Green Line LRT
Business Case

"A strong public transit system that is well integrated into the very fabric of our communities contributes to a vibrant city."

— Mayor Naheed Nenshi

Since 1979, Calgary has been continuously building and expanding its Light Rail Transit (LRT) systems and has created one of the largest and well used public transit systems in North America. Building on this success and utilizing over 30 years of experience gained, Calgary is now embarking on the most extensive transit expansion in Alberta's history.

Our vision for the Green Line represents a significant evolution in how we implement public transit in our city. We have learned that it is critical to integrate transportation planning, land-use zoning and city building into the project from the start. The Green Line will help Calgary become a more compact, sustainable, less congested, mobile, livable and prosperous community. Once completed, it will not only help over a hundred thousand citizens get to school and work every day, it will also connect major institutions and communities. Combined with the existing transportation system and new Bus Rapid Transit (BRT) lines being constructed, the Green Line will allow citizens to easily move around their community like never before. It will also stimulate residential, office and industrial development along the corridor, while reducing greenhouse gas emissions and road congestion.

The Green Line will offer direct connections to the new South Health Campus, new recreation centres, major employment centres such as Quarry Park, the new $191 million National Music Centre, the new $245 million Central Library, Stampede Park, and several business revitalization zones from the far north of Calgary to the deep southeast. The Green Line will also integrate with future rail connection to the Calgary International Airport, which is the fourth busiest airport in Canada and is in the midst of a $2 billion expansion.

I look forward to working with you to continue the dialogue on how The City of Calgary and The Province of Alberta can work together to deliver the city shaping Green Line LRT for all Calgarians and Albertans.

—

Naheed Nenshi
Mayor, The City of Calgary

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Executive Summary

"The Green Line is a momentous investment in Calgary's future. It will lay a framework for mobility, community development, cultural amenities and resources. The project we are building will serve our city for many generations to come."

- Malcolm Logan

Transportation General Manager, The City of Calgary

Calgary is a growing city, gaining recognition globally as both a livable city and a place of economic opportunity. In order to ensure that Calgary realizes its full potential as a global city, it is crucial to invest in infrastructure that will not only meet the needs of Calgarians today, but will continue to serve future generations. The Green Line is a key investment in the future of Calgary.

Today, the population growth in the northern communities of Calgary exceeds the capacity of the existing transit system and an LRT is required to meet this demand. The population in the southeast communities of Calgary is rapidly growing and is expected to double in the next 20 - 25 years. Calgary's southeast is facing a number of challenges whereby transit cannot efficiently operate reliably, quickly, and therefore cannot grow its ridership. There is a requirement for a system that will meet both present and future demand. Ultimately, the Green Line LRT will run for over 46 kilometres, from Keystone to Seton, and will provide fast, frequent, and reliable transit service to over 27 communities and 90,000 - 140,000 trips per day by opening. Reaching the northern and southeastern edges of this city, the line will provide valuable service to regional customers. Investment in Green Line also has the potential to alleviate congestion on regional transportation routes such as Deerfoot and Stoney Trail.

The potential of the Green Line LRT extends beyond the tracks. A layered approach has been developed In order to maximize the benefits of the Green Line. The first layer focuses on the transit infrastructure, which is the foundation on which the other benefits will be realized. The second layer is focused on facilitating connections to stations, ensuring that Green Line integrates into communities and is easily accessible to riders. Layer 3 and 4 will be enabled through the Green Line planning process, but will be realized over the longer-term. These layers focus on Transit Oriented Development (TOD) which concentrates development around select stations, enabling sustainable growth. The final layer is focused on City Shaping, which looks at the wider benefits of Green Line and opportunities to change the growth patterns of the city by contributing to well-connected, healthy, and vibrant communities.

The Green Line will address challenges of a growing population and fulfill both current and future demand on transit. There are numerous additional benefits that address the economic, social, environmental, and cultural needs of a growing city. These benefits are aligned with Provincial and Federal priorities and contribute to a shared vision for Calgary, Alberta, and Canada to be places of economic resiliency, social equity, environmental responsibility, and cultural vibrancy.

The City of Calgary seeks partnership with the Province of Alberta and the Government of Canada to deliver the Green Line to Calgarians.

In support of Calgary's application for GreenTRIP funding, this business case is intended to provide a full picture of this project and demonstrate the benefits of investing in the Green Line. Work on the detailed design, precise alignment and cost estimates is ongoing, with Administration and City Council finalizing decisions on design over 2016 and into 2017. The City of Calgary will also look at opportunities for value engineering, while retaining healthy contingencies for risk.

The Green Line can be staged and implemented in phases, based on funding availability, to provide the maximum benefit of this investment. There are also a variety of alternate financing options that could be employed to assist with the delivery of the project. This business case shows the benefits of the Green Line for the purpose of further discussion. The City of Calgary is committed to working together with funding partners to find the best solutions for delivering the Green Line to generations of Calgarians and Albertans.

2

Introduction

2.1 GREEN LINE LRT

FIGURE 2.1.1 Green Line LRT Route
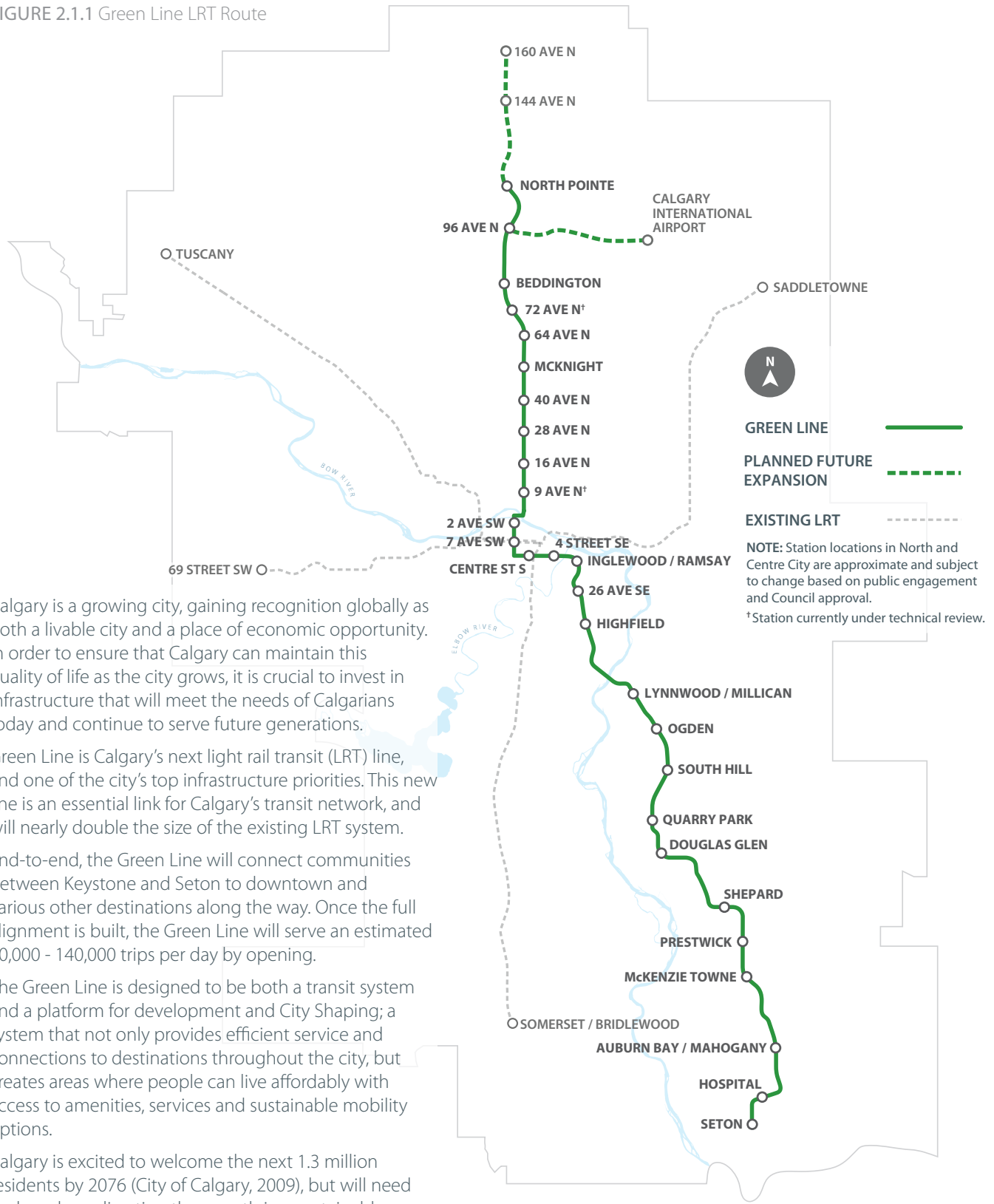
Calgary is a growing city, gaining recognition globally as both a livable city and a place of economic opportunity. In order to ensure that Calgary can maintain this quality of life as the city grows, it is crucial to invest in infrastructure that will meet the needs of Calgarians today and continue to serve future generations.

Green Line is Calgary's next light rail transit (LRT) line, and one of the city's top infrastructure priorities. This new line is an essential link for Calgary's transit network, and will nearly double the size of the existing LRT system.

End-to-end, the Green Line will connect communities between Keystone and Seton to downtown and various other destinations along the way. Once the full alignment is built, the Green Line will serve an estimated 90,000 - 140,000 trips per day by opening.

The Green Line is designed to be both a transit system and a platform for development and City Shaping; a system that not only provides efficient service and connections to destinations throughout the city, but creates areas where people can live affordably with access to amenities, services and sustainable mobility options.

Calgary is excited to welcome the next 1.3 million residents by 2076 (City of Calgary, 2009), but will need to do so by redirecting the growth in a sustainable manner that maintains the city's livability and economic attraction.

3

Background

3.1 LIGHT RAIL TRANSIT IN CALGARY

The first LRT line opened in 1981, revolutionizing transportation in Calgary. The system has rapidly expanded over the past 35 years to become the backbone of the regional transit network. Today, Calgary's LRT system is the most successful in North America, transporting over 320,000 passengers (American Public Transportation Association, 2016) on the average weekday, consisting of 59.9 kilometres of track and 45 stations. The high ridership on the LRT network in Calgary provides viable transportation choices to Calgarians and plays an important role in reducing road congestion.

The Red and Blue LRT lines were planned and built when Calgary arguably did not have the population to warrant an LRT system. However, the forward thinking decision to build these lines was one that has shaped Calgary since the 1980s.

Through strong partnerships with the Provincial and Federal governments, Calgary has extended the Red and Blue lines to accommodate Calgary's growth. These lines now reach towards the edges of Calgary, providing transportation options to riders throughout Calgary as well as the greater Calgary region. However, there are areas of the city that are outgrowing the capacity of the existing transit network. The Green Line addresses this need and serves the needs of Calgary's north and southeast communities.

Centre Street North has evolved into the busiest bus rapid transit (BRT) corridor in the city. Ten bus routes transporting 35,000 Calgarians travel up and down this corridor every day. The demand along this corridor regularly exceeds the capacity of the current BRT system during the morning and evening rush hours. This spurred discussion of the need for another LRT line to connect north Calgary with downtown.

The need for an LRT line in southeast Calgary has been under consideration since the mid-1980s, when it became apparent more transportation options were needed in these rapidly expanding communities. While funding to build this line was not available at that time, beginning in the 1990s new communities set aside land in anticipation of future LRT development in the area. In recent years, the southeast has seen the largest growth in the city, and is expected to more than double in population over 25 years.

3.2 THE CREATION OF THE GREEN LINE

The already established ridership north of the Bow River, combined with the rapidly expanding population and job growth in the southeast, offered an opportunity to efficiently serve both areas with one new line - and so the Green Line vision was born.

Due to the limited funding previously available, The City started looking at interim solutions to address the need for rapid transit in the north and southeast. Drawing on experience from other cities around the world, The City moved forward with a proposal to build the portions of the Green Line as a bus-only transitway, which could later be converted to an LRT system. While it would not provide the capacity and reliability of an LRT route, this option would bring improved service to communities along one portion of the line in the interim, without the significant initial capital investment required for LRT. The bus transitway infrastructure would be converted at an additional cost to LRT, and extended to the far southeast and north when sufficient funding became available. With support from the Province's GreenTRIP Fund, The City moved forward with planning of the Green Line transitway in 2013-2015.

In July 2015, the Government of Canada recognized the merits of the overall Green Line vision and announced that up to $1.53 billion from the Public Transit Infrastructure Fund would be awarded to the Green Line light rail transit (LRT), contingent on The City's application. This, combined with The City's commitment of $1.56 billion over 30 years and with a matching contribution from the Government of Alberta, could be the single largest public infrastructure investment in Alberta's history. It would offer the opportunity to move forward on the Green Line as an LRT project, rather than incurring the longer-term expense of converting a transitway to LRT in the future. The Green Line will provide much needed capacity for ridership in the north while addressing the need for reliable transit in the rapidly expanding southeast.

The City of Calgary sees a role for the Green Line to play in the regional transportation network. The terminal stations will serve as transfer points to the public transit services evolving in the region's municipalities. Park and Ride lots at stations will intercept regional commuters, providing many Albertans with sustainable and reliable transportation alternatives.

Calgary's Primary Transit Network

+ *Frequent, fast, reliable, connected*

+ *10 minute frequency*

+ *15 hours / day*

+ *7 days / week*

4

Business Need

4.1 ASSESSING THE NEEDS OF A GROWING POPULATION

Calgary is rapidly growing, attracting new citizens, visitors, business and talent to the city. There are two major contributors to increased demand on the city's transit network: population growth and changes in the way people choose to move around the city.

In order to meet the needs of a growing and changing population, it is crucial to invest in infrastructure to support future generations of Calgarians. Investments should focus on projects that support sustainable growth and contribute to vibrant, safe, and healthy communities. The decisions made today will shape the future economic, social, environmental and cultural well-being of Calgarians in the coming years.

Calgary's Need
+ Investment in infrastructure to support the next 1.3 million Calgarians by 2076

Need to accommodate population growth

Today, the southeast is the fastest growing area of the city, with the residential population expected to double in the next 25 years. North Calgary is a well-established and densely populated area, and will continue to grow with over 50,000 new residents anticipated over the next 20 years.

By 2023, the population of both the north and southeast catchment areas are expected to be similar. If Calgary is to continue to welcome the growth it has historically seen, reliable, connected, and efficient transportation is required to support this increase in population.

Population

TABLE 4.1.1 Projected population growth (2014 - 2076)

YEAR	POPULATION		GROWTH SINCE 2014	
	NORTH	SOUTHEAST	NORTH	SOUTHEAST
2014	165,000	120,000	–	–
2023	180,000	185,000	9%	54%
2033	210,000	230,000	27%	92%
2043	240,000	270,000	45%	125%
2076	340,000	365,000	106%	204%
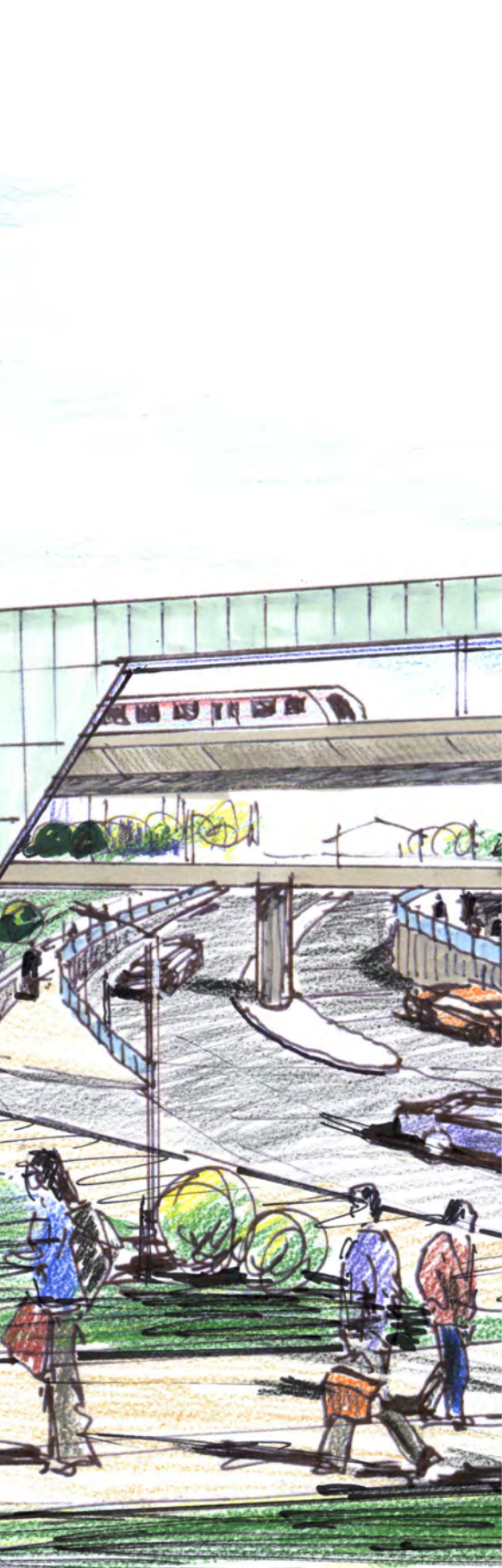
Need to respond to mobility trends

Mobility trends in Calgary are changing, with a shift towards increased transit ridership.

- Between 2001 and 2011, there was a 4.8% increase in the number of people who took transit to work from 13.9% to 18.7% (City of Calgary, 2013, p. 19).
- For commuters travelling to the downtown core, there was an increase in transit mode share from 36% to 45.7% between 2001 and 2011 (City of Calgary, 2013, p. 19).
- 57% of transit users are under 30 years old (City of Calgary, 2014a, p. 22),

These trends indicate that as the population grows and development occurs around stations, more people will choose to live more transit oriented lifestyles, increasing the percentage of people using transit. Increasing the reliability and capacity of the transit network will be essential in meeting the demand for efficient public transit.

Need for reduced road congestion

Road congestion is an ever increasing issue in Calgary as the city grows. Investments which contribute to reducing congestion are crucial from an environmental and economic/productivity standpoint. There will be a cost to addressing road congestion either through investing in road infrastructure or investing in transportation alternatives. Investing in transportation will reduce the number of vehicles on the road, increase productivity with fewer people waiting in traffic, and reduce greenhouse gas emissions.

Need to keep pace with job creation

The number of jobs along the Green Line route are expected to increase over the long term, despite the current economic downturn. As noted in Table 4.1.2, there is expected to be over 100,000 new jobs created in north and southeast Calgary over the next 25 - 30 years, creating destinations for thousands of Calgarians. Providing transit to employment hubs located outside the downtown will be key to reducing congestion and pressure on the downtown core, and will provide opportunities for economic diversification by creating affordable and accessible places to do business.

Jobs

TABLE 4.1.2 Projected job growth (2014 - 2076)

YEAR	JOBS		GROWTH SINCE 2014	
	NORTH	SOUTHEAST	NORTH	SOUTHEAST
2014	40,000	100,000	-	-
2023	50,000	125,000	25%	25%
2033	60,000	145,000	50%	45%
2043	85,000	165,000	113%	65%
2076	105,000	210,000	163%	110%

4.2 THE NEED FOR ATTRACTIVE TRANSIT OPTIONS

There is a need for fast, frequent, reliable and consistent transit that connects to destinations. The Green Line will address four key objectives for transit service in Calgary:

- **Ride time** Provide efficient service to Calgarians

- **Reliability** Maintain a reliable and predictable schedule

- **Ridership** Attract customers to ensure the transit service is economically viable

- **Transit Oriented Development (TOD)** Enabling mixed-use development to occur around stations to contribute to ridership and livability

Need for reliable transit

Calgary Transit has heard through their commitment to Calgarians "What matters to you matters to us" campaign that reliability is key to attracting and retaining transit customers. The growth of the city demands a reliable transit system that keeps pace and offers alternative mode choices. Users expect the transit network to operate on a consistent schedule and minimize customer wait times. The existing Bus Rapid Transit (BRT) routes are no longer capable of providing reliable service in north and southeast Calgary. This is due to a combination of factors including traffic congestion and high demand for buses. In the southeast, buses travelling on Deerfoot Trail SE are often delayed due to the high volume of vehicles commuting on this route. Transit service includes the bus rapid transit (BRT) Route 302, currently operating every 10 minutes in peak hours and every 30 minutes during off-peak hours. The low frequency of this route often leads to long wait times, and mixed-traffic operations, causing long travel times and inconsistent service (City of Calgary, 2014b, p. 3.13). Travel on bus can currently take up to 40 minutes longer than a car on Deerfoot Trail S, and bus trips can vary by over 30 minutes in the southeast.

This area is in need of frequent and reliable service to serve the rapidly expanding development in the area.

In the north, the high ridership exceeds the capacity of the BRT system, resulting in longer wait times for customers at the far ends of the route. Centre Street North is currently the busiest bus transit corridor in the city. Two major routes – the Route 3 and 301 - account for almost half all bus overloads citywide from 2012 to 2014, meaning passengers could not physically get on board due to crowding.

Ride Time

Ridership

&

Reliability

TOD

TRANSIT USER PRIORITIES

Top five engagement themes identified by the RouteAhead process were related to:

- Reliability

- Frequency

- Network design

- Fares

- Vehicles

Southeast
+ *Travel times in the Southeast take up to 40 minutes longer than a private vehicle.*

+ *Unreliable transit results in long wait times, long travel times, and inconsistent service.*

North
+ *Travel times on the Centre Street N corridor bus are comparable to private vehicles, only taking 3-8 minutes longer during peak hours.*

+ *Buses on Centre Street N come at a 4-5 minute frequency, however this still cannot meet transit demand. 44% of overloads city-wide occur on route 3 and 301.*

Need for urban and regional connections

Calgary Transit's existing service caters to commuters and experiences high ridership in the morning and evening rush hours, both urban and regionally.

