show some form of tunnel between 6 Avenue SW and 10 Avenue SW in order to avoid at-grade crossings of the existing LRT on 7 Avenue.

CALGARY NORTH CENTRAL LRT

Round 1 Options
February 12, 2014

The depth of tunnel for the 8 Ave alignment requires engineering detail. The at-grade turns within the Downtown were examined and found to be tight but operable. Option 10 remained at-grade.

5.3 OPTIONS 4 & 6 TO 17 AVENUE

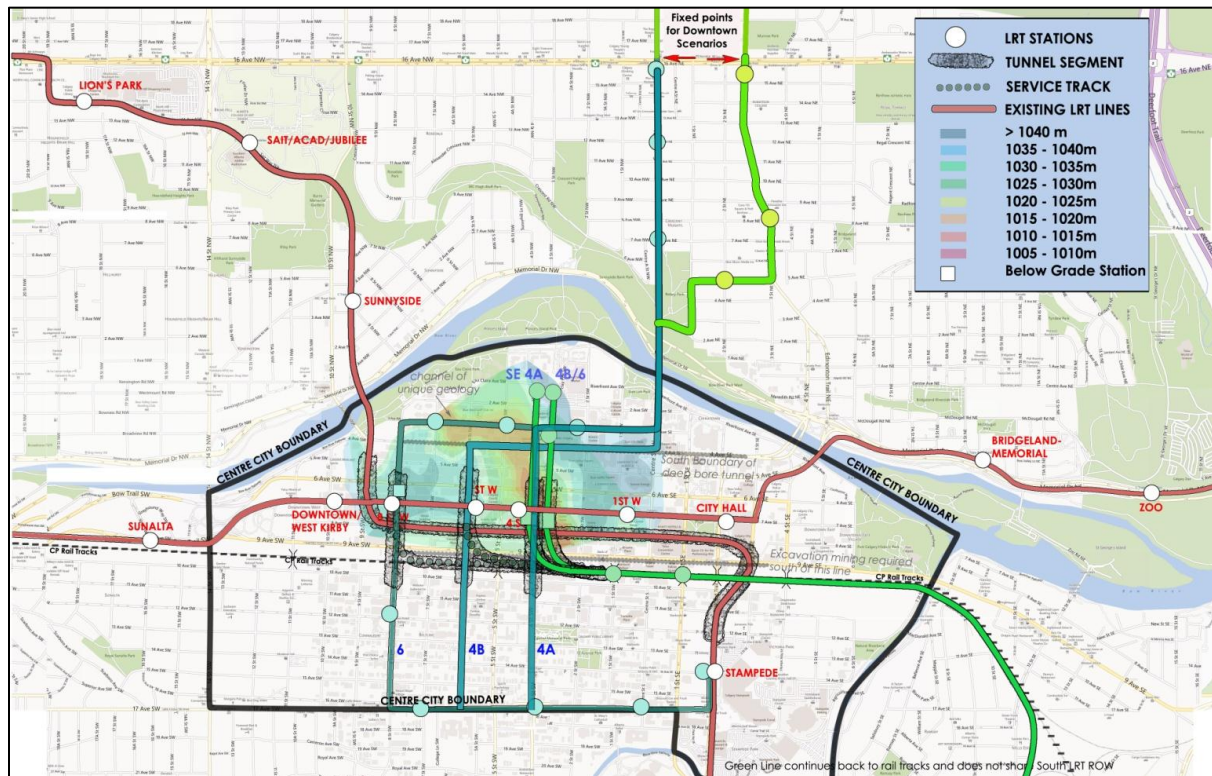


Figure 14 – OPTIONS 4A, 4B & 6

This group of options keeps the lines connected via service tunnels but separates them with respect to destinations. The north central portion of the Green Line travels westward in Downtown along 3 or 4 Avenue SW then travels south to 17 Avenue at 4 Street, 6 Street or 8 Street. At 17 Avenue the line proceeds eastward to connect up with the South LRT line at Stampede Station. The SE Green Line moves westward to 3 or 4 Street to move northward to the Eau Claire area. Passenger transfers are via surface stations in proximity in the Eau Claire area.