Residents of the surrounding region commute into Calgary every day. Currently, 45% of workers from Airdrie commute to Calgary daily for work (City of Airdrie Transit Master Plan, June 2016, pg.34). Existing private sector commuter bus services, including Airdrie, Crossfield, Chestermere, Strathmore, Okotoks and Cochrane show that there is demand for commuter options, beyond private vehicles.

Calgary Transit currently sees approximately 10% of the ridership at the terminal LRT stations coming from regional commuters. The provision of park and ride at these locations provides an affordable alternative and one that reduces congestion on downstream roads leading to employment and education destinations.

There is a need to provide additional transportation options for these regional commuters in order to manage demand on the road network as the region grows.

4.3 THE NEED TO INVEST IN CALGARY'S FUTURE

The Green Line is part of a long-term investment in Calgary's future. As the city grows, there is a need to make balanced investment choices that benefit the economic, environmental, social and cultural well-being of Calgarians.

Need for economic resiliency

There is a need to invest in infrastructure that will play a role in attracting talent to Calgary and contribute to diversifying Calgary 's economy. Diversification is necessary to create a more resilient economy that can withstand fluctuations in the energy sector. In addition, during the current economic downturn, there is an opportunity for job creation through infrastructure investment.

Need for environmental responsibility

There is a need for investment in transportation options that draw on diverse energy sources and reduce carbon emissions. Continued reliance on personal vehicles will increase greenhouse gas emissions. In order to meet environmental targets there is a need to invest in alternate modes of transportation that contribute to a lower carbon footprint.

Green Line will directly reduce greenhouse gas (GHG) emissions by 52,000 tonnes of carbon dioxide equivalent annually.

Need for social equity

In order to grow as an inclusive and livable city,there is a need for infrastructure that supports mobility and services for all ages and socioeconomic groups.

Need for cultural vibrancy

There is a need to invest in infrastructure that increases accessibility to Calgary's cultural assets and supports vibrant communities, such as the National Music Centre, and Calgary Stampede (both within walking distance of future Green Line stations).

$ Economic

Environmental

Social

Cultural

5

Project Description

5.1 GREEN LINE LRT

The Green Line LRT will be the largest infrastructure investment undertaken by the City of Calgary, and is a top infrastructure priority in the city. There is an unprecedented opportunity for the Green Line to shape the future growth of Calgary by influencing the development along the route. The Green Line will connect communities in the north and southeast Calgary with the downtown core and provide connections to key city facilities and services along the line.

The Green Line will use low-floor LRT technology, enabling the infrastructure to fit within communities. At street level, low floor LRT creates opportunities to create or complement a vibrant and active street.

The Green Line will be used to reinforce civic facilities, social programs and opportunities for community life. The Green Line will provide choices in mobility, housing, recreation and employment for all citizens and age groups, today and in the future. It will enable development along the line to connect people with places and spaces. The City of Calgary realizes there is a benefit to enhancing walking, cycling, and transit to create neighbourhoods that provide people with choices that lead affordable and healthy lifestyles.

QUICK FACTS

The Green Line infrastructure will include:

- Over 46 km of track
- 28+ planned stations
- 11 planned Transit Oriented Development station sites
- A fleet of low-floor light rail vehicles
- A light rail storage and maintenance facility near Shepard station
- A satellite light rail storage and maintenance facility near the Aurora Development
- 10 bridges
- 4 river crossings
- 11 Park and Ride facilities
- 13 transit hubs with bus connections
- Accommodation for a future airport connection

Green Line benefits:

- 27+ communities directly served
- An estimated 90,000 – 140,000 trips per day by opening day
- Opportunities for regional connections from Airdrie, Crossfield, Okotoks, Black Diamond, Turner Valley and High River
- More than 20,000 direct and indirect jobs created through the construction of the Green Line
- $15.6 billion net increase in GDP from the construction and operation of the Green Line, leading to approximately $1billion in additional Provincial income tax
- $1.9 billion increase in property values
- Reduction of 52,000 tonnes of greenhouse gas (GHG) carbon dioxide equivalent annually

5.2 A LAYERED APPROACH

Green Line is more than just moving people between destinations, it's purposely planning for future growth with the goal of providing more choices to citizens in the way they move, live, work and play. Through collaboration with all City departments, external partners, industry and all levels of government, with a layered approach to integration of core transit infrastructure, connections to stations, Transit Oriented Development (TOD) supportive infrastructure, and City Shaping connections to services and local and regional destinations. By adopting this layered approach, the outcomes of the Green Line project will not only meet the increasing demand for transit in Calgary, but also integrate the economic, social, environmental, and cultural needs of a growing city.

Funding for the Green Line LRT will enable the implementation of Layer 1 (transit infrastructure) and essential components of Layer 2 (connections to transit stations).

FIGURE 5.2.1 Layers of the Green Line

1 Transit infrastructure

2 Connections to stations

3 TOD supportive infrastructure

4 City-shaping
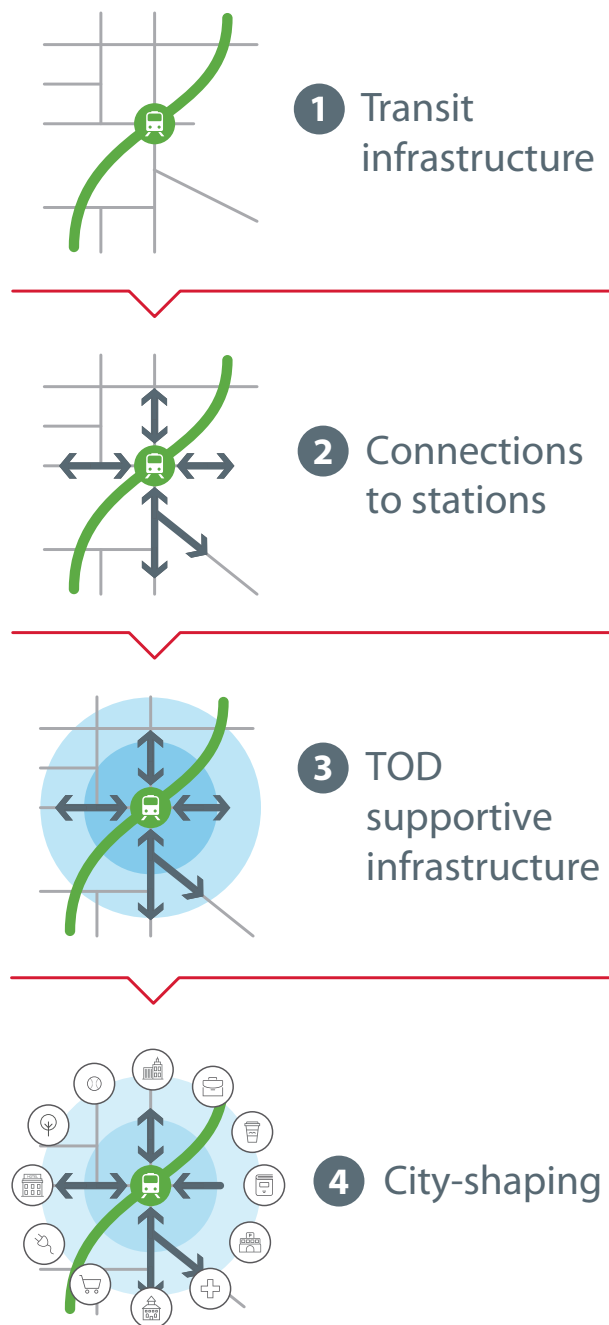
1 Transit infrastructure

Layer 1: Transit infrastructure

The product of this layer is the physical infrastructure that will form the Green Line LRT including stations and tracks. Green Line infrastructure will meet all safety and operational standards as set by The City of Calgary, the Province of Alberta and other governing regulatory bodies.

In contrast to existing LRT in Calgary, the Green Line will use modern low-floor light rail vehicle (LRV) technology that better integrates into the community, and incorporates curb level and less obtrusive station and platform infrastructure.

FIGURE 5.2.2 High floor vs. low floor LRT technology

KEY INFRASTRUCTURE ELEMENTS

The Green Line features the following key Layer 1 elements:

- Scalable station platforms that integrate into the context of each community
- Station plazas and Park and Rides
- Pedestrian crossings and amenities
- Cycling amenities
- A light rail storage and maintenance facility near Shepard station
- A satellite light rail storage and maintenance facility near the Aurora development

High floor LRT: Current Red Line and Blue Line
- Platform height: 0.9m (~ 3 feet)

Low floor LRT: Future Green Line
- Platform height: 0.3m (~ 1 foot)
- More flexible vehicles
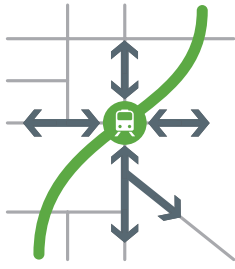
2 Connections to stations

Layer 2: Connections to stations

Layer two of Green Line focuses on infrastructure connecting riders to stations. This includes integration of pedestrian, cycling, bus and automobile connections to the Green Line ensuring that stations are accessible to riders. Enabling citizens to safely and conveniently access stations is crucial to Green Line ridership.

Essential components of Layer 2 that would be covered by Green Line funding would include areas directly adjacent to stations where there is missing or unsafe infrastructure which inhibits pedestrian access.

Other components of mobility such as bicycle pathways, walkways and road works will be addressed through other programs and initiatives.

Barriers and a lack of pedestrian crossings may prevent people from safely accessing stations.

STATION   STATION
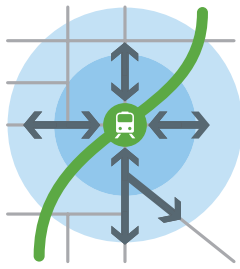
3 TOD
supportive
infrastructure

Layer 3: Transit Oriented Development (TOD) supportive infrastructure

The City of Calgary has made significant investments and long range policy commitments to optimize the use of public transportation infrastructure by encouraging development that supports transit use. Transit oriented development (TOD) focuses on future growth and development close to transit stations. The result is the provision of affordable and active lifestyles that support the use of transit in the community.

Transit Oriented Development

Communities where residents can live, work, play, shop and learn in a mixed-use environment that is in close proximity to rapid public transit and where the private automobile is an option, not a necessity.

Eleven station sites along Green Line have been selected for study and land use policy planning as Green Line TOD Priority Sites. The sites were selected based on geospatial data, market analysis, long term development plans, and stakeholder input (community, developers, and subject matter experts). The table below summarizes the forecasted developable area, forecasted population increase at TOD Priority Sites as office area development along the corridor.

TABLE 5.2.1 Green Line corridor TOD development potential (2015-2045)

TOD PRIORITY SITE	DEVELOPABLE AREA SITE ADJACENT (HA)	POPULATION INCREASE SITE SPECIFIC [1]	OFFICE AREA INCREASE SITE SPECIFIC (MILLION SQ-FT)
96 Ave N	TBC	TBC	
64 Ave N	18.3	5,000	
40 Ave N	14.03	TBC	3.3 - 4.6 [2]
28 Ave N / 16 Ave N / 9 Ave N	24.98	TBC	
Inglewood | Ramsay / 26 Ave SE	2.03	12,400	
Lynnwood | Millican / Ogden	6.76	4,000	0.5 - 2.1 [3]
South Hill	14.56	7,000	

[1] Assuming 2 persons per new residential unit (apartments and attached)   (City of Calgary, 2015b; City of Calgary, 2016)
[2] Includes development along Green Line from 9 Avenue N to 16 Avenue N
[3] Includes development along Green Line from Inglewood to Seton

For each TOD Priority Site, a multi-day stakeholder workshop was used to develop a TOD Community Concept Plan with the Green Line station at its core. The session brought together citizens, developers and policymakers with the goal of identifying opportunities for development and creating supportive planning policies and land uses. The City is currently amending the existing policies and land uses in three of the TOD Priority Sites in the southeast based on the TOD Community Concepts. Similar work will be undertaken at the four remaining Priority Sites.

FIGURE 5.2.3 TOD Priority Sites - North segment

Legend:
- Community Landmark Adjacent to Green Line
- Industrial - Employee Intensive Areas *(Muncipal Development Plan, 2009)*
- Activity Centres and Corridors *(Muncipal Development Plan, 2009)*
- TOD Priority Site

Map labels:
- 160 AVENUE N
- 144 AVENUE N
- 201
- 201
- 2
- NORTH POINTE
  - Vivo Recreation Centre
  - Notre Dame High School
  - Country Hills Towne Centre
- 96 AVENUE N
- Harvest Hills Shopping Centre
- Beddington Towne Centre — BEDDINGTON
- Huntington Hills Community Association
- 72 AVENUE N
- 64 AVENUE N
- John G. Diefenbaker High School
- Thornhill Recreation, Health and Library Centre
- McKNIGHT BOULEVARD
- 40 AVENUE N
- 28 AVENUE N
- 16 AVENUE N
- Crescent Heights High School
- 9 AVENUE N
- 2 AVENUE SW
- 7 AVENUE SW
- Fort Calgary
- CENTRE STREET S
- 4 STREET SE
- N

FIGURE 5.2.4 TOD Priority Sites - Southeast segment

CENTRE STREET S
4 STREET SE
INGLEWOOD/RAMSAY
Crossroads Market
26 AVENUE SE
HIGHFIELD
LYNNWOOD/MILLICAN
Pop Davies Athletic Park
OGDEN
Glenmore Inn
SOUTH HILL
QUARRY PARK
Remington YMCA and Glenmore Square Library
DOUGLAS GLEN
SHEPARD
South Trail Crossing Shopping Centre
PRESTWICK
McKENZIE TOWNE
AUBURN BAY/ MAHOGANY
South Health Campus
Seton Recreation Centre and Library
HOSPITAL
SETON

Community Landmark Adjacent to Green Line

Industrial - Employee Intensive Areas *(Muncipal Development Plan, 2009)*
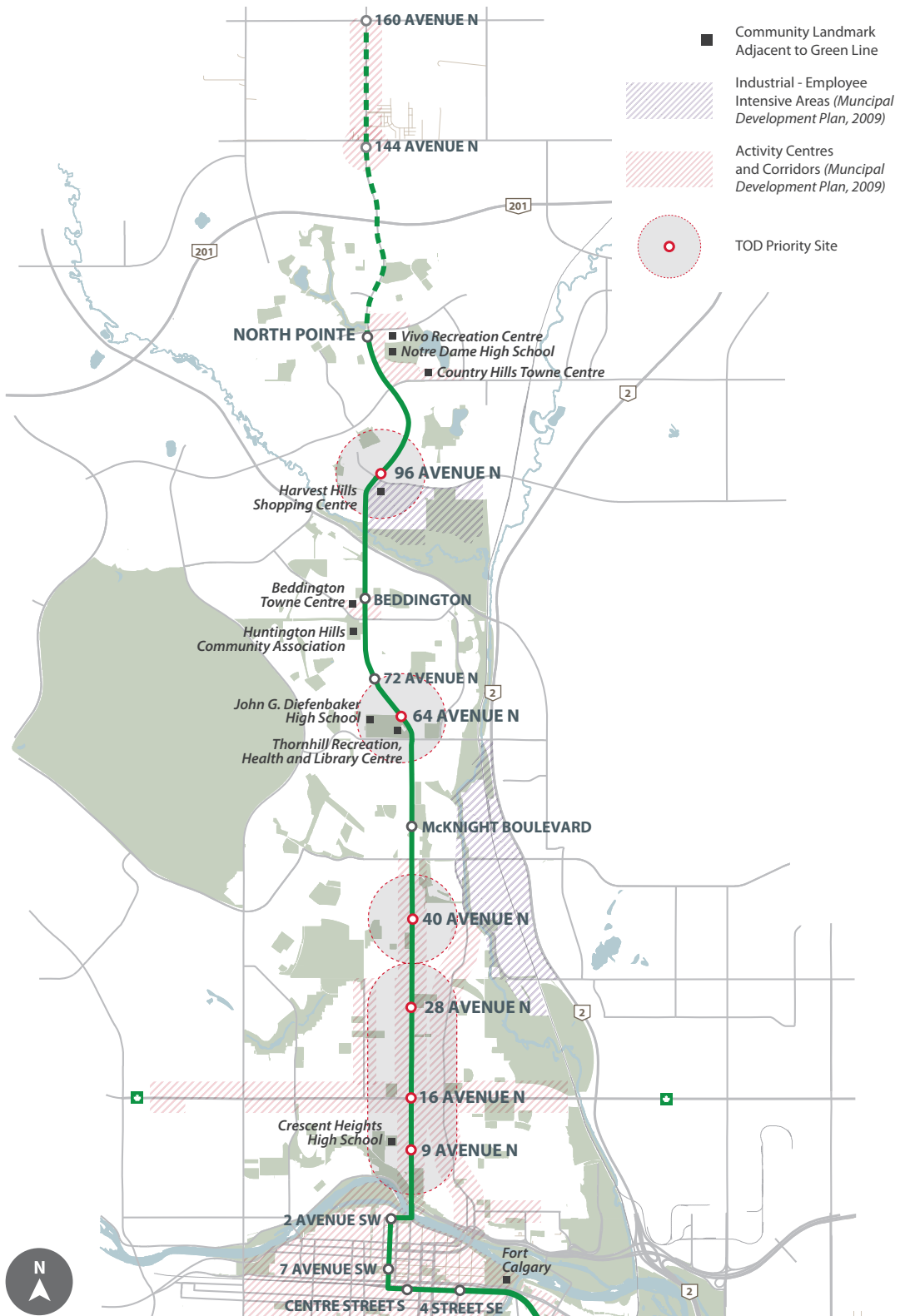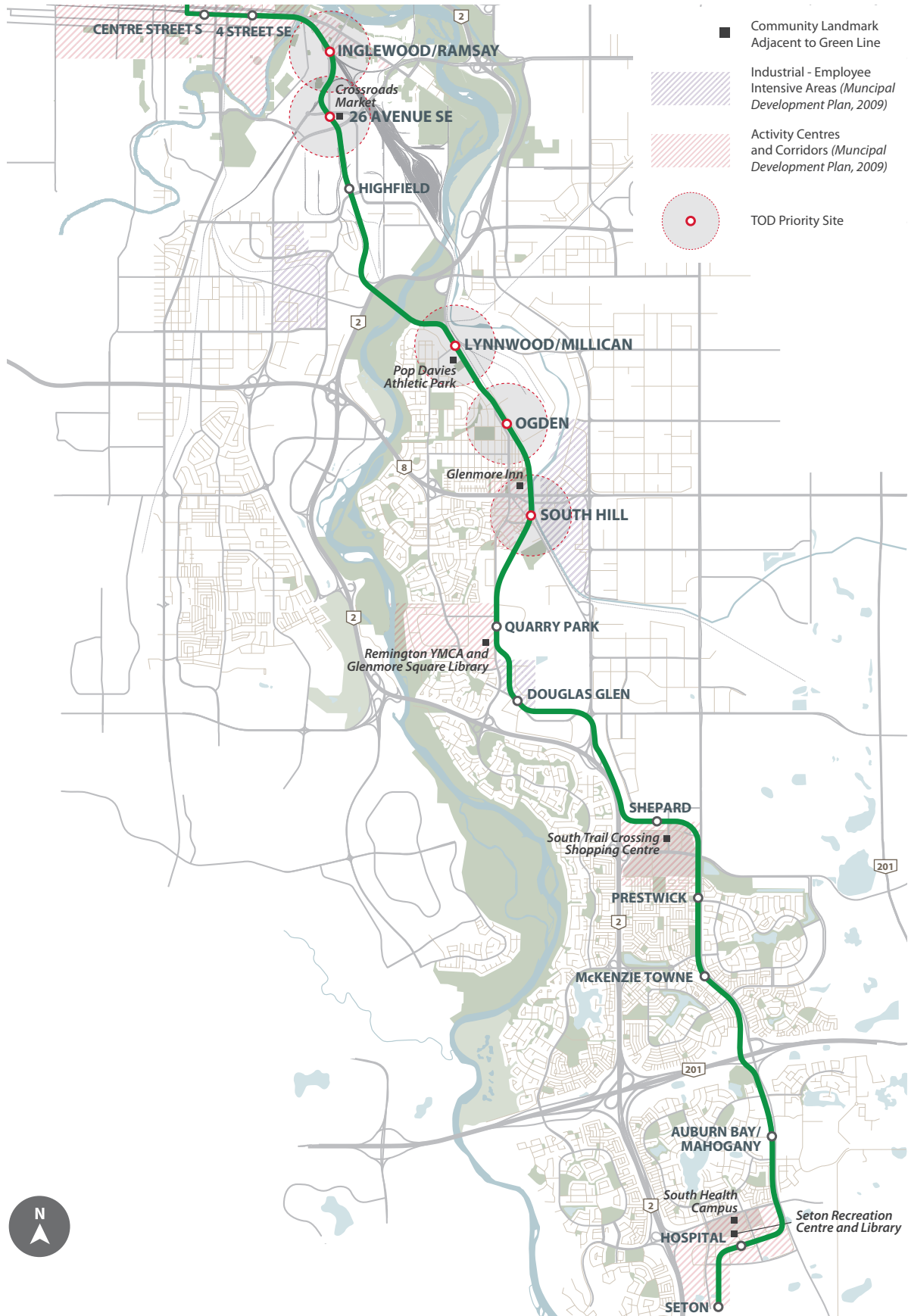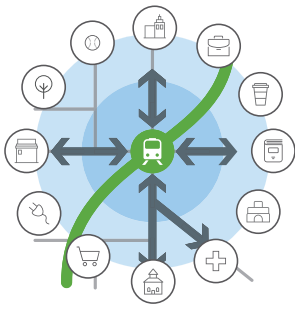
Activity Centres and Corridors *(Muncipal Development Plan, 2009)*

TOD Priority Site

N

4 City-shaping

Layer 4: City-shaping

The Green Line is more than just a transit project; it has the potential to shape the way the city develops. The implementation of the first three layers will help redirect the growth patterns of the city, towards places and destinations connected by transit. Additionally, Green Line will offer the opportunity for the city to re-prioritize and potentially accelerate other initiatives to leverage the investment in transit infrastructure as a catalyst for community integration and connectivity. Realizing this potential requires five key components, which are outlined below:

+ **Connecting people and important destinations:** Green Line will address the needs of riders to provide connection to existing services and facilities as well as key destinations. Building an understanding of these services, facilities, and destinations is crucial in order to design Layer 1 and provide infrastructure that meets the needs of riders. This focus on connections will *shape the way that Calgarians move.*

+ **Leveraging opportunities with new development around LRT stations:** Working to strategically plan and develop TOD sites will create mixed use neighbourhoods around stations. Further leveraging this opportunity to locate civic facilities around stations will contribute to building diverse and healthy communities which will *shape the growth and development of Calgary.*

+ **Collaborating with internal and external stakeholders:** Collaboration and partnerships will be crucial to realizing the development potential along Green Line. Internal stakeholders include other City of Calgary departments who will be instrumental in the planning and development of services and facilities along the Green Line. External stakeholders such as developers, civic partners, and businesses, will need to collaborate to implement development plans and realize the vision for vibrant communities along Green Line. This focus on collaboration will *shape the way that we build community.*

+ **Integrating space and services:** When looking at future investments along the Green Line, there is the potential to invest in mixed use spaces that provide services and amenities for citizens. This focus on the integration of civic facilities along the Green Line will *shape the way that the City provides services to Calgarians.*

+ **Choices to the citizens in Calgary:** Green Line is about shaping a future where Calgarians have choices both in their transportation options, but also in the communities that they choose to live in. Providing opportunities for affordable lifestyles along the Green Line will *shape the way that Calgarians live, work, play, and move.*

City shaping starts with a collective vision of the future and leads to a long-term shift in development patterns away from further expansion and towards connected places. The intent is to provide a safe, accessible, integrated and sustainable transportation system that connects people to each other and the civic services they need and expect. This in turn will contribute to resilient and vibrant communities for Calgarians today and in the future.

5.3 OUTCOMES OF A LAYERED APPROACH

Spotlight on 64 Avenue N Station

The results of the layered approach to community integration can be exemplified by considering how the Green Line will change the area around the proposed 64 Avenue N station:

+ **Layer 1:** Low floor trains integrate directly into the community. A station design with a transit plaza creates a gathering and meeting space for riders which reflects the character of the community and contributes to the cultural vibrancy of the area.

+ **Layer 2:** Green Line ensures safe access to the station for customers. Through partnerships with other City departments, investment in connections such as multi-use pathways are made to ensure people can access the station using multiple modes of transportation.

+ **Layer 3:** Transit Orientated Development occurs around the station resulting in a mix of residential and commercial spaces that meet the needs of community members as well as attract people to the community.

+ **Layer 4:** This investment in public transit creates an attractive location for future private development and public facilities to serve the community. The station location was strategically selected based on proximity to existing facilities, including a health centre, schools, recreation centre, grocery store and daycare. Affordable housing is located near the station. Land use policy will be updated to enable mixed-use development to occur over time. The design of the station will ensure it is well-connected to the surrounding community for all modes of transportation. Owning a car in this community is a choice not a necessity as the Green Line connects to additional employment, social, and cultural destinations throughout the city.

FIGURE 5.3.1 64 Avenue & Centre Street N - TOD Charrette outcomes
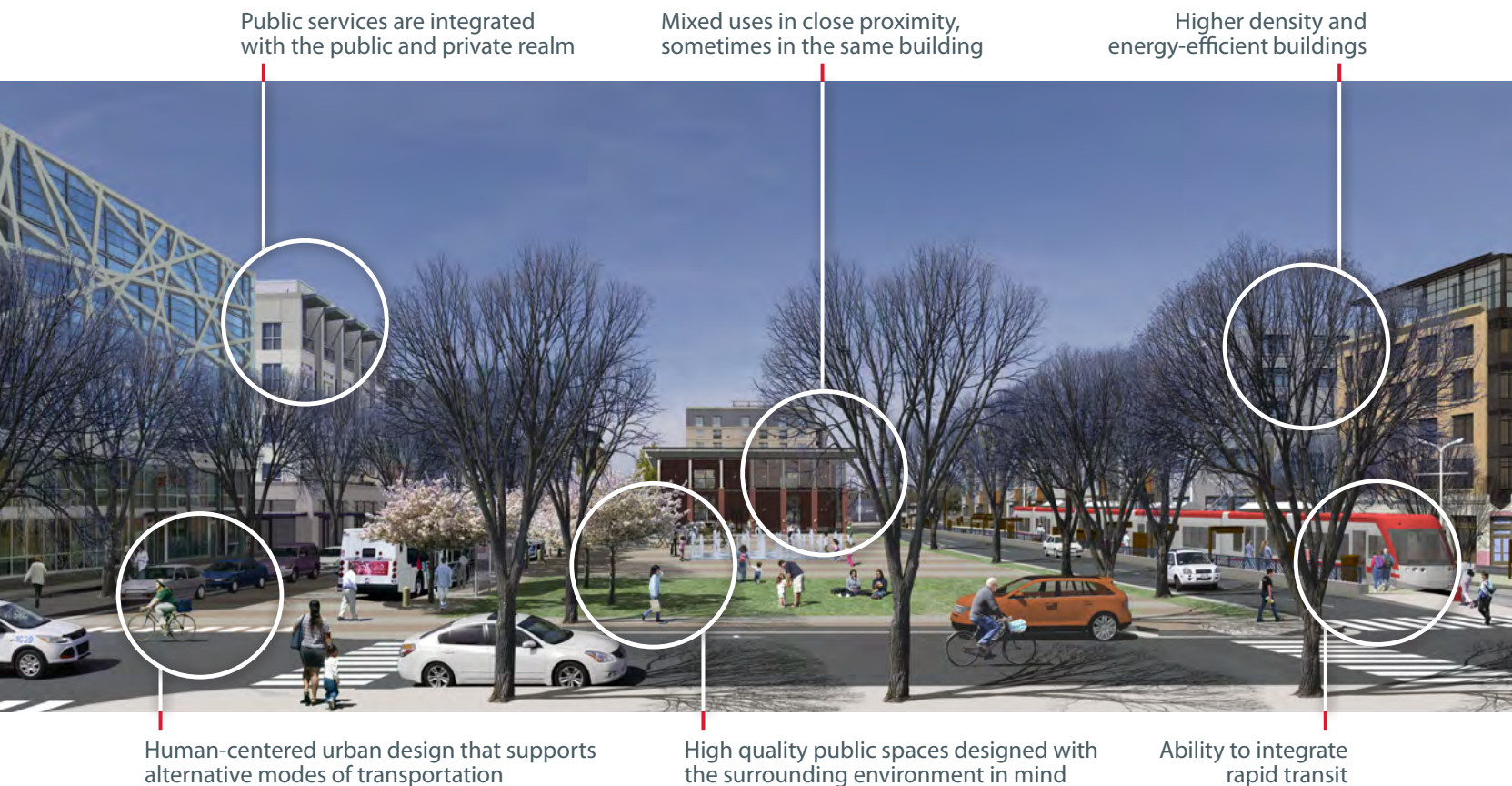
Public services are integrated with the public and private realm

Mixed uses in close proximity, sometimes in the same building

Higher density and energy-efficient buildings

Human-centered urban design that supports alternative modes of transportation

High quality public spaces designed with the surrounding environment in mind

Ability to integrate rapid transit

6

Benefits of the Green Line

6.1 MEETING THE NEEDS OF A GROWING POPULATION

The Green Line is an opportunity to not only provide much needed transportation options, but to invest in a more sustainable future for Calgary.

NOTE: *The following benefits are based on an analysis of the Green Line from North Pointe to Seton, and do not include the future extension to Keystone (160 Avenue N) and to the Calgary International Airport.*

Population growth

Today's population in north and southeast Calgary is 285,000, and is expected to grow by 420,000 by 2076. For these future Calgarians, the Green Line will provide high quality transit to residents, businesses, and commuters along the route. TOD development around stations will allow people to live and work close to transit, helping to manage urban sprawl in the city. TOD will also provide ridership for the system, ensuring it remains operationally sustainable

Changing mobility trends

The Green Line LRT will address shifts in mobility trends by providing a service that allows people to easily access safe and reliable transit. Stations will be positioned strategically within communities along the route, with consideration for pedestrian, cycling, and vehicle connections.

The Green Line will complement the range of mobility options available today, including car share programs and other emerging trends.

Reducing road congestion

Calgary's road networks experience high volumes, especially on north-south routes like Deerfoot Trail as well as the recently expanded Stoney Trail. The Green Line will run parallel to Deerfoot Trail in the southeast, and has the potential to ease congestion on the road network. By taking cars off the road, it can improve capacity and regional connections for commercial vehicles and goods movement. The Green Line is essential to developing an integrated Provincial transportation strategy in Calgary, particularly to offset demand on the Deerfoot Trail/QE II Highway/North-South Trade Corridor. Deerfoot and Stoney Trail will benefit from the relief offered by high-capacity public transit, particularly in peak periods.

Keeping pace with job creation

The Green Line will connect 19 industrial, employment and commercial centres across the city, providing high quality transit to these areas. This includes:

- South Health Campus with 2,500 employees today, expected to grow to 5,000 in the future.
- Remington developed the Quarry Park area, with 2 million square feet of development completed, and a total expected 4 million square foot buildout. Quarry Park is now home to major corporate head offices such as Imperial Oil and the surrounding area currently employs over 11,500 employees, and will see a 25,000 job increase by 2076
- Aurora Business Park is currently undergoing development, but anticipated to be a business park on 183 developable acres of land
- Connection to the Calgary International Airport with 25,000 employees.

Providing reliable transit

The Green Line will provide fast, frequent and reliable service that is important to Calgarians. Calgary Transit is committed to tracking service reliability for the Red and Blue lines and will continue to provide the high level of service with the addition of Green Line as shown in figure 6.1.1 that transit users enjoy on Calgary 's current LRT lines.

In order for transit to be a viable option, service in the southeast must become faster and more reliable. The Green Line LRT service will run on dedicated infrastructure, enabling Calgary Transit to adhere to a set schedule and efficient run times.

In the north, the Green Line will increase capacity, addressing demand in peak hours.

Improving system reliability will in turn attract more riders, increasing financial sustainability of the service and providing a greater return on investment.

Southeast

+ *Travel times for the Green Line in the southeast will decrease from 20-25 minutes during peak hours (compared to current day BRT service)*

+ *Peak frequency will double from every 10 minutes to every 5 minutes*

+ *Off-peak frequency will improve from every 30 minutes to every 20 minutes*

North

+ *Northbound and southbound travel times will be consistent (currently, it takes longer to travel northbound during the evening peak)*

+ *Off-peak frequency will improve from every 15 minutes to every 10 minutes*

+ *Peak hour capacity will more than double from 3,200 to 8,300 passengers per direction per hour on opening day. The system will meet opening day needs and forecasted 2076 ridership*

* Capacity factors (i.e. number of train cars per consist and headway) will be revised based on staging limits, development potential and feeder bus network Integrating into urban and regional infrastructure

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Integrating into urban and regional infrastructure

Urban connections

The Green Line is an important piece of Calgary's Primary Transit Network, which will enable Calgarians to make cross-town connections, and provide convenient and reliable service to a number of destinations throughout the city. Figure 6.1.1 shows Calgary's planned Primary Transit Network and how the Green Line will connect to key transit services.

The Green Line will connect diverse areas of the city, ranging from suburban neighbourhoods to industrial lands, major employment centres and well-established inner-city neighbourhoods. It will directly serve over 27 communities, and provide access to the following destinations which include important medical, education, employment and cultural centres. Figures 6.1.2 and 6.1.3 highlights key connections located along the Green Line.

FIGURE 6.1.1 Calgary's Primary Transit Network

Primary Transit Network

+ Frequent, fast, reliable, connected
+ 10 minute frequency
+ 15 hours / day
+ 7 days / week

EXISTING NETWORK
— Light Rail Transit LRT Network
— Primary Transit Network

PLANNED CONSTRUCTION
— Green Line Light Rail Transit (LRT) Line
•••• Bus Rapid Transit (BRT) Network

Final route alignments are subject to change

N

KM
0   1   2   4   6

FIGURE 6.1.2 Key connections - North segment
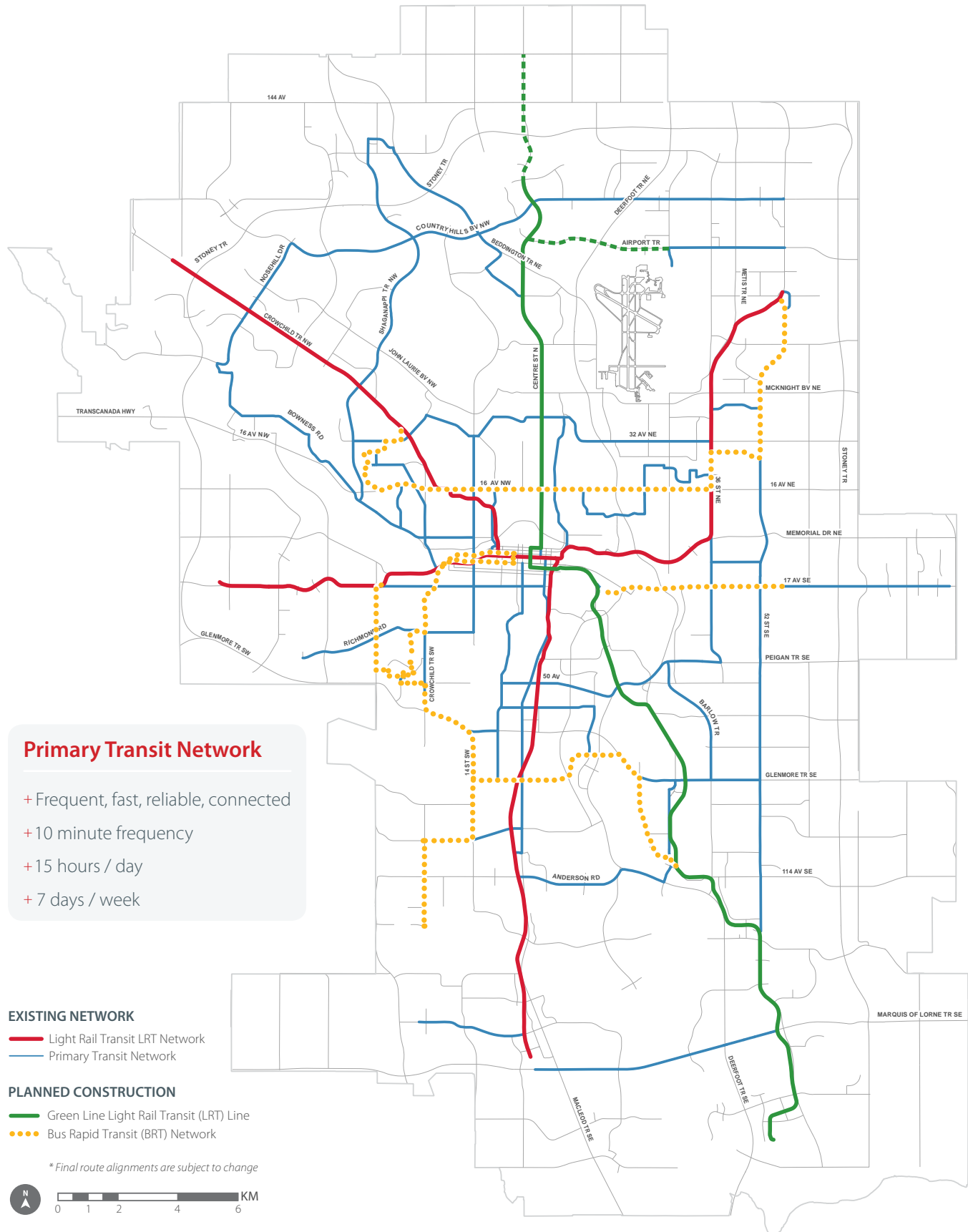
FIGURE 6.1.2 Key connections - North segment
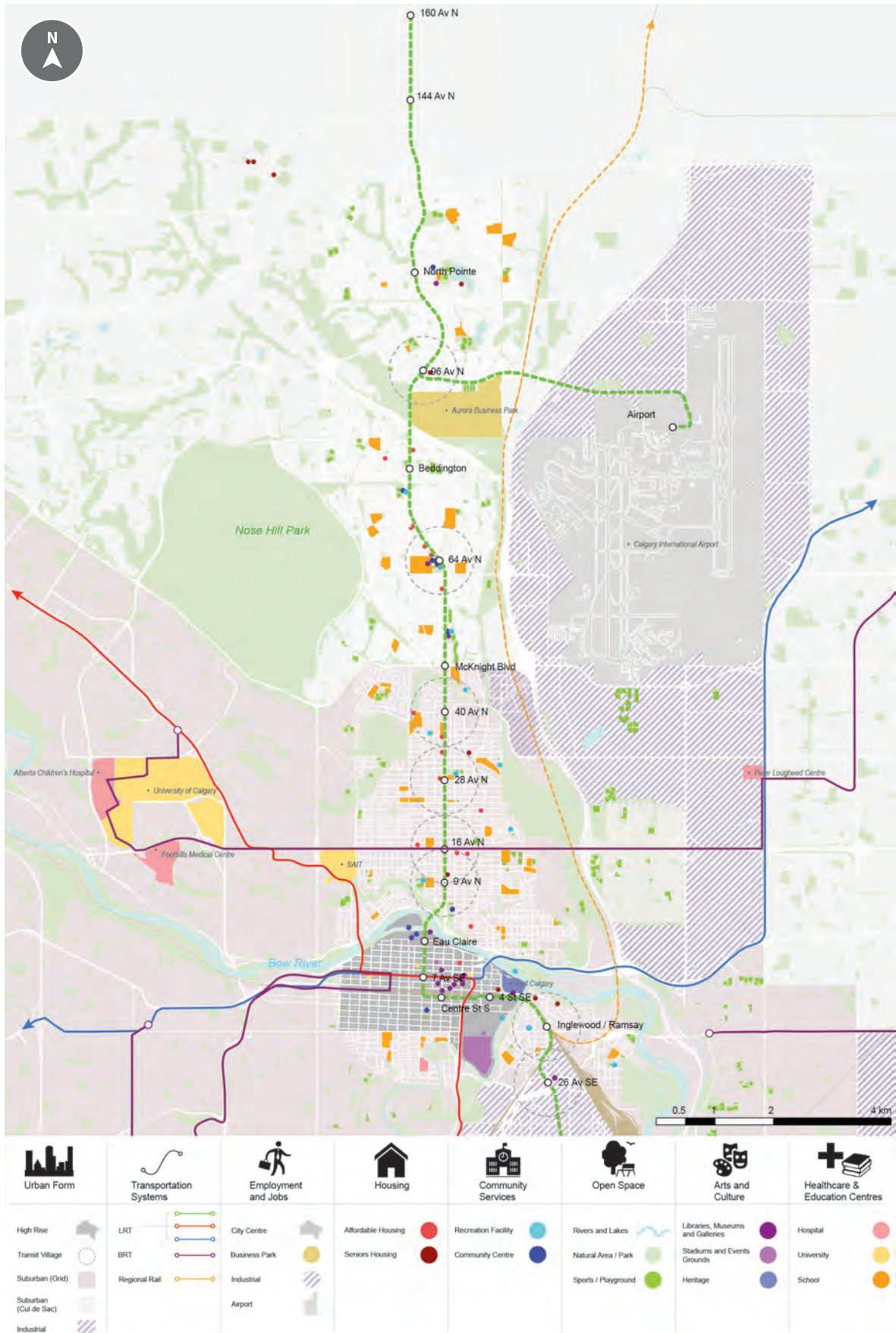
FIGURE 6.1.3 Key connections - Southeast segment
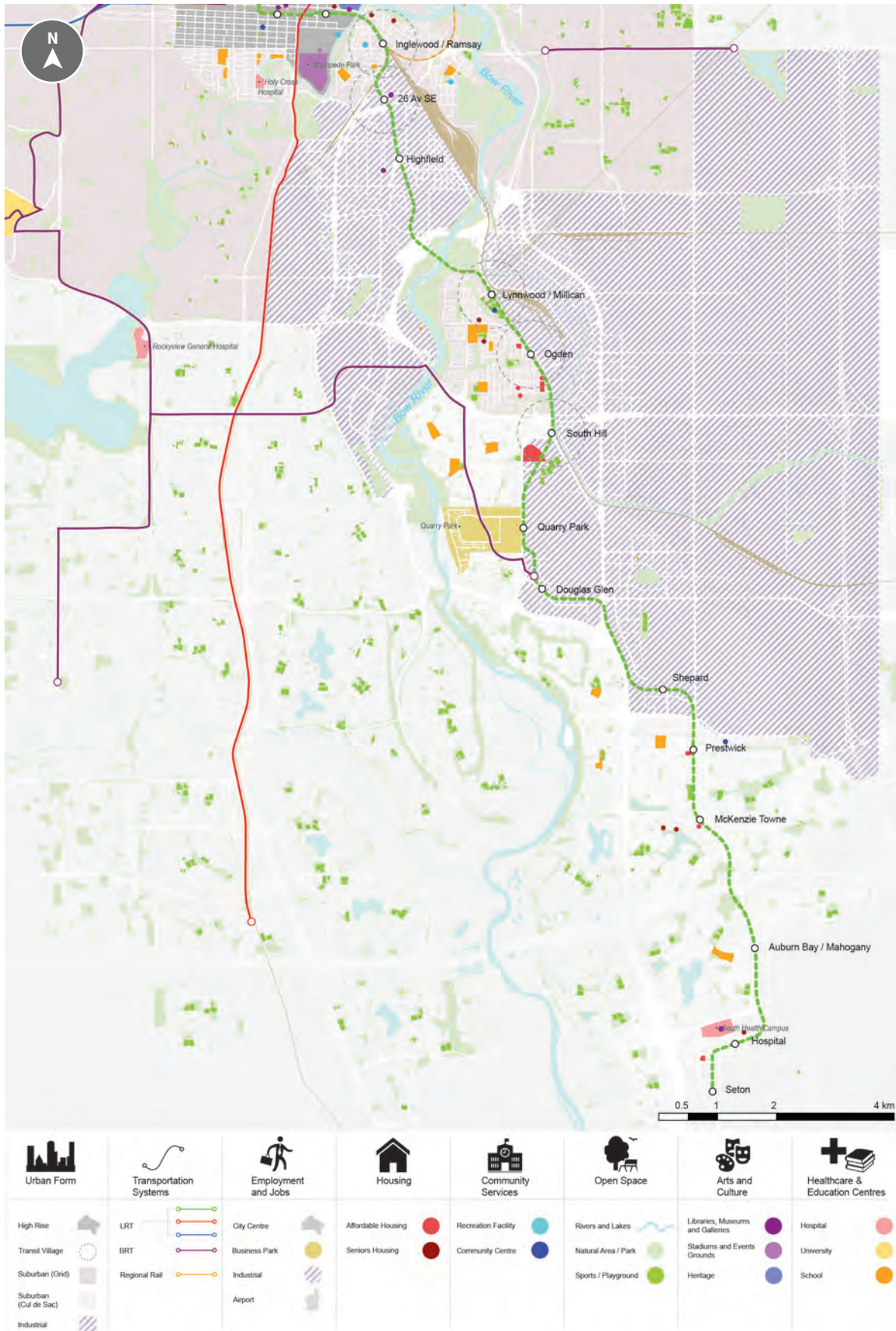
Table 6.1.1 is a comparison of Green Line's forecasted 2029 daily weekday trips to the current ridership on the Red and Blue Lines.