CALGARY NORTH CENTRAL LRT

Round 1 Options
February 12, 2014

5.4 OPTIONS 11 & 12 TO 12 AVENUE

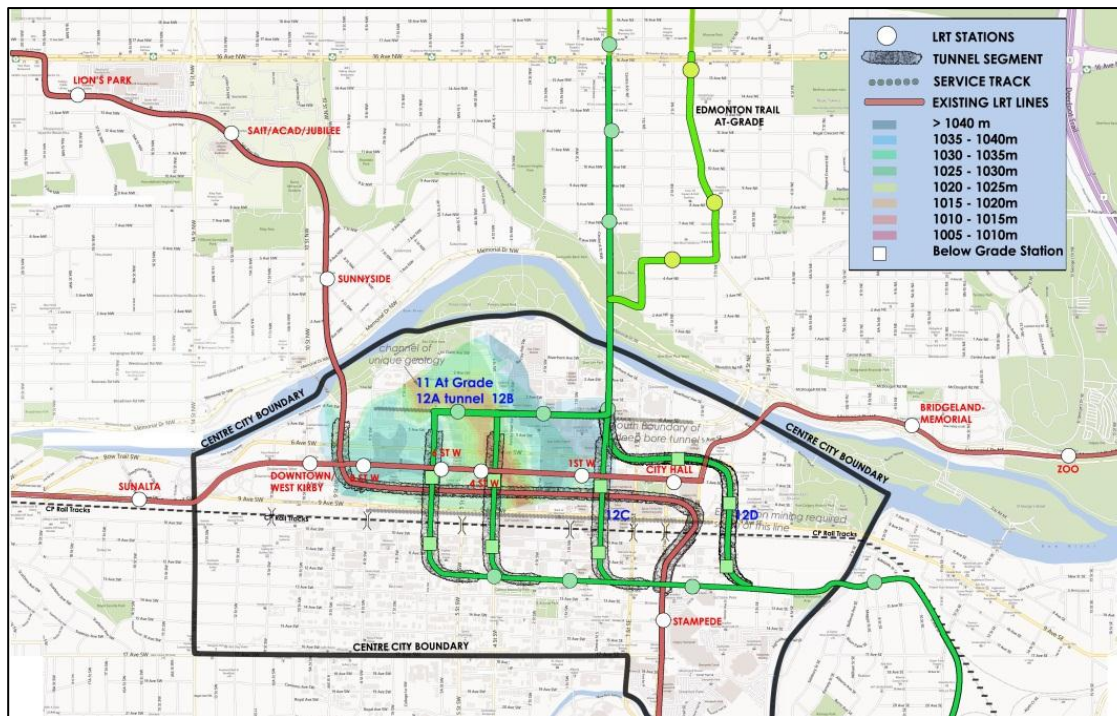


Figure 15 – OPTIONS 11, 12A, 12B, 12C, 12D

These variations aim at connecting the Beltline area via 12 Avenue SW. Alignments 11, 12A and 12B turn west on 4 Avenue SW then south on 4 Street or 6 Street. Option 12C stays on Centre Street while 12D is the only option that travels through the East Village. Note that Option 11 may be infeasible if a rail-rail crossing along 7 Avenue is found to impede throughput or pose a safety issue.

Most of the options seek to maximize the amount of service in the northwest portion of Downtown and connect the Beltline and Stampede before moving onto the SE alignment.