TABLE 6.1.1 Green Line corridor TOD development potential (2015-2045)

LRT LINE	RIDERSHIP (TRIPS PER WEEKDAY)	YEAR
Green Line	90,000 - 140,000	Opening Day
Red Line	200,000	2015
Blue Line	105,000	2015

Regional connections

As part of the 2009 Calgary Regional Transit Plan, created through the Calgary Regional Partnership, Green Line will facilitate important connections in the regional transportation strategy. Green Line will connect to existing and planned regional transportation services. Commuters from Airdrie will be able to connect with three points along the Green Line, further benefiting the regional transportation network.

Park and Ride facilities located at Green Line stations will benefit regional commuters, reduce road congestion and benefit the overall regional road network.

Figure 6.1.4 shows connections to commuter bus service (Airdrie ICE, Calgary Regional Partnership In-It service), potential Provincial high speed rail connections, potential airport rail connections, and the Red Arrow and Greyhound service.

FIGURE 6.1.4 Regional connections

TO EDMONTON

567

Airdrie

567

567

2

772

Airdrie Intercity Express
(ICE) connection

Potential connection
to Calgary International
Airport (YYC)

Provincial High Speed
Rail connection

Cochrane

1A

564

On-It Regional Transit Service (High
River, Black Diamond,Turner Valley
& Okotoks) connection

8

Chestermere

Airdrie Intercity Express
(ICE) connection

560

Langdon

22x

22

22x

2A   2

On-It Regional Transit Service (High
River, Black Diamond,Turner Valley
& Okotoks) connection

22

552

Okotoks

547

7

799

N

GREEN LINE

PLANNED FUTURE EXPANSION

EXISTING RED LINE LRT

EXISTING BLUE LINE LRT

PLANNED REGIONAL RAIL

High River

23

6.2 INVESTING IN CALGARY'S FUTURE

"Calgary Economic Development will work with stakeholders to support a strategy that attracts new and diverse businesses in communities along the Green Line."

Building economic resiliency

The Green Line will create jobs and Gross Domestic Product (GDP) growth, with direct benefits resulting from construction, operations, and maintenance. The Green Line LRT will contribute to the economy in Calgary and within Alberta in many ways:

- **Job creation and GDP increase due to Green Line construction and operations.** Green Line will create more than 20,000 direct and indirect jobs from 2017 to 2026. Approximately $15.6 billion in additional real gross domestic product will be created within the Calgary Metropolitan Area between 2016 and 2046.

- **Increased property values.** Assessed property values along the Green Line LRT corridor will increase by approximately $4.7 billion by 2046. This represents approximately $1.9 billion in present value terms.

- **Increased income tax revenue.** $940 million in additional Provincial income tax (between 2016 and 2046).

- **Potential increased property tax revenue.** Potential gains in property taxes to Calgary and Alberta are estimated at approximately $630 million in present value dollars ($450 million in property taxes will go to the City and $180 million will go to the Province between 2016 and 2056)*

- **Savings for households.** Approximately 13,000 households are within 600 meters from a planned station. By utilizing the Green Line, these households are estimated to save approximately $4,000 per year on transportation costs. Savings are expected to result in approximately $1000 in additional annual discretionary spending for these households.

- **Productivity gains.** Preliminary estimates indicate that approximately 140,000 Green Line passengers (estimated opening day ridership) will see a reduction of up to 20 minutes per trip. The total annualized travel time savings for those Green Line passengers in the first year alone will be 1,300 hours, or approximately $3 million in labour savings.

- **Contribution to economic diversification.** Improvements in Calgary's ability to attract diverse talent and businesses through transit oriented development.

* The City of Calgary currently has a revenue neutral municipal tax policy. Please see note on page 9 of Appendix A.1 for more information on this.

The Green Line will meet the needs of a growing population and contribute to strengthening and building a resilient economy. *Appendix A – Economic Analysis* provides details on this analysis.

Provincial policy alignment

Infrastructure Business Plan: 2016-19

"Infrastructure investments can help stimulate the economy by creating jobs while ensuring Albertans have access to necessary health, learning and government facilities."

Transportation Business Plan: 2016-19

"A reliable, multi-modal transportation network will enable a diversified economy that supports Alberta's potential, fosters innovation and supports Alberta's growing population."

Federal policy alignment

Federal Budget 2016: Chapter 2, Growth for the Middle Class

"Investing in infrastructure creates good, well-paying jobs that can help the middle class grow and prosper today. And by making it easier to move people and products, well-planned infrastructure can deliver sustained economic growth for years to come."

Infrastructure Canada Report on Plans and Priorities 2016-17

"Strategic infrastructure investments are needed to create jobs, build sustainable communities and support economic growth for years to come."

Addressing environmental sustainability

The Green Line aligns with the environmental priorities of the Provincial and Federal Governments as it is designed to be a sustainable, low carbon, low emission mode of transportation. The Green Line will:

- Directly reduce greenhouse gas (GHG) emissions by 52,000 tonnes of carbon dioxide equivalent annually.
- Replace many bus trips, especially on Centre Street with an emissions free mode.
- Displace 22 million liters of gasoline and diesel fuel by powering the Green Line with renewable electricity (or lower carbon energy).
- Achieve efficiency gains with as few as 18 LRT passengers/train, which is the "break even" point for LRT energy savings when compared to 18 automobiles.
- Leverage Calgary Transit's previous investments and expertise in energy efficiency, pollution control, and renewable energy.
- Reduce a projected two per cent of Calgary's smog-forming tailpipe emissions.
- Facilitate land use densification in transit hubs and corridors, resulting in further long-term environmental benefits.

Further details can be found in the *Appendix B – Environmental Benefits.*

Provincial policy alignment

Alberta Energy Business Plan: 2016-19

"Alberta is committed to taking great action and tackling the problem of climate change…Alberta's Climate Leadership Plan drives a shift to a lower carbon economy which is essential to elevating Alberta's environmental reputation."

Federal policy alignment

Federal Budget 2016: Chapter 4, A Clean Growth Economy

"Protecting the environment and growing the economy are not incompatible goals. A clean environment and a strong economy go hand-in-hand. The government is committed to leaving future generations of Canadians a sustainable and prosperous country."

Enabling social equity

The Green Line aligns with the social priorities of the Provincial and Federal Governments. It is designed to improve quality of life by providing people with options on how to move, work, live, and play, and allows more affordable access to essential community services.

Green Line supports walkable and connected communities, giving people the opportunity to increase their levels of physical activity and improving the overall health and well-being of individuals. The Green Line will:

- Contribute to affordable lifestyles: nearly 35% of lower-income citizens use public transit to get to their everyday destinations, compared to 17% of moderate income respondents (City of Calgary, 2015a, p. 18).

- Increase potential affordable housing sites such as 64 Avenue N: transit is a key consideration for affordable housing sites (City of Calgary, 2015a).

- Provide positive health outcomes: transit users have been found to get 24 minutes of walking per day (meeting the recommended 22 minutes of physical activity per day) (Basser & Dannenberg, 2005). In addition, transit users have been found to get an additional 8 minutes of physical activity per day compared to non-transit users (Lachapelle et al., 2011).

- Connect citizens with recreation areas. Improving access to these centres will have both mental and physical health benefits for citizens.

- Connect to the South Health Campus, providing an affordable alternative to access healthcare services.

Provincial policy alignment

Culture and Tourism Business Plan: 2016-19

"The quality of life of any society is often measured by the social and economic well-being of its citizens. Inclusive communities that foster active participation are better equipped to tackle social issues related to a growing population."

Federal policy alignment

Federal Budget 2016: Chapter 2, Growth for the Middle Class

"Canadian cities have been growing at a rapid rate, but investment in public transit has not kept pace. This has led to more traffic congestion, and long commutes that make it harder for people to get to work and for families to spend time together….Canadians need immediate investments in their communities' public transit systems, so that they can get to work on time, and back home at the end of a long day."

Canadian Transportation Agency Report on Plans and Priorities 2016-17

"The national transportation system is critical to the prosperity and social fabric of Canada. Individuals and companies depend on it every day, whether they are travelling for work, visiting family and friends, or shipping materials and products to market".

Supporting cultural vibrancy

Culture is a major economic engine in the local economy with over 50,400 people directly employed in creative industries in Calgary (Calgary Economic Development, 2015). The Green Line aligns with the cultural priorities of the Provincial and Federal Governments as it will connect people to cultural facilities they may not have had access to previously. Cultural considerations are foundational to planning spaces, places, policies and programs.

The Green Line station areas will offer opportunities to leverage cultural connections between communities through the use of plazas, open spaces, mixed use streetscapes and more. The Green Line will:

- Increase connections to important cultural destinations in the city, including the National Music Centre, Stampede Park, and the Inglewood/Ramsay art communities.
- Incorporate public art along the line.
- Provide connections to places of cultural significance such as Chinatown, a number of places of worship, and community and recreation centres.

Provincial policy alignment

Alberta Culture and Tourism Business Plan: 2016-19

"Vibrant communities and diverse cultural opportunities enhance Albertans' quality of life."

Federal policy alignment

Federal Budget 2016: Chapter 5, An Inclusive and Fair Canada

"Canada's heritage, shaped by our diversity, deserves to be celebrated and shared."

7

Implementation & Cost

7.1 PROGRAM CONTEXT

The north, southeast and Centre City segments of Green Line vary greatly in urban context, community priorities, and opportunities and are also at different stages of planning, design and cost estimation. As such, each of these segments require different levels of effort to bring them to the same state of design and cost certainty. By June 2017, the full Green Line recommendations will be presented based on available funding.

Variables yet to be determined which will impact the overall project costs include:

- Centre City alignment
  + *Length and type of grade separation – CPR tracks to 24 Ave N*
  + *Alignment and type of grade separation along 10 / 11 / 12 Ave S*

- Functional Design for north segment – vertical alignment, specific station locations, tie-ins, land requirements, and pedestrian connections; awaiting finalization and Council approval

- Land requirements – partial or full parcel purchases

- Design / functionality of a satellite Maintenance Facility in the north (Aurora)

- Fleet requirements – will be determined by the first stage of construction

The implementation strategy for Green Line is focused on the long term outcomes for citizens. The Green Line is viewed as an investment for Calgary's future and so it is crucial to design a project that will provide for demand on opening day as well as for years to come.

With the interest from the Government of Canada to make a significant investment in the Green Line LRT, the City decided to accelerate the Green Line planning and bring all three segments of the Green Line to the same level of project definition in time for funding applications to the Governments of Canada and Alberta as early as the second quarter of 2017. This design development is independent of the funding available. Calgary's previous LRT lines were planned incrementally and lack a consistent design philosophy. Lessons learned from the planning of the Red and Blue lines have shown that it is beneficial to take a comprehensive approach to designing and planning infrastructure. Construction of the Red and Blue lines occurred incrementally, as funding became available. Green Line construction can be phased, depending on available funding, to achieve the maximum benefits for Calgarians.

7.2 SCHEDULE

Table 7.2.1 describes the milestones set for the design and construction start of the Green Line. This includes: descriptions of percent completion of (1) Project Milestones: capital cost estimates, design, land purchasing, procurement, Transit Oriented Development, City Shaping and engagement for respective southeast, Centre City and northern segments of the project, and (2) proposed municipal, provincial and federal milestones for funding decisions.

It should be noted that design for the southeast segment is at a 30% level of project definition and is ahead of the other segments. Likewise, correlated capital cost estimates, risk assessments and early works planning are also further in progress for the Southeast segment of Green Line. Once the Centre City alignment has been approved by Council, design will progress to a 30% level of project definition. It is anticipated that the functional design for all three sections of the Green Line including cost estimates will be at 80% certainty by the end of Q2 2017. Subject to funding being secured, a delivery model will be determined and construction of the main contract could begin by Q3 2019.

TABLE 7.2.1 Green Line program milestones (2016 - 2019)

Layer	Deliverable	2016		2017				2018				2019		
		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
	Capital Cost Estimate													
1 & 2	+ Southeast	80% Certainty			80% Certainty									
	+ Centre City	Order of Magnitude			80% Certainty									
	+ North	Order of Magnitude			80% Certainty									
	Design													
1 & 2	+ Southeast	Preliminary			Reference Concept Design			Reference Concept Design						
	+ Centre City	Functional			Functional			Reference Concept Design						
	+ North	Corridor			Functional			Reference Concept Design						
	Land													
1 & 2	+ Southeast	Land Purchase 4 St SE - Douglas Glen		Land Purchase Douglas Glen - Seton	Land Purchase 24 Ave N - 4 St SE								All Land Acquired	
	+ Centre City	Opportunity Purchases											All Land Acquired	
	+ North	Opportunity Purchases				Land Purchase North Pointe - 24 Ave N							All Land Acquired	
	Procurement													
1 & 2	+ Program-wide	Strategic Assessment			Approval of Contracting Strategy	Issue RFQ		Issue RFP					Start Construction	
	Transit Oriented Development													
3	+ Program-wide		Southeast Land Use Policy					North & Centre City Land Use Policy					Land Use Redesignation	
	City Shaping													
4	+ Program-wide | Social	Vision & Collaboration			Resiliency Plan (Strategic Framework)				Implementation Strategy		Service Plan Delivery (Phase 1 Quick Wins)	Develop City Shaping Funding Model		
	+ Program-wide | Economic	Vision & Collaboration			Resiliency Plan (Strategic Framework)				Implementation Strategy		Service Plan Delivery (Phase 1 Quick Wins)	Develop City Shaping Funding Model		
	+ Program-wide | Environmental	Vision & Collaboration			Resiliency Plan (Strategic Framework)				Implementation Strategy		Service Plan Delivery (Phase 1 Quick Wins)	Develop City Shaping Funding Model		
	+ Program-wide | Regional	Vision & Collaboration			Resiliency Plan (Strategic Framework)				Implementation Strategy		Service Plan Delivery (Phase 1 Quick Wins)	Develop City Shaping Funding Model		
	Engagement													
1 - 4	+ Program-wide													

Project milestones ●

Municipal milestones ●
- Provincial Business Case Submission #1 Including GreenTRIP Third Call Application
- Federal Public Transit Infrastructure Fund Submission
- Provincial Business Case Submission #2
- FULL FUNDING COMMITMENT
- 2019-2023 Budget Recast
- 2019-2023 Budget Cycle Approval
- City Shaping Funding Request (Provincial & Federal)

Provincial milestones ●
- Provincial Funding Commitment
- FULL FUNDING COMMITMENT

Federal milestones ●
- Federal Application Guidelines Released
- FULL FUNDING COMMITMENT

7.3 PUBLIC ENGAGEMENT

Public engagement is essential to the success of the Green Line project. Community input on how the Green Line will integrate and function within communities has shaped the route, alignment and TOD plans to date.

Public input has reinforced that Calgarians are supportive of the project and interested in seeing it built right, with the long-term city shaping vision in mind.

Public engagement has included opportunities to participate in workshops, information sessions, individual meetings with subject matter experts, and intensive design sessions. Most importantly, results of the public engagement sessions have been incorporated into the designs and implementation strategy for Green Line.

FIGURE 7.3.1 Green Line engagement statistics to date

Over **5,500** interactions at public events & festivals around the city
April - August 2016

Over **3,000** attendees at public sessions
Since January 2015

Over **2,000** participants in online engagement
Since March 2015

5,000 visits to the online engagement portal to learn about the Centre City & Beltline route options
Since April 2016

30,000 views on Green Line related blog posts
Since January 2015

Hundreds of individual stakeholder meetings
Since January 2015

Almost **100,000** visits to calgary.ca/greenline
Since January 2015

26,000 views on the Green Line route video
Since July 2015

Engagement Statistics

7.4 COST

Capital Cost

The Green Line is a multi-billion dollar investment in Calgary's future, and will likely need to be staged in order to deliver the full program. Planning, design and cost estimates are currently underway for the full program, from Seton to Keystone.

The first phase of Green Line could have $4.59 billion in funding, assuming the Federal Government contributes $1.53 billion, as per the announcement in July 2015, and other orders of government equally match these funds. The Green Line LRT project can be staged in order to provide maximum benefit to Calgarians in the shorter-term, while setting specifications and technology for future expansion. This will provide shovel-ready projects for the future, similar to the extensions that have been undertaken on the Red and Blue lines.

Currently, discussions with funding partners at all three levels of government are ongoing to address the magnitude of available investment, the investment term, and the delivery model. Each of these factors will influence the cash flow available and the project staging. Details on project implementation will be confirmed as more information becomes available, and the project may then be staged according to the available funding.

In order to inform construction staging decisions,the full project functional design must be completed to set the alignment, station locations, and required land. The City is committed to working within available funding to deliver a project that provides the maximum benefit to Calgarians, with the full project benefits to be realized over a number of years. Staging options and value engineering examples have been included to illustrate potential options. These staging options are intended to begin a discussion, and are not intended as finalized design decisions.

An investment of this significance requires a comprehensive plan to guide future decisions. Phasing with the goal of reaching the desired end outcome is expected.

FIGURE 7.4.1 Green Line program extents

FULL PROGRAM PLANNING
AND DESIGN

**Total Capital Cost
To Be Determined**
Keystone (160 Ave N)
to Seton

160 AVE N

144 AVE N

NORTH POINTE

CALGARY INTERNATIONAL AIRPORT

96 AVE N

BEDDINGTON

72 AVE N

64 AVE N

MCKNIGHT

40 AVE N

28 AVE N

16 AVE N

9 AVE N

BOW RIVER

2 AVE SW

7 AVE SW

CENTRE ST S

4 STREET SE

INGLEWOOD / RAMSAY

ELBOW RIVER

26 AVE SE

HIGHFIELD

LYNNWOOD / MILLICAN

OGDEN

SOUTH HILL

QUARRY PARK

DOUGLAS GLEN

SHEPARD

PRESTWICK

McKENZIE TOWNE

AUBURN BAY / MAHOGANY

HOSPITAL

SETON

NOTE: Based on previous Federal funding announcements and assuming historical 1/3 matching funds of $1.53 Billion from each level of Government, the first phase of Green Line would have a total of $4.59 Billion available. Limits of Phase 1 Green Line will be determined once funding is known.

7.5 STAGING CONSIDERATIONS

As discussed earlier, construction of the Green Line can be staged to deliver the full line as funding is available. The following staging scenario was developed taking into account the need to meet ridership demands while also recognizing constraints related to operation and maintenance thereby providing the best value to Calgarians over time.

Two of the key considerations in developing a staging plan for Green Line are in relation to (1) vehicle maintenance requirements and (2) connection to the downtown core.

1. Maintenance and Storage Facility Requirements

The location for the Maintenance and Storage facility for Green Line LRVs is at Shepard, located along the southeast segment of the line. Located approximately 17 kilometres from Downtown, the Shepard site is a 70 acre parcel of land that can accommodate the heavy repair, light maintenance and storage of the full fleet of LRVs for Green Line. Any staging of the Green Line must include a connection to the Shepard location so that LRVs can be maintained and stored when not in use.

A secondary light rail maintenance and storage facility may be located at the 15 acre Aurora location on city-owned land near 96 Avenue N along the north segment of Green Line. This facility would improve the efficiency and cost effectiveness of operations when staging transit service at the start and end of the service day, for the full build out of Green Line.

2. Connection to downtown

There is a need to connect Green Line with the downtown core and provide a key transit connection with the existing Red and Blue LRT lines. Although not yet approved by City Council, the evaluation of the Centre City segment has determined that the optimal approach for connecting the Green Line to the Centre City is via a tunnel under the Bow River and under the downtown core. This portion of the alignment must be completed as a continuous construction project to provide the best cost efficiency.

7.6 STAGING OPTIONS

Core infrastructure: Beddington to Shepard

This core section would extend from the Beddington station in the north, cross into the Centre City via twin bored tunnels, and terminate at Shepard station (adjacent to the Maintenance and Storage Facility). The total length of this section would be 26.5 kilometres.

The City of Calgary has determined that Beddington would be the most viable southern-most staged terminus location for the north segment of the Green Line. This ensures that the Green Line captures an acceptable amount of the north ridership while balancing operations and maintenance costs of feeder bus service until such time as the Green Line could be built out to the Keystone terminus.

If the core section was constructed initially, staging options could include the following extensions:

Beddington to North Pointe Extension

Extending the Green Line to North Pointe results in both operational benefits as well as increases Green Line accessibility for customers. Benefits of reaching North Pointe include:

- Public transit connection to a regional high school, regional recreation centre, library, and commercial employment destination

- Park and Ride facilities are in place at North Pointe which benefits local and regional commuters

- Reduced operational costs of running buses down Centre Street

Shepard to Seton Extension

The benefits of reaching Seton include:

- Serves existing and future ridership in southeast communities
- Provides connection to regional health centre, and a mixed-use Town Centre
- Better serves regional customers

North Pointe to Keystone (160 Avenue N) Extension

Extending the Green Line to Keystone results in both local and regional benefit.

- Provide primary transit service to the Livingston Town Centre area, north of Stoney Trail
- Enable a transit corridor linkage north to Airdrie
- Potential for additional Park and Ride stalls

7.7 DESIGN OPTIMIZATION, STAGING AND VALUE ENGINEERING

Opportunities to scope the Green Line to manage cash flow and available funding can be achieved through staging and/or through value engineering. For the purposes of the Green Line LRT project, the term "staging" refers to the following:

- Deferring certain elements of the project to a later date. Work is deferred, but not eliminated from scope. The cost savings for a staging opportunity which is related to a deferral of an element must consider the initial up-front capital cost of works which will be included to allow for the full element to be implemented at a future date.

For the purposes of the Green Line LRT project, the term "value engineering" refers to the following:

- Deletion of certain elements from the project scope. This scenario distinguishes itself from staging, in that an element can be permanently deleted or replaced by a more cost effective solution in the scope. The option to reintroduce this element into the project scope at a later date is not included or facilitated in this approach.

Value engineering will be explored to ensure the initial funding is used wisely, to the benefit of all Calgarians. Value Engineering opportunities for the core infrastructure (Beddington to Shepard), are provided in Table 7.7.1 to help evaluate the opportunity to bridge the gap in current available funding or help make a case for additional funding to be secured.

TABLE 7.7.1 Green Line value engineering opportunities

| OPPORTUNITY	DETAILS	CATEGORY
Defer Construction of 72 Avenue N station	Station can be built at a later date.	Staging
Defer Construction of 64 Avenue N station	Station can be built at a later date.	Staging
Combine 16 Avenue N and 9 Avenue N stations into one single underground station (serving both areas)	Permanent solution, no future construction or deferral.	Value Engineering
Defer Construction of 2 Avenue SW (Eau Claire) station	Station can be built at a later date. As this station would be built in the future, the shell of the station would be included in initial construction. Assume deferral/savings of 40% of total cost.	Staging
Defer Construction of Centre Street S station in the Beltline	Station can be built at a later date. As this station would be built in the future, the shell of the station would be included in initial construction. Assume deferral/savings of 40% of total cost.	Staging

7.8 OPERATIONAL SUSTAINABILITY

In 2011, City Council established a target that Calgary Transit operate with a revenue to cost ratio of 50% or better. That means that a minimum of half of the cost to operate the system would be recovered by the fares that riders of the system are charged. The fares are augmented by advertising and Park and Ride revenue.

Calgary Transit has consistently met or exceeded the Revenue/Cost (R/C) target in recent years.

Looking forward, the Green Line LRT system is forecasted to cost between $69 to $95M to operate. The range of the estimate is dependent on decisions, which will be made by end of the second quarter of 2017, to define the design and extent of the first stage of construction. Based on R/C targets the City's net operating budget for Calgary Transit is estimated to increase by $35 to $48M to cover new costs. Calgary Transits operating budget before revenue is approximately $440M so the Green Line represents an approximate 16 to 22% increase in the gross operating budget.

NOTE: *The forecasted Calgary Transit operating cost is based on projected Transportation Department and Calgary Transit operating cost extrapolated 2012 & 2013 actual costs and forecasted expenditures for 2014-2018. Calgary Transit is assumed to account for 54% of the Transportation Department's operating costs.*

8
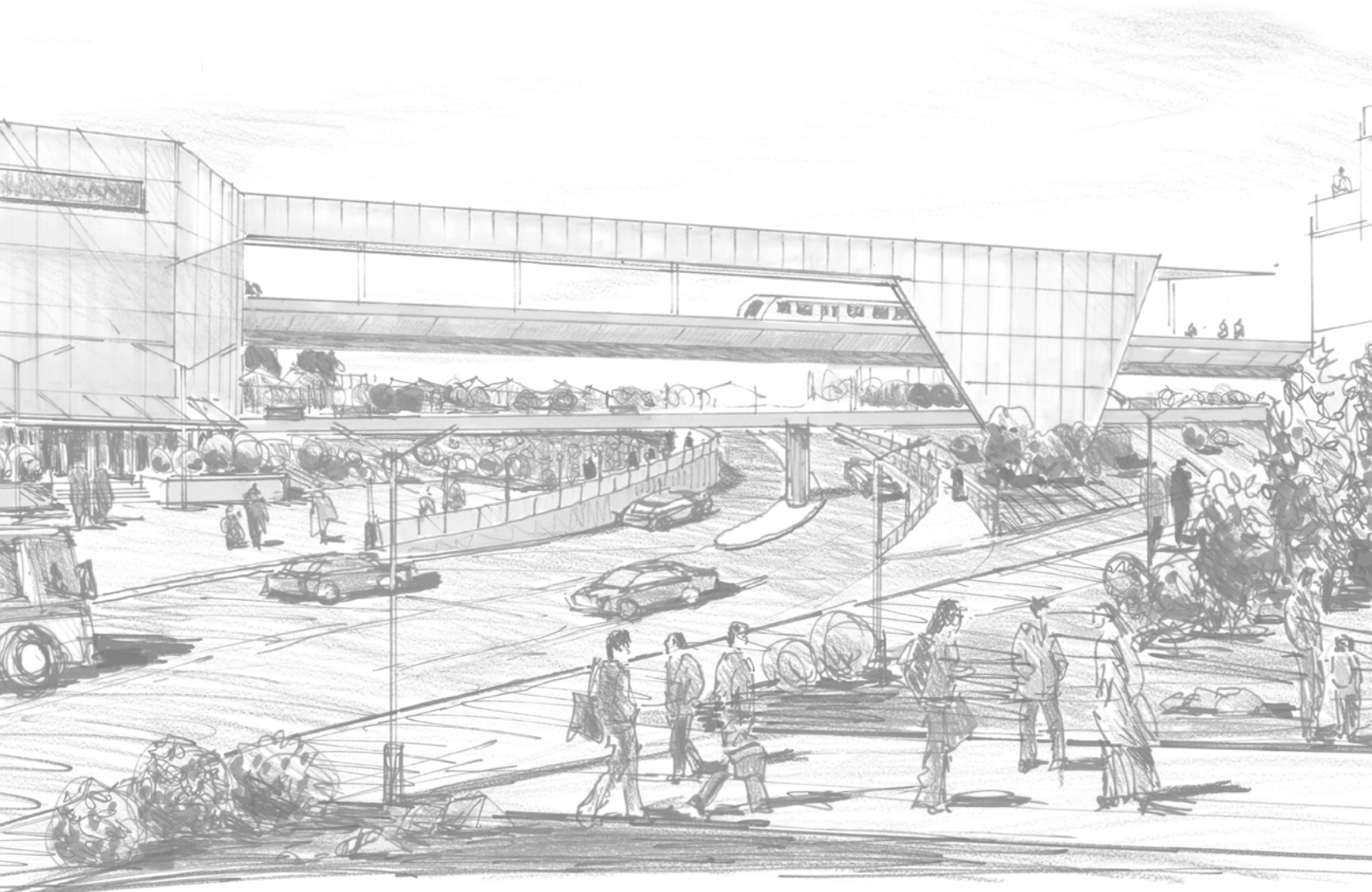
Project Risks & Mitigation

8.1 QUANTITATIVE RISK-BASED APPROACH

The Green Line is using a quantitative risk based approach to determine project contingency and manage project risks and opportunities. The approach is designed to categorize project risks into four risk response categories of Avoidance, Reduction, Transfer and Retention. This will be achieved by means of a formal systematic risk management approach that makes use of subject matter experts, workshop sessions, risk registers and risk simulation software to qualitatively and quantitatively assess and evaluate project risks.

The highest severity risks for this project are considered to be property, scope change, design, construction and management. A project of this magnitude has a number of risks that will need to be managed. Through this analysis, it was determined that all risks can be mitigated through the expertise of the design team, and through the selection of the contracting strategy.

Identification of risks were assessed for potential impact and probability in qualitative (numeric ranges) or quantitative (specific dollar amount or duration) terms. The probability/likelihood scale and the consequence/severity scale, are shown in tables 8.1.1 and 8.1.2.

TABLE 8.1.1 Risk probability likelihood scale

	PROBABILITY / LIKELIHOOD		SCALE
5	Very High / Probable	Likely to happen more than once during project execution	90% to 100%
4	High	Likely to happen at least once during project execution	70% to 90%
3	Moderate	Could happen during project execution	30% to 70%
2	Low	Unlikely to happen during a single project execution	10% to 30%
1	Very low / Improbable	Unlikely to happen during repeated project executions	< 10%

TABLE 8.1.2 Consequence severity impact scale

	1 VERY LOW	2 LOW	3 MODERATE	4 HIGH	5 VERY HIGH
Cost Impact	< $500K	< > $500K - $5M	< > $5M - $10M	< > $10M - $50M	> $50M
Schedule Impact	Days	Weeks	Months	1 to 2 years	> 2 years
Reputational Impact	*Negligible lack of confidence or harm to reputation;* *No media coverage or interest, business as usual, restricted to internal communication only.*	*Minimal lack of confidence or little harm to reputation.* *Limited negative media coverage – local news, short term interest and targeted internal communication.*	*Moderate lack of confidence or noticeable harm to reputation.* *Negative media coverage – one off.*	*Major lack of confidence or material harm to reputation.* *Negative media coverage over several days.*	*Long-term lack of confidence/harm to reputation;* *Sustained negative media coverage.*

The numerical severity and risk scores are listed in table 8.1.3 below. The risks were evaluated from 1 to 5, with the higher numbers representing greater risk.

TABLE 8.1.3 Green Line project risk, severity and probability

RISK	SCORE		
	SEVERITY	PROBABILITY	TOTAL
Property			
+ Property acquisition costs	5	5	10
+ Additional land required by proponent over and above right of way (PR2)	5	3	8
Scope			
+ Scope change – public stakeholders	5	5	10
+ Environmental scope increase	5	5	10
Design			
+ Risk associated with errors and/or omissions In the project design	4	4	8
Construction			
+ Construction delays caused by public sector	5	4	9
+ Integration risk	4	5	9
+ Labour and material availability	4	4	8
+ Utilities relocation	4	5	9
+ Damage by Contractor to third parties	4	4	8
+ Disputes between Contractor and The City	3	5	8
Management			
+ Project management / integration / delay of construction procurement is not managed efficiently	4	4	8

Risks shown below are categorized based on pre-determined financial thresholds. Risks that carry a higher financial impact to the project receive a higher total score in the analysis. Associated sub-categories of each risk, severity, probability and potential mitigation measures are described below.

1. Property

There is a risk that actual land costs may exceed the estimates. Increase in costs are attributed to two main factors, (1) cost of individual parcels exceeding estimated cost, and (2) updates to design requiring additional land.

Cause 1: Cost of individual parcels exceeding estimate

The actual cost of acquiring property has the potential to be greater than anticipated by the project. Increased cost of individual parcels would result in the costs of the properties exceeding their associated allowance. The risk of increased acquisition cost has been mitigated by the creation of a Green Line Land Acquisition Strategy. As part of this plan, land acquisition for all parcels along the Green Line was approved on June 2016. The probability of property acquisition costs exceeding the budgeted allowance is very high, hence the score of 5. Preliminary evaluations estimate that an increase in acquisition costs have a high probability to be above the budgeted cost. This may result from increased costs associated with buildings or businesses on the land and/or a shift in the Calgary real estate market during the land assembly time period. The risk will continue to be mitigated through ongoing negotiations and/or expropriations. Additionally for high risk parcels of land, alternative alignments will be investigated to relocate the alignment to more cost effective land.

Cause 2: Updates to design requiring additional land

Updates to the design by the contractor may result in additional land requirements not identified in early phases of design. Additional land requirement could result in a delay and/or increase in cost for the purchase of land. The risk is assumed to have a moderate probability of occurrence but increase in acquisition costs up to $50 million above the budgeted cost. This risk will be mitigated by applying The City's experience identifying right of way requirements and defining the alignment of the project at the Request For Proposal (RFP) phase of the project.

2. Scope change

There is a risk for project costs to increase due to scope change before and during construction. Due to the large size of the project, any major scope change before and/or during the construction period has the potential to increase the engineering, design and construction costs by over $50 million. Changes in scope are anticipated to be caused by both (1) changes in political and/or technical requirements and (2) change in scope due to environmental remediation or protection.

Cause 1: Public and/or technical requirements

The City may require a change to project scope before or during construction. These could be caused by public, political and/or technical factors not known at the time of early phases of design. The result is a potential increase to engineering, design and/or construction costs. Due to the long project delivery timeline, there is a high risk of changing and unforeseen policy and stakeholder decisions.

In order to mitigate this risk, The Green Line project has started public engagement very early in the process and is working towards a lockdown of project scope elements. Engagement for the project began with studies in the 1980s and continued through functional design updates and the preliminary design process from 2011 until present time. Previous projects have shown that continued communications and engagement between the design and construction phases will decrease the risk of design changes.

Cause 2: Environmental remediation and protection

Environmental remediation and protection scope may increase due to two main reasons: (1) as the project progresses in design detail, additional environmental remediation is identified and/or (2) changes in design initiated by the contractor result in environmental scope change. The effect of the scope change would be an increase in cost and a potential delay in project timeline. It is estimated that additional costs incurred may be upwards of $50 million and delays could hold up completion of the project by two (2) years. The probability of occurrence is also high due to the large size and degree of complexity of the project.

In order to mitigate this risk The City is in the process of completing Phase I Environmental Impact Assessment, Phase II Environmental Impact Assessment and Biophysical Impact Assessment as part of the pre-design process. These studies will be used to create a soil and groundwater management plan. The risk of increased environmental remediation and protection will also be mitigated by creating contractual incentives for sharing scope change.

Phase I Environmental Impact Assessment (EIA)

Consists of site visits, reports and records review of potentially contaminated sites.

Phase II Environmental Impact Assessment (EIA)

Soil and groundwater sample analysis.

Biophysical Impact Assessment (BIA)

Assessing environmentally sensitive and ecologically diverse areas in order to reduce construction impacts upon them.

Soil and Groundwater Management Plan

Plans and procedures for handling and disposing of excavated soils, groundwater and the monitoring and procedures for air management

3. Design

Cause 1: Errors or omissions in the project design

Errors and/or omissions in the project design may arise due to lack of coordination between designers. The design errors would require re-design and an increase in costs to pay for the additional work. It is estimated that extensive re-work could increase the cost of the project by $10-50 million. This risk has a relatively high probability of occurrence due to the project's large scope, high degree of complexity and extensive design interfaces. This risk will be mitigated by transfer to the engineer or contractor and managed through process controls and insurance.

4. Construction

Cause 1: Construction delays caused by public sector

Construction or commissioning delays may be caused by public sector influence (ie. The City, Project Team and other public sector stakeholders). These delays may be attributed to government approvals, certifications, delays due to scope changes, and commissioning. It is estimated that these delays may set the project back by up to two years. Based on The City's previous experience, construction delays caused by the public sector are common. This risk will be mitigated by early completion of preliminary design and permit applications, and efforts to build project knowledge with key approval bodies such as Alberta Environment.

Cause 2: Integration risk

There is a risk that the LRT system does not perform optimally due to poor integration of components. Systems at risk include LRV-track interface, LRV-station integration, electro-magnetic interference, safety, lighting, signaling and power distribution systems. The lack of integration may be caused by sub-optimum design and/or construction component by component rather than as a whole.

If the LRT system performs sub-optimally, the resulting effect would likely be a loss of reputation and costs required to correct the design. Additional costs are estimated to be between $5-50 million if multiple components of the system need to be corrected or replaced. It is assumed that this risk has a very high probability of occurrence, due to the large project scope, associated number of system components, and size of the project in comparison to previous projects executed by The City. This risk can be mitigated by transferring it through selection of delivery model.

Cause 3: Labour and material availability

Risks associated with labour material and availability include: labour and materials not being readily available in required quantities, a lack of suppliers for the required goods and a highly competitive construction market (e.g. The City may be required to import labour or pay more for materials due to an overall shortage in the Alberta market. These risks are likely to result in delays to the project schedule and/or increased cost of acquisition. If there is a constrained supply of labour and materials due to a highly active construction market, delays and escalated costs could increase the project budget by $5 to $50 million.

It is highly probable that this risk will occur because there are many North American LRT projects, and other major infrastructure projects, anticipated to be delivered at the same time. Projects expected to be constructed concurrently with the Green Line include the Surrey LRT and Hamilton LRT projects, and secondary stages of Ottawa and Edmonton LRT lines. In order to mitigate this risk, the project will undertake market soundings in advance of procurement and re-evaluate level of contingencies. Labour supply risk is low at this time and can be mitigated by The City's defined completion date.

Cause 4: Utilities relocation

Poor co-ordination with utility providers, construction problems, unanticipated soil or environmental condition and/or insufficient incentive for the contractor to mitigate risks could result in cost increasing above the budgeted amount, a delay in construction or requirement of the contractor to accelerate construction. It is assumed that if this risk occurs, the schedule could be delayed by over two years and/or costs increased by over $50 million. The risk of cost and schedule increase due to utility relocation will be mitigated by early completion of utility studies, relocation and protection of utilities prior to award of contract.

Cause 5: Damage by contractor to third parties

Damage to third party property may be incurred by the contractor during the construction process. The potential results include an increase to project costs required to compensate for the damage, schedule delays should the damage hinder access to the construction site, or schedule delays and cost increases due to lawsuits from a third party. Incidents resulting in litigation are estimated to delay the schedule by approximately one to two (~1-2) years and have the potential to increase the budget by $10-50 million depending on the extent of the damage. This risk is assumed to have a high probability of occurrence due to the magnitude of the project. The risk is to be mitigated by transference via contractual and insurance provisions, and through applying resources to support businesses during adjacent construction.

Cause 6: Disputes between contractor and The City

Disputes may arise between the contractor and The City due to disagreements related to interpretation of the contract, lack of sufficient detail or conflict in consultant drawings. The result of these disputes would likely be delays and increased costs. Cost increases are estimated to be between $3-10 M but would depend on the number of disputes that arise. Delays are not expected to have as great of an effect on schedule because construction would continue despite ongoing disputes.

It is highly probable that this risk would occur based on The City's previous experience in delivering major capital projects. In order to mitigate this risk, The City will assign an appropriate level of contingency for potential litigation which is equal to approximately $50-150 million, or roughly 1- 3% of the project cost. The City will also design a robust dispute resolution process and perform a detailed review of contract documents. Risks can also be mitigated through the selected delivery method.

5. Management

Cause 1: Poor internal management of interfaces

Inefficient management of the project interfaces during construction have the potential to yield higher project costs and cause delays in schedule. It is estimated that costs could increase from $10-50 million and may delay the construction schedule by over two years. Construction delays may also be made more severe due to the limitations on construction during the winter. This risk has a high probability of occurrence due to the significant number of interfaces.

This risk could be mitigated by transferring it to a third party via an alternative procurement model and/or implementation of a new governance structure that reduces the number of design reviews required by The City.

9

Funding

9.1 FUNDING AND FINANCING SCENARIOS

The Provincial and Federal governments have been instrumental in the success of Calgary's past LRT projects. Projects of the scope and size of the Green Line can only be accomplished with the participation of all levels of government: municipal, provincial and federal.

At time of writing, full commitment and details of funding the Green Line are yet to be established, particularly the total funding that would be made available and the timing. A number of scenarios have been developed to inform stakeholders of the magnitude of funding choices. These are developed as a reference for discussion, and do not imply any commitments or recommendation.

It is the desire for the City of Calgary to be funded over 10 years in order to match the construction timeline and to minimize the financing costs as shown below. Figures 9.1.1 and 9.1.2 compare how much annual funding would be required for a given capital expenditure over 10, 20, or 30 years, with varying Municipal, Provincial and Federal contributions.

BASED ON:
Equal contributions by Federal, Provincial & Municipal Government

Required annual funding to deliver within 10 years ($ Millions)

$4.5 BILLION CAPITAL EXPENDITURE

GOVERNMENT		Federal	Provincial	Municipal	TOTAL INTEREST PAYMENTS INCLUDED
FUNDING SHARE		33.3%	33.3%	33.3%	
Annual Funding Over:	10 Years	152	152	152	51
	20 Years	88	88	88	785
	30 Years	69	69	69	1,670

Required annual funding to deliver within 10 years ($ Millions)

$6 BILLION CAPITAL EXPENDITURE

GOVERNMENT		Federal	Provincial	Municipal	TOTAL INTEREST PAYMENTS INCLUDED
FUNDING SHARE		33.3%	33.3%	33.3%	
Annual Funding Over:	10 Years	202	202	202	67
	20 Years	117	117	117	1,047
	30 Years	91	91	91	2,227

Required annual funding to deliver within 10 years ($ Millions)

$7 BILLION CAPITAL EXPENDITURE

GOVERNMENT		Federal	Provincial	Municipal	TOTAL INTEREST PAYMENTS INCLUDED
FUNDING SHARE		33.3%	33.3%	33.3%	
Annual Funding Over:	10 Years	236	236	236	78
	20 Years	137	137	137	1,222
	30 Years	107	107	107	2,598

NOTE:
1. Project size reflects total capital expenditures and does not include any debt servicing costs.
2. Assumes 10 year construction spend profile.
3. Ten year construction period starts in Year 1.
4. Cash funding from all three levels of government begins simultaneously in Year 1.
5. ACFA financing (i.e. amortizing loans) utilized each year there is a cash deficit during the construction period and fully repaid by the end of the funding period.
6. Interest costs reflect an updated ACFA interest rate forecast as of June 15, 2016.