CALGARY NORTH CENTRAL LRT

Round 1 Options
February 12, 2014

5.5 OPTION 13 TO 17 AVENUE

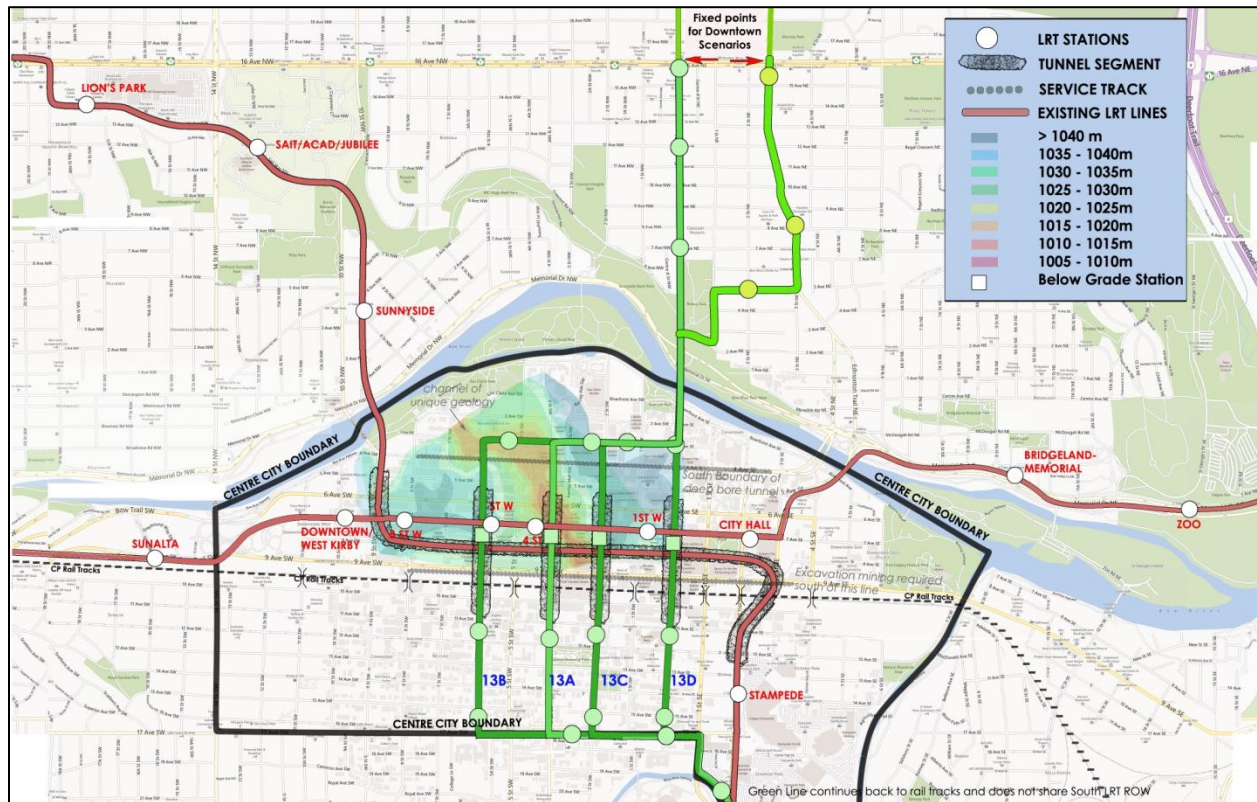


Figure 16 – OPTIONS 13A, 13B, 13C & 13D

This set of options connects the Beltline via 3 Avenue SW and the connecting streets that line up with 7 Avenue LRT stations. From 17 Avenue the alignment moves south along the edge of the Stampede Grounds until it can rejoin the SE alignment.

These options have the LRT bypass the Ramsay/Inglewood neighbourhoods in favour of connecting to the Beltline, Stampede and the South LRT line. Tunnels within the Downtown separate the various LRT lines and rail lines to avoid similar level grade crossings

CALGARY NORTH CENTRAL LRT

Round 1 Evaluation
February 12, 2014

6.0 Round 1 Evaluation

The initial evaluation of the options, just using the transportation criteria, resulted in the identification of 7 options that had scores of 30 or higher. These were brought forward for evaluation against other criteria. For more information on how this evaluation was carried out, please see Appendix A.

MAE Account	Downtown Analysis Criteria	Options																	
		1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Transportation	Congestion	5	4	2	4	3	2	1	2	3	1	1	1	4	4	2	2	2	3
	Parking Impacts	5	5	4	5	4	3	2	1	4	3	3	3	4	4	3	2	3	4
	Pedestrian and Bicycle Mobility	5	5	4	5	4	2	1	1	3	1	2	3	5	3	2	1	3	4
	Ease of Transfers (Average)	3.7	3.7	3.7	3.7	3.7	2.7	2.7	2.7	3.3	3.3	3.7	3.7	3.7	2.3	3.7	3.7	3.7	3.7
	New Destinations	3	2	3	2	3	4	4	4	2	3	3	3	2	1	4	4	3	3
	Ease of Understanding	5	5	4	5	4	2	2	2	5	4	4	4	5	4	4	4	4	5
	Travel Speed	5	2	2	4	2	2	2	2	1	1	2	2	4	2	2	2	2	4
	Reliability (Average)	5	4.5	4	4.5	4	3.5	3.5	3.5	2	2	3.5	3.5	4.5	4.5	3.5	3.5	3.5	4
	Length (Score)	4	4	4	5	4	3	3	1	4	4	4	4	4	4	4	4	4	5
	TOTAL	40.7	35.2	30.7	38.2	31.7	24.2	21.2	19.2	27.3	22.3	26.2	27.2	36.2	28.8	28.2	26.2	28.2	35.7
	AVERAGE	4.5	3.9	3.4	4.2	3.5	2.7	2.4	2.1	3.0	2.5	2.9	3.0	4.0	3.2	3.1	2.9	3.1	4.0

Table 1 – Round One Evaluation Results

CALGARY NORTH CENTRAL LRT

Round 2 Options
February 12, 2014

7.0 Round 2 Options

The Round 2 Options that were brought forward include:

- Option 1
- Option 3A
- Option 3B
- Option 3C
- Option 3D
- Option 12C
- Option 13D

While most of these options were similar in concept to the preferred alignments brought forward in the December workshop, many made use of a Centre Street or 1 Street SW alignment rather than the streets further to the West. The main reasons these options fared well is that they could achieve favourable travel times, make less noise due to turns, and have fewer impacts on Downtown circulation.

CALGARY NORTH CENTRAL LRTRound 2 Evaluation
February 12, 2014**8.0 Round 2 Evaluation**

MAE Account	Options						
	1	3A	3B	3C	3D	12C	13D
Transportation	4.5	3.9	3.4	4.2	3.5	4.0	4.0
Deliverability	3.7	3.8	2.4	4.0	2.3	4.1	4.3
Sustainable Environment	5.0	3.0	1.0	5.0	1.0	5.0	2.0
Community Well-Being	3.7	3.1	3.1	3.1	3.1	3.8	3.0
Prosperous Economy	5.0	3.0	3.0	3.0	3.0	3.0	3.0
Urban Realm / Urban Development	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Financial Capacity / Sustainable Corporation	2.3	4.5	3.0	2.6	3.1	2.8	3.2
Score (Unweighted)	27.2	24.3	18.9	24.9	19.0	25.7	22.5
Score (3X Weight for Financial)	31.8	33.3	24.9	30.1	25.18	31.3	28.9