One of the key variables greatly impacting overall cost of the project is the time span over which funding is made available. Funding spread out over longer periods (20 or 30 years) significantly erodes the overall funding available for a 10 year construction due to debt servicing costs and the time value of money.

A refined project cost estimate for Green Line is under development as part of this phase of functional planning work. Cost estimate refinements will be primarily related to the Green Line Center City and the Green Line North segments, as additional design information becomes available.

The impact of borrowing costs is expected to reduce the available budget for construction by approximately one third of the cost of the project depending on the timeline and cost (specific interest rates) of borrowing. Staging options that meet the available funding will be provided.

FIGURE 9.1.2 Required annual funding to deliver within 10 years ($ Millions) - weighted contribution

BASED ON:

50% Federal contribution

25% Provincial contribution

25% Municipal contribution

Required annual funding to deliver within 10 years ($ Millions)

$4.5 BILLION CAPITAL EXPENDITURE

GOVERNMENT		Federal	Provincial	Municipal	TOTAL INTEREST PAYMENTS INCLUDED
FUNDING SHARE		50%	25%	25%	
Annual Funding Over:	10 Years	228	114	114	51
	20 Years	132	66	66	785
	30 Years	103	51	51	1,670

Required annual funding to deliver within 10 years ($ Millions)

$6 BILLION CAPITAL EXPENDITURE

GOVERNMENT		Federal	Provincial	Municipal	TOTAL INTEREST PAYMENTS INCLUDED
FUNDING SHARE		50%	25%	25%	
Annual Funding Over:	10 Years	303	152	152	67
	20 Years	176	88	88	1,047
	30 Years	137	69	69	2,227

Required annual funding to deliver within 10 years ($ Millions)

$7 BILLION CAPITAL EXPENDITURE

GOVERNMENT		Federal	Provincial	Municipal	TOTAL INTEREST PAYMENTS INCLUDED
FUNDING SHARE		50%	25%	25%	
Annual Funding Over:	10 Years	354	177	177	78
	20 Years	206	103	103	1,222
	30 Years	160	80	80	2,598

NOTE:
1. Project size reflects total capital expenditures and does not include any debt servicing costs.
2. Assumes 10 year construction spend profile.
3. Ten year construction period starts in Year 1.
4. Cash funding from all three levels of government begins simultaneously in Year 1.

5. ACFA financing (i.e. amortizing loans) utilized each year there is a cash deficit during the construction period and fully repaid by the end of the funding period.
6. Interest costs reflect an updated ACFA interest rate forecast as of June 15, 2016.

Providing funding over shorter timelines considerably reduces financing costs, resulting in more funding going directly to the Green Line.

The eligibility to use the Federal and Provincial funds for project assets such as Land Acquisition and Rolling Stock could have a major impact on overall availability of funding if the City of Calgary has to fund these two elements independently over and above the matching funds. As identified in the risk analysis, land acquisition will be a significant consideration. As such, two elements could have a significant impact on the City of Calgary 's ability to implement the Green Line, especially considering that land acquisition is required prior to construction start.

Further discussions on eligible uses for funding and distribution timelines will be important to determine feasible implementation strategies and overall project timelines.

9.2 INTERACTION WITH FUNDERS TO DATE

In July 2015, the Federal Government announced up to $1.53 billion in funding for the Green Line Light Rail Transit project. At this time, there are ongoing conversations with the Federal and Provincial Governments regarding funding timelines.

To allow the Green Line project to continue to move forward, the following funding applications have been made:

- The GreenTRIP Third Call funding application associated with this business case asks that $105 million funding be allocated to Calgary. The second part, should any of the GreenTRIP Third Call funding for regions outside the Calgary and Capital regions ($294 million) remain unallocated, the City has asked that the Green Line project be considered for that funding as well, as a way of narrowing the overall funding gap within existing Provincial funding availability.

- Initial Federal funding has been applied for under the Public Transit Infrastructure Fund – Phase 1 in the amount of $111 million for Green Line. There will be ongoing discussions regarding Phase 2 of the Federal funding.

9.3 NEXT STEPS FOR FUNDING

Assuming each level of Government (Federal, Provincial and Municipal) provide equal/matching levels of funding, based on previous funding announcements, it is assumed that the first phase of Green Line will have $4.59 billion in funding. The financing details related to each level of funding are however unknown as conversations with all levels of government are ongoing.

It is important to emphasize the commitment of The City of Calgary to adjusting the implementation strategy to accommodate available funding and stage the implementation of Green Line in a way that will maximize this investment. This business case is meant to show benefits of the Green Line in order to show the full picture of this project and begin a discussion regarding funding and implementation options.

10

Contracting Strategy & Delivery Model

10.1 DELIVERY METHOD ASSESSMENT

The City of Calgary is currently evaluating Contracting Strategies and Delivery Models to determine which approach will provide the best value to citizens. The City is considering the entire spectrum of procurement models including Traditional and Alternative Delivery Methods. Listed below are potential options for the first of the two scenarios.

TABLE 10.1.1 Traditional and alternative delivery methods

TRADITIONAL DELIVERY METHODS	ALTERNATIVE DELIVERY METHODS
• Design-Bid-Build (DBB)	• Design-Build-Finance (DBF)
• Construction Management (CM)	• Design-Build-Finance-Maintain (DBFM)
• Integrated Project Delivery (IPD)	• Design-Build-Finance-Vehicle-Maintain (DBFVM)
• Construction Management at Risk (CM @Risk)	• Design-Build-Finance-Operate-Maintain (DBFOM)
• Design-Build (DB)	• Design-Build-Finance-Vehicle-Operate-Maintain (DBFVOM)

In accordance with Calgary's Corporate Project Management Framework and other City procurement policies, The City has been following the process outlined in Figure 10.1.1 to compare and contrast Alternative Delivery Methods. The initial project screen, completed in September 2015 evaluated the potential value of an Alternative Delivery project and recommended further consideration. The subsequent Strategic Assessment will provide The City with an assessment of the various Traditional and Alternative Delivery models. The final input to the Contracting Strategy is the completion of a Value for Money Assessment which will lead to a recommended Delivery Model for the project.

FIGURE 10.1.1 Delivery method assessment process

DELIVERY METHOD ASSESSMENT

INITIAL PROJECT SCREEN → STRATEGIC ASSESSMENT → VALUE FOR MONEY ASSESSMENT

The Strategic Assessment will bring together detailed case study investigations, a market assessment, qualitative risk assessment and delivery model options. This assessment will recommend if the project should consider an Alternative Delivery Method, and if so, which Alternative Delivery Method is most suitable.

Qualitative criteria to be considered in the Strategic Assessment include:

- Total Project Cost Certainty & Efficiency
- Lifecycle Approach
- System-wide Operational Integration
- User Perspective
- Operational Flexibility
- System Scalability
- On-time Delivery
- Design & Construction Risk Allocation
- Design Flexibility
- Capacity & Oversight for Administering Contract
- Operational Risk Allocation

The recommended contracting strategy will be presented to City Council in June 2017. This recommendation will include the Strategic Alignment (Municipal / Provincial / Federal) and Opportunity/Risk Assessment in addition to the Value-for-Money Analysis.

11

Conclusions &
Recommendations

11.1 AN INVESTMENT IN THE FUTURE OF CALGARY

An investment in the Green Line is an investment in Calgary's future as an environmentally responsible, economically resilient, socially equitable, and culturally vibrant city.

The Green Line is a platform for change. Transit Oriented Development along the line will shape future growth and development in the city, creating more compact, mixed-use communities that support active and affordable lifestyles.

To allow the Green Line to continue to move forward, The City of Calgary has applied for GreenTRIP third call funding for the amount of $105 million, and PTIF Phase 1 funding in the amount of $111 million. Additionally, The City has asked that the Green Line project be considered for any remaining Provincial GreenTRIP funding.

In support of Calgary's application for GreenTRIP funding, this business case has been prepared to give a full picture of this project and demonstrate the benefits of investing in the Green Line.

While the full City Shaping benefit of the Green Line will only be realized once the entire alignment is constructed, there is significant benefit in investing in a staged approach to delivering the project. Through strategic staging decisions, The City will work with the Province and Federal Government to determine how to maximize each part of this investment.

This business case is meant to be the foundation for future discussions regarding full funding and implementation of this project. The funding available for the first phase is estimated to be $4.59 billion. The City of Calgary looks forward to ongoing conversations with all levels of government to determine how to best work together to deliver the Green Line.

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Green Line LRT
Business Case: Appendix

Contents

A

A1. Economic Benefit Analysis
Hatch

Calgary Green Line

Business Case
Analysis

HATCH

THE CITY OF
CALGARY

Contents

Executive Summary

Investments in light rail have proven to show lasting economic benefits in the communities they serve. Hatch reviewed existing economic studies, reports and models of the economic impacts of light rail systems across North America. This analysis found compelling and substantiated quantitative evidence of the benefits generated from light rail systems. While the magnitude of economic benefits varied by system, urban characteristics and area congestion, this analysis finds that urban areas consistently benefit from light rail throughout economic sectors and demographics.

The core economic benefits areas include:

Direct and indirect economic injection of the light rail system during its construction and ongoing operations

Improvements in worker productivity associated with reduced commutes and increased dependability

Increases in property values for those properties directly served by a robust and efficient transit system and the development inducement and additional spending created within the station areas

Reduction in transportation costs for commuters converting from personal vehicle use to light rail use and the corresponding savings for households

Increased attractiveness to employers that value accessible and livable urban communities, resulting in increased economic diversification

The corresponding City and Province tax revenues due to the growth in income and property values as well as the savings in municipal services associated with more-compact development enabled by the Green Line LRT. [1]

Other Economic Benefits. In addition to these core positive economic attributes, the City and the Province gain additional public benefits not currently estimated in this economic chapter. Academic research indicates that alternative modes of transportation, combined with compact development, can lead to healthier (i.e. more physically active) communities than lower density, auto-dependent communities. There also health gains associated with improved air quality, due to lower automobile emissions. These health benefits result in lower health care expenditures and increased worker productivity. These benefits are *not* enumerated in this chapter but still contribute to residents' overall well-being. The remainder of this chapter provides a brief explanation of the enumerated core economic benefits to Calgary and the Province of Alberta.

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[1] The City of Calgary has a "revenue neutral municipal tax policy" which means that the property tax rate is adjusted for taxpayers citywide based on what it needs. As such, any property tax rate increase within the transit nodes would essentially offset/discount property owners in other areas of the City.
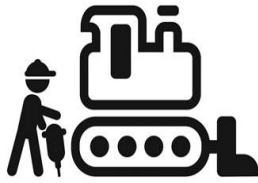
Construction and Operations: Direct and Indirect Economic Impacts

Calgary Corporate Economics (Corporate Economics) has developed an economic evaluation tool that considers the direct and indirect impacts of local investments or policies to metropolitan area GDP and employment. The calculations for the project were prepared with the aid of a multi-sector economic forecast model of the Calgary economy (C4SE) and an Input-Output (IO) model for the Calgary Economic Region. Using the economic forecast model, Corporate Economics estimated the annual economic impact of the Green Line LRT project on the Calgary Metropolitan Region, based on a $5 billion in capital investment and 30 years of approximately $20 million in ongoing operation expenditures (results in

Table 1). These estimates show that the Green Line LRT project will have a positive net economic impact (shock scenario minus base scenario) on the city's economy over a 30-year period. Investment in the Green Line will provide a short-term stimulus in the construction phase and then generate long-term economic benefits to the region.

Green Line Construction investment	Construction Year										
Investment Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Totals
Distribution of Investments less Land Purchases	$20	$30	$207	$567	$907	$907	$897	$717	$277	$73	$4,602
Inflated Investment Costs (2% per year)	$20	$31	$220	$614	$1,001	$1,021	$1,030	$840	$331	$89	$5,198
Construction Investment Distribution over time	0.4%	0.6%	4.2%	11.8%	19.3%	19.7%	19.8%	16.2%	6.4%	1.7%	100%
Machinery & Equipment (ME) Purchases				190	190	190	180				750
M&E Inflated				206	210	214	207				836
M&E Share of Investment				24.6%	25.1%	25.6%	24.7%				100%

Table 1: Green Line Construction Investment Schedule

Employment Impacts.

The Green Line LRT will create more than 20,000 direct and indirect jobs[2] from 2017 to 2026. Under the Calgary Corporate Economics model, the construction phase of the Green Line (2017-2026) will average approximately 1,200 jobs annually in construction (direct employment) and another 800 annually in the supply chain (indirect employment). Another 4,500 "induced" jobs will be generated annually from the additional spending and net-migration of the direct and indirect workers. In total, the construction phase will increase area employment by approximately 6,500 jobs per year. Direct investment is projected to slow after 2026, when the Green Line expenditures shift from capital spending to operation spending, averaging 850 direct, indirect, and induced jobs per year, post-construction. Over the entire 30-year evaluation period, the annual average employment gain is estimated at 2,600 jobs per year.

[2] "Direct employment" in the model refers to the job creation associated with the construction process as well as maintenance and operations. "Indirect employment" refers to the additional jobs and wages produced in order to service and provide for the direct jobs, as the $5 billion enter and ripple throughout the regional economy. Jobs are presented in job-years. In other words, one full time employee working for two years would count as two jobs, or two full time employees working for 6 months would count as one job.

Green Line will create more than 20,000 direct and indirect jobs from 2017 to 2026.

GDP Impacts.

In the timeframe of the Input Output analysis (2016-2046)[3], the Green Line LRT will create approximately $15.6 billion in additional real gross domestic product within the Calgary Metropolitan Area, with approximately $11.1 billion realized during the construction phase and $4.5 billion during the operations phase (estimated in 2016 dollars). This economic injection amounts to approximately 15 percent of Calgary's GDP in 2015. To put this in perspective, that amount equates roughly to Calgary's entire manufacturing, wholesale trade and retail trade sectors in 2015 (i.e.13 percent of total Calgary GDP or approximately $14.5 billion), or the Province of Alberta's entire public administration sector in 2015 (i.e. approximately $15.3 billion).

Productivity Gains

The development of the Green Line LRT corridor is expected to increase worker productivity on three fronts.

1. It will save time for current transit commuters by either making their current trips shorter, their transfers more efficient, or both.

2. The faster and more reliable system is poised to attract new riders, either providing a shorter commute during peak hours and or saving them the operational expenses of their private vehicle.

3. It will reduce traffic by shifting mode share in the Calgary network during peak morning and evening hours, cutting congestion and saving time for non-transit commuters as well.

In short, a more efficient and reliable commute makes workers, and therefore businesses, more productive. Full traffic modelling of how the Green Line will impact congestion is underway but not available for this analysis. Rather, the City is able to estimate the approximate net travel time benefits to transit commuters travelling to the Central Business District. Preliminary estimates indicate that once the Green Line begins operation, approximately 200,000 daily riders will see a reduction of up to 20 minutes per trip. The total annualized travel time savings for those Green Line riders in the first year alone will be 6,000 hours, or approximately $16 million in labour savings. The result is a present value benefit of $338,000,000 in the first 30 years of operations.[4]

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[3] *Note that Calgary Corporate Economics estimated economic benefits to 2046 only, based on a more-conservative 20-year amortization of the rail line. Those benefits are then converted to 2016 present value worth. In contrast, the overall benefit analysis aggregates benefits over 30 years of operations. Thus, the property value, increase in consumer spending and property taxes are estimated to 2056 and then discounted to estimate their present value benefit in 2016.*

[4] *Present value is defined as the current worth of future cash flow over time. Also referred to as the "discounted value", it represents the opportunity costs of investing current cash into other things, with future nominal values showing lower worth. Simply put, a dollar today is worth more than a dollar five years from now. In this case, a 2056 dollar is worth $0.31 in 2016 present value terms.*

Property Values

Calgary properties in proximity to the proposed Green Line Stations are likely to appreciate in value. Analysis of a range of economic research reports across North American cities indicates that the development of rail infrastructure creates an uplift in property values and in the corresponding property tax, especially where the transit station provides additional development capacity. This research suggests that increases in value are generally confined to properties within 600 meters of the light rail station or less than a 15-minute walk from a passenger's origin to the station. The percent appreciation also varies by land use, with retail and office uses typically realizing higher property value gains than residential uses.

Table 2 shows the growth projections due to the construction of the Green Line LRT. The percentage is amortized over a conservative 20-year period, since research shows price volatility during construction phases, when noise and increased traffic may cause temporary depreciation.

Property Type	Low Confidence Interval	Median Value Increase	High Confidence Interval
Retail	11 %	**33 %**	55 %
Residential	8 %	**13 %**	18 %
Office	5 %	**25 %**	45 %

Table 2: Green Line Property Expected Value Appreciation

To evaluate the potential gain in property uplift, team economists identified case studies that are relevant to Calgary and its LRT network based on population size, density and ridership. The estimates herein vary the property value gains based on the development inducement potential of each station area, as estimated by the Green Line LRT Multiple Accounts Evaluation Summary Report completed in May 2016. Those station areas with high TOD potential were assigned the highest property uplift rates and, conversely, those with low TOD potential were assigned the lower range of property value appreciation.

Based on the comparable studies, assessed property values along the Green Line LRT corridor will increase by approximately $4.7 billion by 2046. This represents approximately $1.9 billion in present value terms. Economic research indicates that the full property value gains are typically not realized immediately but are generated over time. The result is a gradual market response to improved access to transit (in this case, the full gains are assumed to not be realized until 2046).

Based on comparable studies of light rail's impact to property values, assessed property values along the Green Line LRT corridor will increase by approximately $4.7 Billion by 2046 which represents approximately $1.9 Billion in present value worth.

Increased Consumer Spending

Economists have identified a correlation between home appreciation and an increase in spending on non-durable goods.[5] Two reports from the University of Chicago found that every dollar of increase in home values resulted in approximately 2 to 9 cents of additional consumer spending in non-durable goods annually. These are estimated as one-time gains in consumer spending, resulting from the wealth generation of increased homeowner property values.[6] Conservatively assuming only 2 cents of additional non-durable goods spending per dollar of homeowner appreciation results in an average annual economic injection of approximately $800,000 in non-durable goods spending. This equates to approximately $16 million in additional spending from 2016 to 2056.

Research shows that every dollar increase in home values results in approximately 2 to 9 cents of additional consumer spending in non-durable goods annually.

Induced Development

The increased property values along the light rail stations can also induce higher-density development where zoning allows. The City is already undertaking town planning efforts to enable transit-oriented development near its proposed green line stations. Two recent market reports for the Green Line indicate that the Highfield and 9 Ave N stations are prime sites, capable of becoming transit villages that provide commercial and retail services and serve as job centers to surrounding communities.[7]

A 2015 TOD market study published by the City of Calgary specifies that while the Green Line LRT is not expected to unilaterally change the amount of new construction, it will become an important factor in influencing development patterns in the following decades. Specifically, the TOD study projects that 20,000 multi-family and semi-detached units will be constructed due to investment in the Green Line. This spike in more-dense construction in the coming decades marks a trend away from single-family detached homes, which currently make up 47 % of the building stock. Under the Green Line growth scenario, the TOD study estimates single-family homes will represent only 35% of homes in 2046.[8] This analysis does not quantify the direct economic benefits associated with the development induced through the Green Line.

Achieving 20,000 units of compact urban housing around the Green Line LRT yields a yearly savings of $5.5 million in operational savings for the city of Calgary by 2046.

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[5] Guerrieri, Lorenzoni, and Vavra, *Housing Prices and Consumer Spending, Berger,* University of Chicago, 2015. Mian, Sufi, and Rao, *Household Balance Sheets, Consumption, and the Economic Slump,* University of Chicago, 2013.

[6] The additional household spending is only applied to owner-occupied residential units within the 600 meter Green Line catchment areas.

[7] Ten Principles for Successful Development Around Transit, Urban Land Institute 2011.

[8] The City of Calgary "Market Opportunities for High Density Urban Development along the Proposed Green Line Southeast Transitway" February 2015.

Reduction in Household Transportation Spending

Households with access to available quality public transit typically spend less on transportation than households with fewer transit options. The Green Line LRT will reduce transportation costs for those households proximate to a Green Line station. Those households will be able to reallocate those savings to discretionary and non-discretionary expenditures (e.g. housing, retail spending, leisure spending). Initial calculations estimate approximately 13,000 households live within 600 meters from a planned station.[9] At an average estimated cost of $0.57 per kilometer (Canadian Revenue Agency), average household savings will amount to approximately $4,000 per household. This would result in approximately $1,000 in additional annual discretionary spending for each transit-proximate household based on existing household spending behavior. Initial calculations of these household savings demonstrate a net economic injection to Calgary equivalent to approximately $750 million (2026 – 2056).

Initial calculations estimate approximately 13,000 households live within 600 meters from a planned station. This would result in approximately $1,000 in additional annual discretionary spending for each transit-proximate household based on existing household spending behavior.