Table 2 – Round 2 Evaluation Results

The Round 2 evaluation applied criteria from six other accounts to the seven remaining options. The results are summarized to the left and suggest that Option 1 best meets the needs of the City if cost is weighted equally to other factors. However, if additional weighting is given to cost, for example, a weight of 3 where the other accounts are given a weight of 1, then Option 3A is the highest ranked. In both scenarios, the alignment is straighter and further east than the alignments identified by workshop participants. However, it is important to note that workshop participants did not have the benefit of complete technical information (e.g., potential geological constraints and potential challenges with at-grade alignments) to support their discussions. The alignments suggested in Options 1 and 3A represent a further refinement that is generally consistent with the workshop results.

While there are a number of differences between the alignment identified in the workshop and that identified by the MAE process, many of the key features offered by Options 1 and 3A are consistent with

CALGARY NORTH CENTRAL LRT

Round 2 Evaluation
February 12, 2014

what workshop participants were hoping to achieve with the line, such as a connection to the Stampede grounds and a hub between 7 and 8 Avenues.

Option 1 is below ground and addresses many of the challenges identified by workshop participants of locating the LRT at grade through the downtown. A number of participants at the workshop commented that the LRT in the downtown should be underground similar to other major cities. This reduces the potential for conflicts with other forms of transportation, and can contribute to more efficient land use and livability in the downtown area.

Option 3A is two to three blocks east of the north –south corridor identified in the workshop. It is above grade coming off of the Centre Street Bridge and northern section of the Downtown core, then descends into a tunnel to cross the 7 Avenue transit mall, future 8 Avenue transit tunnel, and CPR tracks. It then uses 10 Avenue, the routing approved for SETWAY, to connect to cross the Elbow River and connect to the Ramsay/Inglewood neighbourhood. Compared to the preferred alignment from the workshop, Option 3A will be less expensive and have less impact on general roadway users. It may also be easier to build due to its location east of the glacial crossing.

CALGARY NORTH CENTRAL LRT

Conclusions
February 12, 2014

9.0 Conclusions

Between the Downtown alignment workshop and the MAE Analysis, an LRT alignment has been more clearly defined between the Bow River and Elbow River to serve the Green Line. Input from City staff and the project team at the December workshop helped to further refine the vision for LRT in the Downtown area and the MAE Analysis applied a consistent evaluation framework to a broad set of options. Specifically, the initial Round 1 MAE considered 18 possible alignment options for the Centre City, and the Round 2 MAE process identified **Option 1** as the best performing option. Option 1 involves a tunnel alignment for the entire Downtown, and as such, it is likely the most expensive option. In the event that cost is a large consideration in determining the ultimate alignment, **Options 3A, 3C, and 12C** were the best performing options that did not require a tunnel approach to the Downtown (although they still required a tunnel to connect the Downtown core to the Beltline) with **Option 3A** ranking the highest. All of these alignments are slightly east than the outcome of the Downtown workshop due to the unknown risks of the geological constraints in the downtown area. Pending further investigation of the downtown geology, Options 3A, 3C, and 12C would be the highest ranked options.

The City and the project team have collaborated on the process to identify a preferred alignment in the Downtown area. The results reflect careful consideration of the vision for the Centre City, the goals for transportation and the technical analysis conducted by the NC LRT project team.

Based on the results of the workshop and technical analysis, the project team is recommending the project proceed with further consideration of Option 1 and Option 3A. Much of the Downtown alignment will be underground, and the main question is whether it will remain underground under the Bow River or travel on an existing or new structure over the Bow River. The viability of an underground option will likely require additional engineering analysis related to grades and geology, while the viability of the surface options rests on the City's willingness to either take lanes away from automobiles on the existing bridge or build a new adjacent bridge.

While the plan may be to tentatively move forward with an underground alignment in the Downtown for the NC LRT Corridor, it is recommended that conceptual design and additional analysis provide a better understanding of how an underground options will impact ridership, operating costs, and maintenance costs, all key elements that were not addressed in the initial MAE process but which could help further differentiate between fully underground and partially underground options.

In addition, conceptual design will help clarify the cost differences between a fully tunneled and partially tunneled option, which is important given that this may be one of the key deciding factors for which approach is ultimately pursued.

CALGARY NORTH CENTRAL LRT

Appendix A DOWNTOWN ANALYSIS MAE
February 14, 2014

Appendix A DOWNTOWN ANALYSIS MAE

DOWNTOWN ANALYSIS MAE SUMMARY

This appendix is arranged to address all of the evaluation criteria that were used to compare the Downtown Options. These include:

- Transportation Criteria (Applied to 18 Options)
- Deliverability Criteria (Applied to 7 Options)
- Sustainable Environment Criteria (Applied to 7 Options)
- Community Well-Being Criteria (Applied to 7 Options)
- Prosperous Economy Criteria (Applied to 7 Options)
- Urban Realm / Urban Development Criteria (Applied to 7 Options)
- Financial Capacity / Sustainable Corporation Criteria (Applied to 7 Options)

As explained in the report text, the transportation criteria were used to reduce the number of options to seven. These seven short-listed options were then assessed in accordance with the other six accounts.