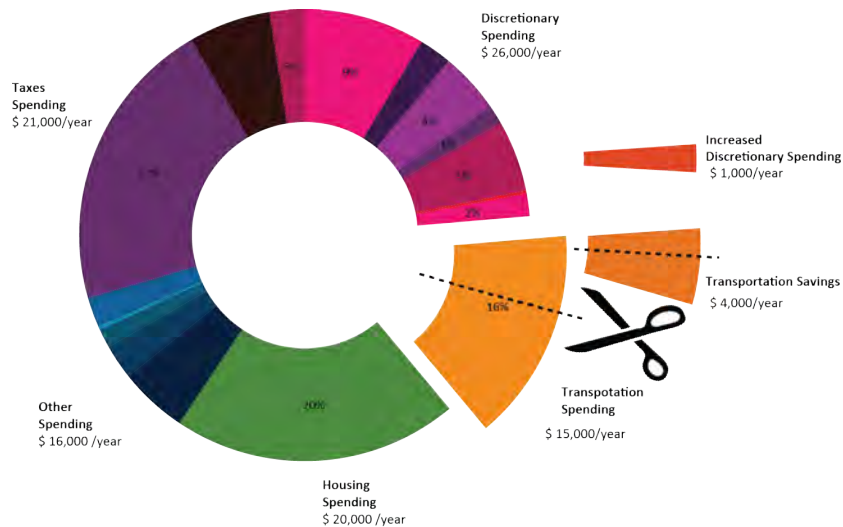*Figure 1: Alberta Household Spending Breakdown and Transportation Savings*

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[9] Perks, R. and C. Raborn (2013) "Driving Commuter Choice in America: Expanding Transportation Choices Can Reduce Congestion, Save Money and Cut Pollution", Natural Resources Defense Council Issues Paper, July 2013. Available at https://www.nrdc.org/sites/default/files/driving-commuter-choice-IP.pdf, accessed August 2, 2016.

Economic Diversification

There is both qualitative and quantitative evidence that denser, more transit-oriented cities draw higher concentrations of innovation, technology businesses, and multi-national corporations looking for high quality labour. This phenomenon dubbed as "economies of agglomeration" consist of innovations centering around dense cluster since these use public services more efficiently and facilitate economic and intellectual connections in the public realm. More-dense cities foster the exchange of ideas which leads to a more productive and innovative workforce. One specific study found that a doubling of population density increased per capita GDP by 10%.

Additionally, research of economic trends across different North American cities shows that transit-oriented commercial centers are gaining jobs, especially in high-skill sectors like knowledge-based industries, even as their share of total regional employment has declined for most industrial sectors during the last few decades. This is a result of young populations seeking dense multi-use cities with robust transit systems. Residents of urban areas are choosing more often to live in places that are "walkable, bike-able, and connected by transit and technology" (Katz & Wagner, 2014). What follows are companies in search of a quality labour force. Technology businesses specifically are attracted to "lifestyle cities" where highly amenitized cities are connected to available recreation and cultural activities are oriented towards its young population.

It is difficult to isolate quantitatively the impact of the Green Line and therefore the benefit analysis does not assign any GDP gains associated with the Green Line. However, it is reasonable to assume that advancing Calgary's light rail capacity can further economic diversification goals for Alberta and increase economic productivity in the region.

Doubling of population density can increases per capita GDP by up to 10%.

Taxes to the Province and to the City

Increased economic activity will result in additional sales and income tax to the City and the Province. The vast majority of increased revenue will be in the form of additional property taxes. However, the Province will also receive increased income taxes associated with the gain in personal income during the construction and operation of the Green Line (see 3.3.4.1). In addition, as part of a larger compact growth scenario, the Green Line will contribute to more-efficient deployment of municipal services. Under the current benefit estimates, the Province would gain approximately $1.9 billion in additional property and income tax in present value worth.

Property Taxes to Calgary and Alberta. [10]

A preliminary analysis of property values along the LRT corridor suggests the increase of property values result in significant gains in property taxes to Calgary and Alberta, estimated at approximately $630 million in present value dollars; approximately $450 million in property taxes will go the City and $180 million will go to the Province between 2016 and 2056. This is a fairly conservative prediction since it only considers existing developments in the catchment area and not induced development.[11]
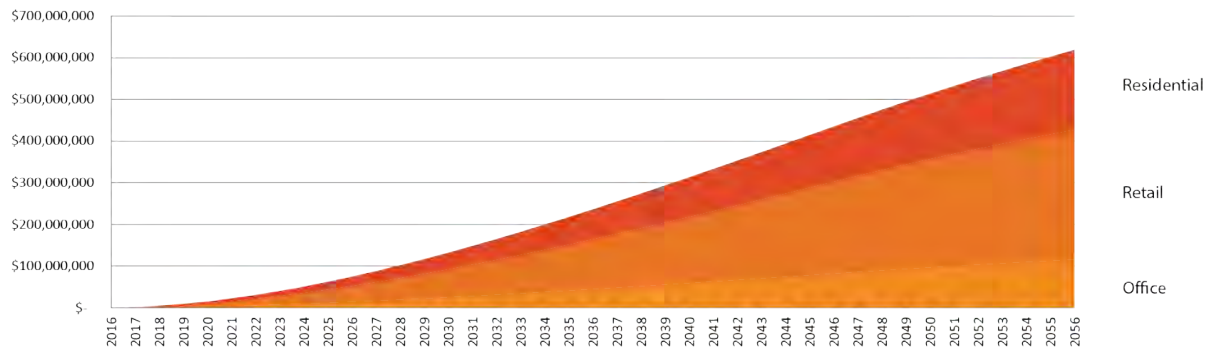

Figure 2: Calgary and Albert Property Tax Increase due to Green line

Income Tax Revenue.

As discussed previously, the Green Line will add approximately $15.6 billion to Calgary's GDP or $9.4 billion in personal income from 2016 to 2046. The GDP and personal income gains are specific to the construction and operation activities per Corporate Economics economic model. The increase in personal income recirculates to the Province in the form additional income tax, estimated at approximately $940 million during the same period.

Municipal Service Efficiency Gains from Compact Development.

Inducing more dense development can also have real quantifiable benefits to the City of Calgary and the finances of Alberta. A report by the Calgary planning department found that a more dense and interconnected Calgary would result in $11.2 billion municipal government savings over the next 60 years. Under the more compact urban development growth scenario –which includes the Green Line- Calgary would save 33% annually in its operational budget versus continuing the historic trend of suburbanization and outward expansion.[12] To put these numbers in perspective, achieving 20,000 units of compact urban housing (or 4 % of Calgary's current households) around the Green Line LRT yields a yearly savings of $5.5 million in operational savings for the city of Calgary by 2046.

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[10] The City of Calgary has a "revenue neutral municipal tax policy" which means that the property tax rate is adjusted for taxpayers citywide based on what it needs. As such, any property tax rate increase within the transit nodes would essentially offset/discount property owners in other areas of the City. This does not change the fundamental benefit of the property value lift from the Green Line and its corresponding impact on property tax revenues as the additional property tax helps to offset the cost of the Green Line. In other words, without the increases in property values along the transit corridor, Calgary property taxpayers overall would have to pay more property taxes to account for the increased costs of building and operating the Green Line.

[11] Avison Young. "A Commercial Real Estate Perspective on Public Transit &Transportation Infrastructure Investment in Metro Vancouver".

[12] City of Calgary "The Implications of Alternative Growth Patterns in Infrastructure Costs" 2009 IBI Group.

Cumulative of Economic Benefits

The Green Line LRT contributes to Calgary's economy and the Province overall in multiple ways:

- $15.6 billion net increase in GDP from the construction and operation of the Green Line, leading to approximately $900 million in additional Provincial income tax
- $1.9 billion increase in property values, resulting in $16 million in additional non-durable goods spending and $630 million cumulative increase in property taxes to Calgary and Alberta
- $338 million in worker productivity gains specifically to Calgary light rail commuters and not including the reduction in travel times from less congestion
- $640 million in household savings as a result of decreased transportation costs
- Improvements in Calgary's ability to attract talent and businesses through provision of transit and mixed-use villages.
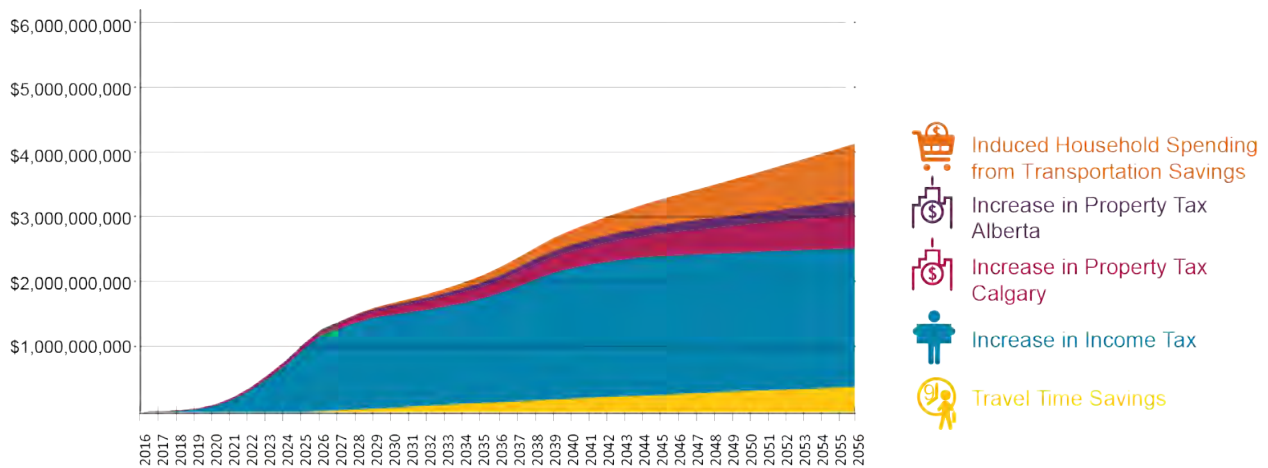

Figure 3: Cumulative Green Line Benefits Timeline

Technical Reports

Introduction

The following is the technical appendix of the Economic and Sustainability portion of the Calgary Green Line LRT Business Case Analysis. The chief purpose of this document is to describe the methodology, sources, and calculations utilized to populate the findings discussed in the economic sustainability section of the main report.

The outline of this technical note follows the outline of the Business Case Analysis. Assumptions, or modelling inputs, will appear in tables in their respective section. Cash flows and projections, or modelling outputs will appear in the Appendix section at the end of the document.

Due to the preliminary nature of this report, it relies chiefly on initial ridership, demographic growth and cost estimates, as well case studies relevant to the context and communities served by the Green Line LRT. Recognizing the preliminary nature of the analysis, the benefit analysis takes a conservative approach to the potential benefits of the Green Line, excluding monetary benefits associated with health, business attraction, reduction in automobile congestion, and development inducement affects. As such, the projected monetary values of the costs and benefits are likely to increase. The benefits explained in this analysis will be developed in more detail in the forthcoming benefit costs analysis, with new benefit categories added as more detailed impact information becomes available.

Overall Methodology

Multiple organizations provided projections included in this report. The analysis includes research completed by Calgary Economic Development, Calgary Corporate Economics, Calgary Light Rail, and Hatch's Sustainable Economics Group. Hatch's Sustainable Economics Group combined the analysis into a 40-year projected costs and benefits scenario (i.e. 10-year construction period and 30-year operation period). As discussed earlier, the benefits are intentionally conservative in their estimates (i.e. low) to account for the preliminarypreliminarypreliminarypreliminarypreliminarypreliminary nature of the Green Line.

This report relies on projections in the following feasibility reports published the city of Calgary:

- Green Line Benefits and Opportunities Package – June 2016
  Green line project report prepared by the city of Calgary. Current draft includes capital costs, preliminary ridership estimates, project timelines and urban planning context of Green Line project.

- The Implications of Alternative Growth Patterns on Infrastructure Costs
  White paper drafted by Plan It Calgary and IBI Group estimating the increase in costs in infrastructure, energy, upkeep and social services due to sprawling growth patterns in subsequent years.

- Green Line Transitway Market Study
  Urban analysis whitepaper published by the city of Calgary in February 2015 outlining the potential development induced by the new rail line. This report also identified different

development typologies for each transit station according to current demographics as well as projected job and population growth.

- Green Line Update on Funding, Staging and Delivery –Update 1.0
Current Green Line project budget outlining capital costs, project phasing options and the institutional context of the project.

Utilizing previous reports, Hatch's analysis incorporates a range of inputs in order to calculate values for the following variables:

- Direct and indirect economic injection of the light rail system during its construction and ongoing operations
- Improvements in worker productivity associated with reduced public transit commutes and increased dependability
- Increases in property values for those properties served by the proposed Green Line
- Reduction in transportation costs for commuters converting from personal vehicle use to light rail use and the corresponding savings for households
- Reduction in infrastructure and maintenance costs produced by a creating a more compact footprint for Calgary
- Corresponding tax revenues realized by the Province and the City due to the growth in income and property values associated with the lift generated by the light rail line

These benefits are monetized using current industry standard as well as the most recent Calgary demographic and economic statistics.[13] For this phase of the analysis, Hatch calculated two scenarios:

- A *baseline* scenario, in which current ridership, mode share, and property value trends are projected to year 2056.
- A *shock* scenario, which accounts for changes associated with the construction and performance of the Green Line LRT.

All cost and benefit values in this report refer to the marginal difference between the baseline and the shock scenarios. See Appendix A for a full cash flow of benefits and costs currently included in the model.
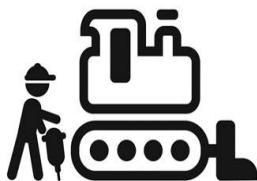
Construction and Operations Direct and Indirect Economic Impacts

The Construction and Operation direct and indirect economic impact calculations are prepared with the aid of a multi-sector economic forecast model of the Calgary economy (C4SE) and an Input-Output (IO) model for the Calgary Economic Region (Calgary Corporate Economics). From the forecast model, the impact of the Green Line on the economy is estimated by comparing two almost identical economic scenarios for the Calgary Economic Region: (A)a base case scenario that the Green Line will not be built; and (B) a shock scenario that the Green Line will be built. The

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[13] Cevero, Robert *Economic Impact Analysis of Transit Investment: Guidebook for Practitioners,* Transportation Research Board, National Academic Press, 1998

differences between the base and shock scenarios are the impacts of the Green Line project on the regional economy, represented by changes to GDP, employment, population and personal income levels over time (2017-2046).

The regional IO model is an open model which means that only direct and indirect effects[14] are measured using industry multipliers. [15] The economic impacts during construction phase (2017-2026) are estimated as direct and indirect jobs[16] created by Green Line investment, plus the increases in Gross Output, GDP and regional income, excluding induced effects.

Construction and operation employment numbers are estimated using the labour/capital ratios in the industry. All future monetary values are discounted by the standard rate of 3.0 % annually to account for the opportunity cost of the capital and all fixed costs and revenues are increased by a 2.5 % annually to account for inflation. All benefit categories are inflated to their current year and then discounted back to estimate their present value impact.

The current model takes the cumulative present value of the benefits incurred by the region in the project's first 30 years of operation as well as any benefits realized during the planning, design, and construction phase (2017-2026). These values are then evaluated against a total capital investment of $5 billion and an increase of $20 million annual operating costs for the Calgary network.

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Distribution of Investment less Land Purchases (in $2016 millions)	20	30	207	567	907	907	897	717	277	72.8	4,602
Inflated Investment Costs (2% per year) ($million, 2016 as base year)	20	31	220	614	1,001	1,021	1,030	840	331	89	5,198
Construction investment distribution over time (%)	0.4%	0.7%	4.5%	12.3%	19.7%	19.7%	19.5%	15.6%	6.0%	1.6%	100%
Machinery & equipment (M&E) Purchases (in $2016 million)				190	190	190	180				750
M&E Inflated ($million, 2016 as base year)				206	210	214	207				836
M&E share of total investment											16%

Table 3. Green Line construction investment assumptions.

In table 3, the construction costs include expenditures on non-residential construction, engineering construction and machinery and equipment purchases, but exclude land purchases[17].

Construction of the project starts in 2017 and ends in 2026. Full operation of the Green Line will start in 2026. The total cost in construction phase is $4,602 million in $2016 dollars and $5,198 million in nominal dollar values. The construction investment distribution is the ratio of annual expenditure to the total construction costs (between

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[14] There are three types of effects measured with a multiplier: the direct, the indirect, and the induced effects. The direct effect takes place only in the industry immediately affected. The indirect effect is the business-to-business transactions required to satisfy the direct effect. Induced effects measure the effects of the changes in household income and are derived from local spending on goods and services by people working to satisfy the direct and indirect effects.

[15] Multipliers are a numeric way of quantifying the secondary impacts stemming from a change such as building the Green Line project.

[16] Direct jobs are the jobs immediately created by constructing the Green Line LRT. Indirect jobs are the jobs added in other industries that supply goods and services to the construction industries.

[17] Land sales do not count as part of GDP.

2017 and 2026). Machinery and equipment (M&E) purchases ($750 million in $2016) should account for 16 per cent of the total construction budget.

The Green Line project is categorized as government owned investment in the transportation and warehousing industry. Following the North American Industry Classification System (NAICS) code, the expenditures are allocated to three categories: non-residential building construction, engineering construction, and machinery and equipment purchase.

As no project specific information was available, industry standards were used to arrive at values for variables such as construction price deflator, productivity and labour/cost ratios. For example, the construction and operation employment numbers are estimated using the labour/capital ratios in the industry. The share of building construction is taken from the industry standard (5 per cent) and thus the engineering construction share is calculated as 79 per cent. Table 4 shows assumptions for the Input-Output portion of the mode.

Investment industry	Construcvtion employment (total)	Labour/capital ratio (LKC) during construction	Operations employment (annual)	Labour/capital ratio (LKO) in annual operation	M&E share of investment	Building construction share of investment	Engineering share of investment	M&E depreciation rate	Building/structure depreciation rate
Transportation & ware housing	11,919	2.59	230	0.05	16%	5%	79%	0.05	0.02

Table 4. Assumptions for the Input-Out portion of the model.

Other important assumptions include average weekly wage rates for Alberta's engineering construction ($94,000) and non-residential building construction ($84,000) taken from Statistics Canada Survey of Employment, Payrolls and Hours (SEPH) data[18]. Profit rate and tax rate for construction companies are assumed as 8% and 5% respectively. Overhead fee is set as 2% of investment plus GST taxes.

As it is, the current model does not account a full Cost Benefit Analysis since ridership projections are approximates, property value increase is calculated through case study research rather specific impact analysis of Calgary's light rail system.[19] Finally, the baseline scenario does not account for the costs incurred due to congestion, VKT increase, and collisions incurred by not improving Calgary's transit network.

The calculations from the forecast model show that the Green Line project will have a positive net economic impact (shock – base) on the city's economy over a 30 year period. In summary, investment in the Green Line will provide short-term stimulus in the construction phase, and generate long-term economic benefits to the region due to higher capital stock built through the project.

Specifically, all shock-minus-base indicators show a three phase pattern:

1. Overshoot phase; positive level difference from base case: when spending on the Green Line construction ramps up, the local economy will achieve a positive multiplier effect[20]. GDP, employment, net-in migration, population and personal income all increase during this period.

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[18] Statistics Canada CANSIM 281-0027, numbers also reflect overtime pay of workers
[19] Note that Hatch will perform a hedonic analysis on Calgary's existing light rail system for the more detailed Benefit Cost Analysis to be completed in June of 2017. This will provide more location specific property lift assumptions that can be applied to the Green Line station areas.
[20] The multiplier effect refers to the increase in final income arising from any new injection of spending.

Also, due to the cost inflation introduced to the system through the construction phase of the shock – higher wage inflation and wage rate due to tighter labour markets would be experienced. This would support higher level consumer spending and overall economic activity.

2. Undershoot phase; negative level difference from base case: as the construction investment phase ends and transitions to the operations phase, the local economy will experience a negative multiplier effect[21]. The completion of the construction will see workers leaving the region for new jobs elsewhere. This would relieve pressure on labour markets and wage inflation would be reduced and this has a negative effect on consumer spending.