DOWNTOWN ANALYSIS MAE SUMMARY

Transportation Criteria

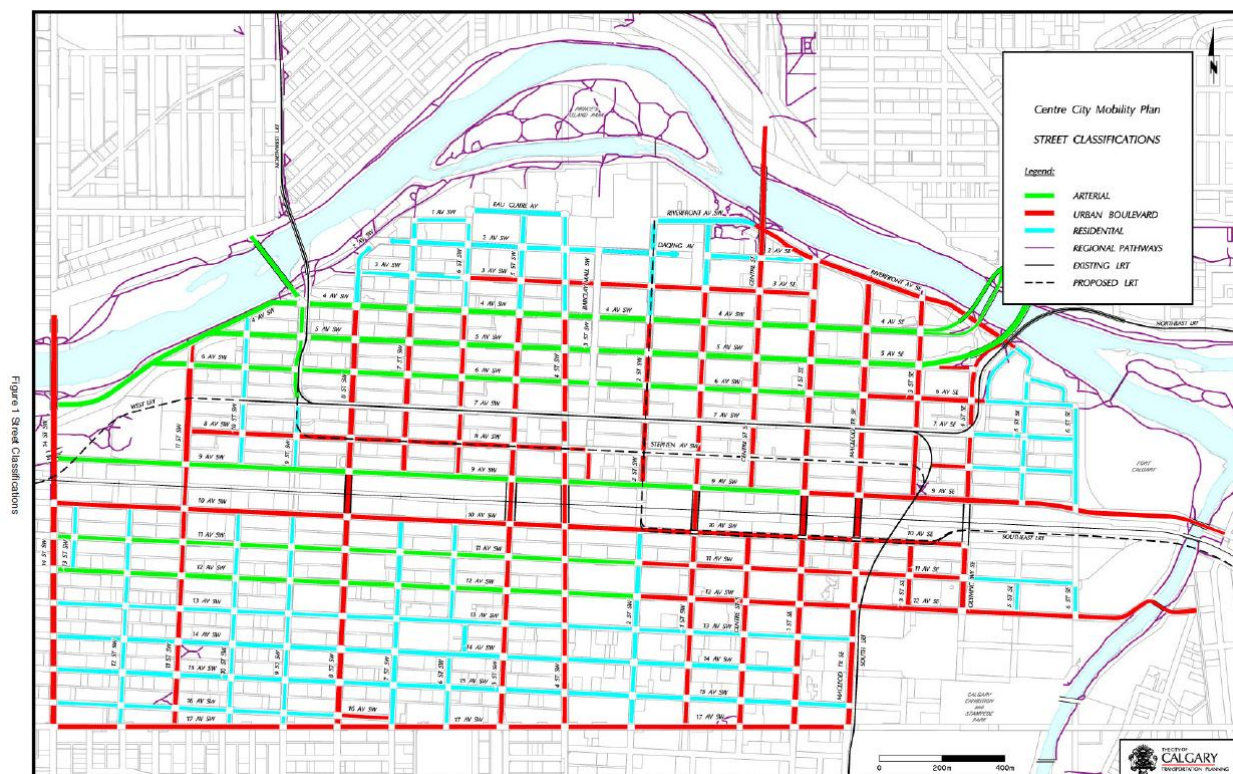
CONGESTION

Each option was given a point for achieving each of the following:

Key

Each option was given a point for achieving each of the following:

- the preservation of traffic lanes for automobiles on Downtown arterials (designations per City Centre Mobility Plan – see below)
- the preservation of traffic lanes on residential streets (designations per City Centre Mobility Plan – see below)
- the preservation of turning opportunities for automobiles on and off arterials (designations per City Centre Mobility Plan – see below)
- no additional congestion for the general road user
- mode shift from automobile to transit and reduction in Downtown buses (all options receive this point)



Discussion

Options 3A, 3B, 12C, and 12D received a 4 because of their ability to preserve traffic lanes on arterial and residential streets and turning opportunities on and off of arterials throughout the Downtown.

DOWNTOWN ANALYSIS MAE SUMMARY

However, only Option 1 received a 5 because of its ability achieve all of the above and cause no additional congestion for the general road user.

The options that minimize conflicts with arterial traffic but which required the use of residential roads were given a 3.

The options that provided travel in an arc (or a “C” shape) through Downtown or which travelled completely at-grade generally received a 2 or a 1 because they would travel on arterials or residential streets for at least a portion of their alignment and restrict turning capacity on and off of arterials.

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Preservation of traffic lanes for arterials	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1
Preservation of traffic lanes for residential streets	1	1	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1
Preservation of turning opportunities on/off arterials	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0
No additional congestion for the general road user	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mode shift to LRT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Score (Congestion)	5	4	2	4	3	2	1	2	3	1	1	1	4	4	2	2	2	3

PARKING IMPACTS

Key

Each option was given a score based on how many blocks would be impacted by its construction, with the view with this would be a proxy for the scale of on-street parking that would be lost and access to parking facilities would be blocked. The number of blocks was counted on an option along its alignment between the Bow River and the Elbow River. It includes the blocks that would be impacted by cut-and-cover construction, with the thought that the reconstruction of the road would be used as an opportunity to redesign the street to better serve pedestrians and transit vehicles, likely at the expense of vehicle traffic throughput. Points were assigned as follows:

- 1 point for more than 28 blocks affected between Bow River and Elbow River
- 2 points for 22 to 28 blocks affected between Bow River and Elbow River
- 3 points for 16 to 22 blocks affected between Bow River and Elbow River
- 4 points for 9 to 15 blocks affected between Bow River and Elbow River
- 5 points for 0 to 8 blocks affected between Bow River and Elbow River

DOWNTOWN ANALYSIS MAE SUMMARY

Discussion

Alignments that were shorter tended to score better because they would create less interference with entrances to parking facilities and more existing on-street parking would remain.

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Block Affected	8	7	13	6	10	21	27	30	11	22	22	17	9	12	20	25	17	13
Score (Parking Impacts)	5	5	4	5	4	3	2	1	4	3	3	3	4	4	3	2	3	4

PEDESTRIAN AND BICYCLE MOBILITY

Key

Each option was given a score based on how many Downtown intersections would be impacted by the option. While at-grade LRT might be able to provide improved mobility for some users, it is assumed that it would make mobility for pedestrians and bicycles somewhat worse due to longer traffic light cycle times, reduced lines of sight, additional tripping/falling hazards, and some blocked off crosswalks.

- 1 points for 20 or more crossings
- 2 point for 15 to 19 crossings
- 3 points for 10 to 14 crossings
- 4 points for 5 to 9 crossings
- 5 points for 0 to 4 crossings

Discussion

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Crossings	2	4	8	2	5	16	22	26	10	23	16	13	4	13	18	21	13	8
Score (Bicycle and Pedestrian Mobility)	5	5	4	5	4	2	1	1	3	1	2	3	5	3	2	1	3	4

DOWNTOWN ANALYSIS MAE SUMMARY

EASE OF TRANSFERS

Key

Each option was given a score that was the average score for the following three transfers: NC-SE, NC – 7 Avenue, and NC – 8 Avenue. Individual transfers were scored as follows:

- 5 for an interlined route
- 4 for a cross-platform or short, vertical, in-station transfer
- 3 for a vertical, in-station transfer with a long walk involved (> 1 block)
- 2 for a transfer that involves having to go outside but a short walk
- 1 for a transfer that involves having to go outside and walk a long distance (> 1 block)

Discussion

All of the options had fairly similar scores, falling within the 2.7 to 3.7 range. However, options that included an interlined NC and SE line had an advantage to the high score given to this type of connection.

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
NC - SE	5	5	5	5	5	2	2	2	5	5	5	5	5	5	5	5	5	5
NC - 7 Avenue	2	2	2	2	2	2	2	2	3	3	2	2	2	1	2	2	2	2
NC - 8 Avenue	4	4	4	4	4	4	4	4	2	2	4	4	4	1	4	4	4	4
Score (Ease of Transfers)	3.7	3.7	3.7	3.7	3.7	2.7	2.7	2.7	3.3	3.3	3.7	3.7	3.7	2.3	3.7	3.7	3.7	3.7

NEW DESTINATIONS

Key

Each option was given a score based on the following inputs:

- 1 point for a station at Eau Claire Market
- 1 point for a station at 10/11/12 Avenue and Centre Street
- 1 point for each station on 17 Avenue (up to two points)
- 1 point for a station in the Downtown Core (all options receive this point)

DOWNTOWN ANALYSIS MAE SUMMARY

Discussion

Options that were more circuitous tended to score better on this criterion due to their ability to serve a larger number of locations.

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Eau Claire Market	1	0	1	0	1	1	1	1	0	1	1	1	0	0	1	1	1	0
10/11/12 Avenue and Centre Street	1	1	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0	1
17 Avenue	0	0	0	0	0	2	2	2	0	0	0	0	0	0	2	2	1	1
Downtown Core (all options receive this point)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Score (New Destinations)	3.0	2.0	3.0	2.0	3.0	4.0	4.0	4.0	2.0	3.0	3.0	3.0	2.0	1.0	4.0	4.0	3.0	3.0

EASE OF UNDERSTANDING

Key

Each option was given a score that corresponded to its ease of understanding with respect to Option 1, which was assumed to be the easiest option to understand, and to Options 4A, 4B, and 6, which were assumed to be fairly difficult to understand.

Option 1 was considered easy to understand because it is direct, with limited backtracking, fewer variations how it could be accessed.

Option 4A only received two points because it is not follow a direct path through Downtown, it involves some backtracking, and because it is not always clear which way it is best to access.

Discussion

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Score (Ease of Understanding)	5	5	4	5	4	2	2	2	5	4	4	4	5	4	4	4	4	5

DOWNTOWN ANALYSIS MAE SUMMARY

TRAVEL SPEED

Key

Each option was scored as follows to reflect travel speed:

- 5 if a straight tunnel with no more than one curve
- 4 if straight with no more than one curve but grade crossings along a portion of the alignment
- 3 if a tunnel with more than one curve
- 2 if more than one curve and grade crossings along a significant portion of the alignment
- 1 if there are multiple curves and the alignment is completely at grade

Discussion

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Score (Travel Speed)	5	2	2	4	2	2	2	2	1	1	2	2	4	2	2	2	2	4

RELIABILITY

Key

Each option was given a score that was the average of a score that reflected the nature of alignment and a score that reflected whether there was an element of the alignment that could introduce significant variability to the line, such as a rail-rail grade crossing.

Score 1 was assessed as follows:

- 5 if the entire alignment is in a tunnel
- 4 if 75% in a tunnel
- 3 if 50% in a tunnel
- 2 if 25% is in a tunnel
- 1 if there is no tunnel portion

Score 2 was assessed as follows:

- 5 = no rail-rail crossings
- 3 = 1 rail-rail crossing
- 1 = 2 or more rail-rail crossings

DOWNTOWN ANALYSIS MAE SUMMARY

Discussion

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Points for Grade Separation in Alignment	5	4	3	4	3	2	2	2	1	1	2	2	4	4	2	2	2	3
Points for Grade Separation at Intersections	5	5	5	5	5	5	5	5	3	3	5	5	5	5	5	5	5	5
Score (Reliability)	5	4.5	4	4.5	4	3.5	3.5	3.5	2	2	3.5	3.5	4.5	4.5	3.5	3.5	3.5	4

LENGTH

Key

Each option was given as score as follows to show the distance of the alignment from Bow River to Elbow River:

- 5 if 2.3 km or less
- 4 if more than 2.3 km or less than 4.1 km
- 3 if more than 4.1 km or less than 5.5 km
- 2 if more than 5.5 km and less than 7.0 km
- 1 if greater than 7.0 km

Discussion

This metric was intended as a proxy for travel time, so the options with the shortest distances were given the best scores.

	Options																	
	1	3A	3B	3C	3D	4A	4B	6	10	11	12A	12B	12C	12D	13A	13B	13C	13D
Length (km)	2.85	2.65	3.3	2.3	3	4.4	5.4	7.3	2.75	4	4	3.65	2.5	2.5	3.25	3.95	2.75	2
Score (Length)	4	4	4	5	4	3	3	1	4	4	4	4	4	4	4	4	4	5

DOWNTOWN ANALYSIS MAE SUMMARY

Deliverability

UTILITY RELOCATION

Key

The options were given scores that correlated with the cost of relocating utilities. These scores considered public utilities, such as sanitary sewers, water lines, and stormwater lines.

Discussion

Score (Utility Relocation)	Options						
	1	3A	3B	3C	3D	12C	13D
	3.1	3.5	2.1	3.9	1.0	4.4	5.0

CP AGREEMENTS REQUIRED

Key

Each option was scored as follows to reflect the amount of risk involved in building a line around CP tracks.

- 5 if no going under CP tracks
- 3 if one location under CP tracks
- 1 if more than one location under CP tracks

Discussion

All of the options that made the short list traveled through a tunnel under the CP tracks in the Downtown area, and that is why they are all scored the same.

Score (CP Agreements Required)	Options						
	1	3A	3B	3C	3D	12C	13D
	3.0	3.0	3.0	3.0	3.0	3.0	3.0

DOWNTOWN ANALYSIS MAE SUMMARY

GLACIAL CHANNEL IMPACTS

Key

Each option was given points as follows to account for the additional risk involved in different sections fo the Downtown geology.

- 1 if through 4 St SW
- 2 if through 3 or 5 St SW
- 3 if through 2 or 6 St SW
- 5 otherwise

Discussion

	Options						
	1	3A	3B	3C	3D	12C	13D
Score (Glacial Channel Impacts)	5.0	5.0	2.0	5.0	3.0	5.0	5.0

DOWNTOWN ANALYSIS MAE SUMMARY

Sustainable Environment

NOISE

Key

Each option was given a score for noise based on the number of outdoor turns there were.

- 5 for an option with no outside turns
- 4 for an option with one outside turn
- 3 for an option with two outside turns
- 2 for an option with three outside turns
- 1 for any other option

Discussion

	Options						
	1	3A	3B	3C	3D	12C	13D
Score (Noise)	5.0	3.0	1.0	5.0	1.0	5.0	2.0

DOWNTOWN ANALYSIS MAE SUMMARY

Community Well-Being

LINKS TO THE COMMUNITY

Key

Alignment options were evaluated based on their connectivity to land uses and the pedestrian network. Each option was evaluated on a scale from 1 to 5 with emphasis on connectivity to various landmarks and areas within the centre city.

Each option was evaluated based on the location of the stations and their proximity to the key destinations seen in the table below. In addition proximity to destinations, the speed in which each option was to arrive at key destinations was also taken into consideration in the final scoring.

Key Destinations

Employment	Retail	Residential	Entertainment/ Recreation	Services	Pedestrian ROWS
<ul style="list-style-type: none"> Proximity to major office buildings; Connectivity to the +15 network. 	<ul style="list-style-type: none"> The CORE Shopping Centre; Scotia Centre; Eau Claire Market; Stephen Avenue Walk; Sunterra Market. 	<ul style="list-style-type: none"> East Village; Riverfront Residential; Beltline Residential. 	<ul style="list-style-type: none"> Stampede Park; Eau Claire Market; Riverwalk; Stephen Avenue Walk; The CORE Shopping Centre; Scotia Centre; EPCOR CENTRE for the Performing Arts; Calgary Tower. 	<ul style="list-style-type: none"> Calgary Municipal Building; EPCOR CENTRE for the Performing Arts; Calgary Public Library; YMCA Fitness on 5th; Eau Claire YMCA. 	<ul style="list-style-type: none"> Stephen Avenue Walk; +15 Network; East Village; Stampede Park; Barclay Mall.

* Higher preference was given to alignments with proximity to the bolded destinations

Discussion

All of the options scored in the same general range, between 3.0 and 3.8.

DOWNTOWN ANALYSIS MAE SUMMARY

	Options						
	1	3A	3B	3C	3D	12C	13D
Links to Employment	4.5	3.5	3.0	4.0	3.5	3.0	3.0
Links to Retail	3.5	3.0	3.5	2.0	4.0	2.5	2.0
Links to Homes	4.0	3.0	3.0	3.0	3.0	3.5	2.5
Links to Entertainment / Recreation	2.5	2.5	3.0	2.5	3.0	4.5	3.5
Links to Services	3.5	3.5	2.5	4.0	3.0	4.5	4.5
Links to Pedestrian ROWs	4.0	3.0	3.5	3.0	3.5	4.5	2.5
Score (Community Links)	3.7	3.1	3.1	3.1	3.3	3.8	3.0

DOWNTOWN ANALYSIS MAE SUMMARY

Prosperous Economy

GOODS MOVEMENT

Key

Each option was given a score based on its impact on roadway capacity entering and leaving Downtown area. The scores were given as follows:

- 5 points for an option that did not impact any of the major roads for connecting into the Downtown area
- 3 points for an option that impacted one of the major roads for connecting into the Downtown
- 1 point for an option that impacted more than one of the major roads for connecting into the Downtown

Discussion

Except for Option 1, each of the short-listed options impacted Centre Street, which is one of the main roads for connecting into the Downtown.

	Options						
	1	3A	3B	3C	3D	12C	13D
Score (Goods Movement)	5.0	3.0	3.0	3.0	3.0	3.0	3.0

DOWNTOWN ANALYSIS MAE SUMMARY

Urban Realm / Urban Development

STREET LEVEL ENVIRONMENT

Key

Each of the options was given a score based on the following:

- 5 points if the option brought at-grade LRT to a designated urban boulevard for most of its Downtown alignment
- 3 points if the option brought at-grade LRT to a designated urban boulevard for a portion of its Downtown alignment

Discussion

Each of the short-listed options received the same score, as each of them has at least some portion of its Downtown alignment at-grade and in an urban boulevard.

	Options						
	1	3A	3B	3C	3D	12C	13D
Score (Street Level Environment)	3.0	3.0	3.0	3.0	3.0	3.0	3.0

DOWNTOWN ANALYSIS MAE SUMMARY

Financial Capacity / Sustainable Corporation

CAPITAL COSTS

Key

Capital costs were estimated for each of the options based on their construction type, the length of the alignment through Downtown, and the potential barriers related to geology and building foundations. Scores from these three items were averaged to get the score for this category.

Discussion

The options that involved a tunnel through the entire alignment unsurprisingly had the highest cost and therefore the lowest score in this category. However, options that used Centre Street did not score as well due to potential topological and building obstructions that would increase costs, construction time, and cost uncertainty.

	Options						
	1	3A	3B	3C	3D	12C	13D
Total Cost	1.0	4.1	3.1	3.3	3.6	3.3	5.0
Total Cost per KM	1.0	4.5	5.0	2.5	4.8	3.1	2.7
Topological and Building Features	5.0	5.0	1.0	2.0	1.0	2.0	2.0
Score (Capital Costs)	2.3	4.5	3.0	2.6	3.1	2.8	3.2