3. Smaller positive level differences from base case: over the longer term economic activities (GDP and employment) cycle up and down as the operation of the line begins

The calculations from the IO model show that excluding the induced effect on household sector, the Green Line project will create more than 20,200 direct and indirect jobs from 2017 to 2026 (See Table 11). The other economic impacts of the project are as follows; $6.7 billion increase in regional gross output, $2.8 billion increase in regional GDP (See Table 12), and $1.9 billion increase in regional income, over the next ten years (See Table 13). The gross regional multiplier is defined by the ratio of regional gross output divided by the total capital expenditure, generating a multiplier value of 1.556.
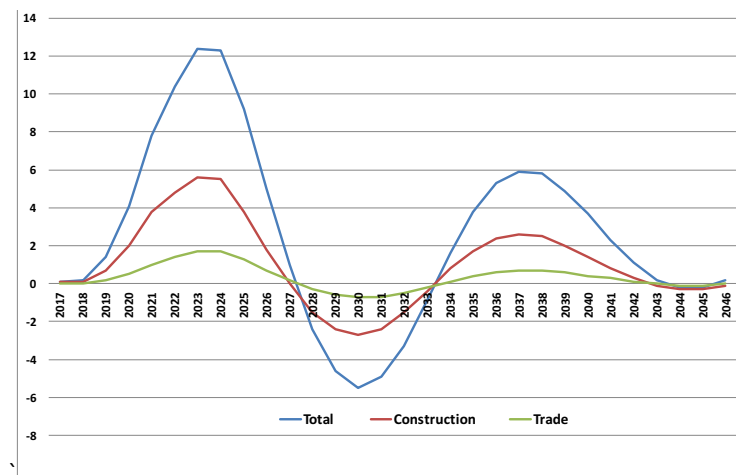

Table 11. Impact on Employment (thousands, 2016-2017)

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[21] In other words, the ramping down of the project begins to displace workers from the region, as fewer resources are required and corresponding reducing incomes as well.
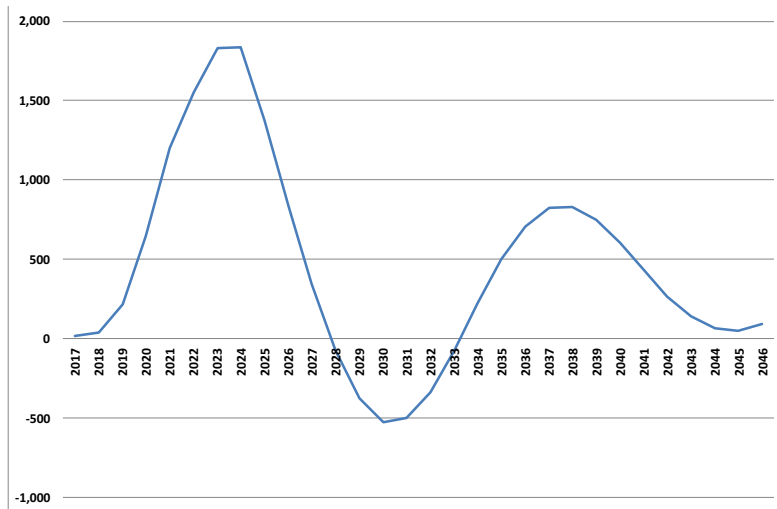
Table 12. Impact on Regional GDP ($2007 millions in basic price)
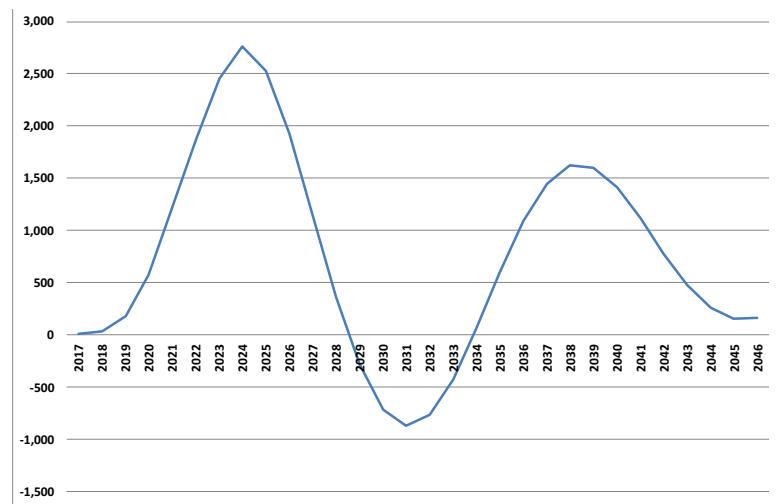
Table 13. Impact on Personal Income ($Millions)

Productivity Gains

The development of the Green Line LRT corridor is expected to increase worker productivity on three fronts.

1. It will save time for current transit commuters by either making their current trips shorter, their transfers more efficient, or both.
2. The faster and more reliable system is poised to attract new riders, providing a shorter commute during peak hours and/or saving them the operational expenses of their private vehicle.
3. It will reduce traffic by shifting mode share in the Calgary network, during peak morning and evening hours cutting congestion and saving for non-transit commuters as well.

For the time being, the benefit analysis only account for the first two types of time savings since a full traffic simulation is necessary to calculate the time savings experience by commuters using private vehicles.[22]

The current model assumes a 20-minute trip reduction from commuters from North Pointe to Downton Calgary. This assumption is distributed proportionally along the subsequent Green Lines stops. On the Southern portion of the Green Line corridor, the analysis only assumes a five minute time savings from Seton to Downtown Calgary and distributes these savings accordingly throughout the Southern portion of the line. Note that the economic impact model does not currently estimate the collision or vehicle traffic savings associated with the investment.

These savings are multiplied by projected population increases in each quarter mile catchment area. These population increases account for the induced Transit Oriented Development in 4th Street and 16th Ave N. Furthermore, the model accounts for projected mode share of each catchment since not all future residents are expected to utilise the Green Line. The mode share variable changes over time, starting with current ridership levels but increasing LRT use over time to account for new riders attracted by the improved service.

Both the population and mode share projections come from the Green Line Transit Way Market study and will be updated with more accurate predictions once a full traffic model is performed. To see the structure of these assumptions see Appendix B and Appendix C.

With these assumptions in place, the model predicts three data points of "Daily Hours Saved" in different years according to projected ridership. We use these points to extrapolate a curve of Daily Hours Saved Increasing the rate every year. The model multiplies the "Daily Hours Saved" rate by 240 since only commuting trips should count as productivity gains. Finally, we use the industry rate of $15 per hour to monetize the time savings of the system.

The $15 per hour rate is inflated 2% annually and the time savings are discounted 3% annually in order to calculate the cumulative value of the commuters' time savings. To see the annual value of time savings through the first 30 years of operations of the Green Line, see Appendix D.

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[22] The traffic simulation is currently underway and is projected to be completed by the end of 2016.

Property Values

Analysis of a series of case studies indicates that the development of rail infrastructure creates a significant uplift in property values and, therefore, property tax levied by the city. The main factors affecting the increase are access to jobs, access to customers, and reduced need for employee parking. As a way to quantify these factors and compare different case studies, the analysis applies metropolitan population as an indicator for size of economy, population density as an indicator for the development potential, and ridership as gage for the effectiveness of the system.

While there is not a perfect comparison to Calgary and its LRT network, the analysis selected San Diego as a proxy for Calgary's population density, Dallas for its metropolitan population and Toronto as the only North American LRT whose ridership compares to Calgary's. In future analyses, the full benefit costs analysis will evaluate light rail's property value impacts specific to Calgary (e.g. the Red Line). Table 5 shows the different case-study cities considered in the preliminary model and their property value appreciation around the station catchment area.

CITY	METROPOLITAN POPULATION (MILLION)	POPULATION DENSITY PPL / SQ KM	DAILY RIDERS PER KM OF TRACK	RESIDENTIAL VALUE INCREASE OVER CONTROL AREA	COMERCIAL VALUE INCREASE OVER CONTROL AREA	OFFICE VALUE INCREASE OVER CONTROL AREA
CALGARY, AL	1.1	2,500	3,500			
TORONTO, ON[23]	2.6	6,700	3,600	1.4%-4%	2%-4%	
HAMILTON, ON[24]	.52	750	n/a	4%-11%	8%-11%	
SAN DIEGO, CA[25]	1.4	2,500	1,400	17%	70%-90%	
PHILADELPHIA, PA[26]	1.5	7,200	2,700	6.4%		
DALLAS, TX[27]	1.2	2,200		13%	37%	13%
ST. LOUIS, MO[28]	2.8	200	700	32%		
SANTA CLARA, CA[29]	.12	4,000	500	45%	23%	41%
BOSTON, MS[30]				6.7%		
SAN FRANCISCO, CA[31]	.87		2,300	15%		
WASHINGTON, DC[32]				10%		

Table 5. LRT Case studies, attributes and property values uplift.

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[23] Steer Davies Gleave *BCA Final Report Huronntario-Main LRT Project Preliminary Design/TFPAP,* 2014: http://lrt-mississauga.brampton.ca/EN/AboutLRT/Documents/HMLRTBusiness%20Case%20Analysis.pdf

[24] Metrolinx, *Rapid Transit Feasability Study Metrolinx*, 2008: http://www2.hamilton.ca/NR/rdonlyres/0975DDF6-D4A1-43DA-9BC1-03184351B6DB/0/RTFSOct20.pdf

[25] Cevero, Robert, *Effects of Light and commuter Rail Transit on Land Prices: Experiences in San Diegeo County,* Journal of Transportation Research Forum, Vol 43 No 1 2004.

[26] Cevero, Robert, *Effects of Light and commuter Rail Transit on Land Prices: Experiences in San Diegeo County,* Journal of Transportation Research Forum, Vol 43 No 1 2004.

[27] Weinstein, Bernard, *Assessment of DART LRT on Taxable Property Issues and Prospects for Ecnomic Developments,* University of North Texas Center for Economic Development and Research, 2004.

[28] Cevero, Robert, *Effects of Light and commuter Rail Transit on Land Prices: Experiences in San Diegeo County,* Journal of Transportation Research Forum, Vol 43 No 1 2004.

[29] Cevero, Robert *Benefits of Proximity to Rail on Housing Markets: Experiences in Santa Clara County,* Journal of Public Transportation, Volume 5 Issue 1, 2002.

[30] Cevero, Robert, Transit's Value-Added Effects: Light and Commuter Rail Services and Commercial Land Values*, Transportation Research Board, December 13 2004

[31] Cevero, Robert, Transit's Value-Added Effects: Light and Commuter Rail Services and Commercial Land Values*, Transportation Research Board, December 13 2004

[32] Cevero, Robert, Transit's Value-Added Effects: Light and Commuter Rail Services and Commercial Land Values*, Transportation Research Board, December 13 2004

The precedent studies show large increases in value concentrated in retail and office properties since they are better positioned to capitalize on increases in foot traffic and reasonable access to other nodes of development. Second, the precedent studies show areas which are already densely urbanized and see only a modest uptick in property values near LRT stations. This is primarily due to the limited capacity to increase additional densities in existing historic central business districts. Third, property value benefits are typically accrued within 600 meters of the light rail stations or roughly within a 15-minute walk of the station. Finally, existing research found a correlation in high increases in property values with the formation of Transit Oriented Development districts. These districts densify in conjunction with the LRT expansion and eventually function as destinations in and of themselves.

Grouping relevant case studies and calculating the median and standard deviation of property value uplift the model produces three property value appreciation coefficients: a base, high development potential and low development potential. Table 6 shows the growth projections due to the construction of Green Line LRT.

	Lower Confidence Interval	Median Value Increase	Higher Confidence Interval
Retail	11 %	33 %	55 %
Residential	8 %	13 %	18 %
Office	5 %	25 %	45 %

Table 6. Appreciation coefficients expected along Green Line Corridor by land use and development potential

The percentages in Table 2 represent increases over the natural expected property appreciation. The base case analysis applies an annual appreciate rate of 3% to all properties in Calgary which is below the nine year historic average (3.2% from 2007 to 2016). See Table 7. The percentages in the table represent the property value lift specifically associated with the Green Line LRT, above the project citywide appreciation rate of 3% annually.

This additional property value lift associated with the Green line are incrementally applied over a 30-year period beginning the first year of construction. The incremental increase is applied because research shows that prices may fluctuate drastically during the first years due to both land speculation and potential negative externalities during the construction process. Therefore, each catchment area achieves it maximum value uplift in 2046 and grows at the citywide rate thereafter (3% per year). Appendix E shows cumulative property values by station and land use. Property values of downtown properties are excluded entirely since these properties are already largely served by transit. [33]

Appendix F shows expected property value uplift according to the case study analysis. Using these value forecasts in order to calculate property values in the interlude between data points the model calculates a the cumulative increase in property value of about $1.5 Billion in present value dollars above the expected growth of current properties. This is a fairly conservative prediction since it only considers the assessed value of existing

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[33] The City of Calgary has a "revenue neutral municipal tax policy" which means that the property tax rate is adjusted for taxpayers citywide based on what it needs. As such, any property tax rate increase within the transit nodes would essentially offset/discount property owners in other areas of the City. This does not change the fundamental benefit of the property value lift from the Green Line and its corresponding impact on property tax revenues as the additional property tax helps to offset the cost of the Green Line. In other words, without the increases in property values along the transit corridor, Calgary property taxpayers overall would have to pay more property taxes to account for the increased costs of building and operating the Green Line.

development in the catchment area and, as such, falls considerably lower than value appreciation predictions of $2.3 Billion in Ottawa[34] and $2.4 in Vancouver. [35]

Year	Median Assessment	Median Tax
2016	$ 480,000	$ 1780
2015	$ 475,000	$1,682
2014	$ 430,000	$1,611
2013	$ 410,000	$1,557
2012	$ 400,000	$1,383
2011	$ 410,000	$1,314
2010	$ 374,000	$1,174
2009	$ 427,500	$1,129
2008	$ 447,500	$1,081
2007	$ 361,000	$1,041
Average Yearly Growth Rate	3.22%	

Table 7: Natural Property Value Appreciation Calgary

Increased Consumer Spending

Economists have identified a correlation between home appreciation and increased non-durable goods spending.[36] Two reports from the University of Chicago reported that for every dollar increase in home values resulted in approximately 2 to 9 cents of additional consumer spending in non-durable goods. This equates to approximately $16 million in additional spending over the life of the Green Line.

The model utilizes property value uplift projections of the previous section in order to calculate, amortize and discount this additional consumer spending. The model applies the value gains only to residential properties and only to those properties owned (i.e. estimated at 70% of residential properties). These are essentially one-time gains in consumer spending resulting from the wealth generation of increased homeowner property values. Conservatively assuming only $0.02 of additional non-durable goods spending per dollar of homeowner appreciation yields in an average annual economic injection of approximately $800,000. The analysis applies approximately 85% of additional sales to the Province.[37] In other words, when owner-occupied housing values increase $1 in a given year, the area receives an estimated $0.017 increase in non-durable good spending for that

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[34] CPCS Transportation, Strategy Consultants Economic Impact Assessment Review for city of Ottawa,2011.

[35] Avison Young. "A Commercial Real Estate Perspective on Public Transit &Transportation Infrastructure Investment in Metro Vancouver".

[36] Guerrieri, Lorenzoni, and Vavra, Housing Prices and Consumer Spending, Berger, University of Chicago, 2015. Mian, Sufi, and Rao, Household Balance Sheets, Consumption, and the Economic Slump, University of Chicago, 2013

[37] The analysis uses the 2014 Survey of Household Spending to estimate those non-durable good categories likely to be spent in and outside of Calgary.

year. The economic injections to the region end in 2046 when property values associated with the rail project are expected to mature.

Inducement of Compact Development

The increased property values along the light rail stations can also induce higher density development where the zoning allows. The city is already undertaking town planning efforts to enable transit-oriented development near its proposed green line stations. Two recent market reports for the Green Line indicate that the Dartmouth Road SE, and Bow River stations are prime sites, capable of becoming transit villages providing commercial and retail services as well as becoming job centers to surrounding communities.[38]

A 2015 TOD Market study published by the City of Calgary specifies that while the Green Line LRT is not expected to unilaterally change the number of new constructions, it will become an important factor influencing development patterns in following decades. The study evaluated urban growth with and without the Green Line LRT. The TOD study forecasts that with the Green Line LRT, Calgary will add approximately 20,000 multi-family and semi-detached more units near the line. This spike in more dense construction in the coming decades marks a trend away from single family detached homes, which currently make up 47 % of the building stock, to their constituting only 35 % in 2046.[39]

Inducing denser development, in turn, can have quantifiable benefits to the City of Calgary and the finances of Alberta. Simply put, municipalities spend less per capita on serving dense urban areas than providing the same municipal services to more suburban areas. A report by the IBI Group estimated that more efficient land use patterns would generate municipal savings of 33% of Calgary's operational budget or $ 11.2 billion over the next 60 years.[40] To put these numbers in perspective, achieving 20,000 units of compact urban housing (or 4 % of Calgary's current households) around the Green Line LRT yields a yearly savings of $ 15 million in operational savings for the city of Calgary by 2046. Table 8 shows total savings associated with a compact development strategy.

Total Cost ($ Billions)

	Dispersed Scenario	Recommended Direction	Difference	% Difference
Road Capital Cost	17.6	11.2	6.4	-36%
Transit Capital	6.8	6.2	0.6	-9%
Water and Wasterwater	5.5	2.5	3	-54%
Fire Stations	0.5	0.3	0.2	-46%
Recreation Centres	1.1	0.9	0.2	-19%
Schools	3	2.2	0.8	-27%
Total	34.5	23.3	11.2	-33%

Table 8: Total Savings Associated with Denser Urban Growth

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[38] Ten Principles for Successful Development Around Transit, Urban Land Institute 2011.
[39] The city of Calgary "Market Opportunities for High Density Urban Development along the Proposed Green Line Southeast Transitway" Febraury 2015.
[40] City of Calgary "The Implications of Alternative Growth Patterns in Infrastructure Costs" 2009 IBI Group.

In order to quantify this urban shift in Calgary The model utilises the $ 11.2 billion projection in the Calgary Infrastructure report and applies induced development's share of the urbanization shift The model assigns savings to the rail proportionally, depending what fraction of Calgary's total urban development is attributed to or connected with the rail corridor. For example, according to current projections by 2056, the construction of 20,000 multifamily units will make up 4 % of Calgary's total households and thereby the peak yearly savings $ 15 million and the cumulative savings in the Calgary's maintenance and operations budget of $ 0.4 billion in the first 30 years of operation.

These savings are then distributed over the first 30 years of operation of the rail project and expected to mature by 2056. While it may be reasonable to expect new housing development as soon as the construction of the rail project is officially announced, as was the case in Minneapolis and Portland, the model pushes the start of new development until the start of operations so as not to overestimate infrastructure savings.

Reduction in Household Transportation Spending

The impact of proximity to the planned Green Line LRT stations on household spending was calculated using estimates of the cost per kilometer of commuting by private vehicle, the reduction of vehicle kilometers travelled that would result from the Green Line LRT, and the share of household spending currently devoted to transport.

The cost of commuting by private vehicle was calculated based on the Canadian Revenue Agency's reimbursement rate of $0.57. A number of other estimates were also identified, but these ranged widely and were not easily converted into cost per kilometer. Alternative estimates of the cost of commuting by car in Canadian cities ranged from $3,900-$6,000, depending on whether they took into account driving costs alone or also included costs such as parking.[41]

The reduction of vehicle kilometers travelled was based on estimates provided by the city of Calgary on peak-level ridership in 2056. The net reduction in vehicle kilometers traveled in 2056 was projected to be 20 million per year. This translated to an annual reduction in vehicle kilometers traveled over 2026-2056 of $640 million per year. Assuming costs of $ 0.57/kilometer, this reduction would result in approximately $4,000 annual savings. The model escalates these savings in accordance to ridership expectation, discounts future savings as they enter the regional economy and inflates the cost of driving by the natural inflation. For a detailed breakdown of the economic injection associated with transportation savings see Appendix H.

The share of savings that would shift to discretionary spending was calculated using data from the Statistics Canada survey of household spending in Alberta in 2014 (see Table 9). [42] Given that discretionary spending represented roughly a quarter of household spending, it was assumed that a quarter of the projected $4000 savings in transportation costs, or approximately $1,000, would be shifted to discretionary expenses. Many of these expenditures, particularly on food, recreation, and household operations, would occur locally, contributing to the growth of the local economy.

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[41] Lower end is based on Canadian Automobile association driving cost of $0.54/km, 30 km average round-trip commute and 240 work days/year. The high end is calculated by Reader's Digest Canada: http://www.readersdigest.ca/home-garden/money/commuting-accounting/.
[42] Survey of household spending, Canada, regions and provinces, 2014. Source: Statistics Canada, CANSIM, table 203-0021 and Catalogue no. 62F0026M.Last modified: 2016-04-06.

Expenditure	$
Shelter	17,160
Household operation	4,393
Transportation	11,891
Health care	2,251
Education	1,502
Miscellaneous expenditures	1,608
Income taxes	14,867
Personal insurance payments and pension contributions	4,871
Personal care	1,207
Tobacco products and alcoholic beverages	1,222
Clothing and accessories	**3,503**
Recreation	**3,843**
Reading materials and other printed matter	**144**
Household furnishings and equipment	**2,067**
Games of chance	**156**
Food expenditures	**8,109**
Gifts of money, alimony and contributions to charity	**1,934**

Table 9. Calgary Household Spending Breakdown

Other economic benefits may also be realized, including greater stability of homeownership in areas with greater proximity to public transport. The Natural Resources Defense Council found that mortgage foreclosures rose as the level of neighbourhood vehicle ownership increased.[43] However, as it is difficult to monetize the benefits associated with fewer foreclosures and establish a direct relationship with access to public transport, this impact was not quantified.

Economic Diversification

The discussion of agglomeration economies was informed by research on the relationship between urban density and knowledge-economy firms, and the impact that transport infrastructure has on agglomeration economies.

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[43] https://www.nrdc.org/sites/default/files/LocationEfficiency4pgr.pdf

Glaeser and Gottleib (2009) posit that agglomeration economies, characterized by productivity increasing with density, result from reducing the cost of transporting goods, people and ideas. As the cost of moving freight has gone down, cities' added value is most apparent in the ease with which ideas move among workers and firms. This link between denser urban areas and the knowledge economy is demonstrated by data they present on the tendency of workers with a college degree to concentrate in metro regions.

The cost of transportation is considered in the research as a key determinant of the size of a regional market for goods and labour. Transport investments can therefore provide agglomeration benefits by increasing the size of these markets and contributing to the productivity of the urban area. An exercise for the UK Department for Transport aimed to determine whether the benefits of the London Crossrail project (an inner-city rail expansion) on agglomeration economies were comparable to the benefits provided by savings in travel time. Urban economic effects were calculated at $US 3.1 million, compared to a combined savings of $US 12.8 million in savings on business, commuting and leisure. Put simply, the productivity gain associated with facilitating the informal interaction and mixing of workers added more than 25% to the productivity gains realized from London Cross Rail.

Calgary Economic Development Analysis of the Green Line LRT

The following is Calgary's Economic Development's analysis of the economic diversification and business attraction opportunities availed through expanding Calgary's light rail system. Note that there is overlap with the independent analysis performed in the previous section above.

Calgary Economic Development is the steward for *Building on our Energy: 10 Year Economic Strategy for Calgary*. The Economic Strategy provides the road map for economic growth and diversification and shared prosperity for Calgary. Calgary Economic Development acknowledges the Government of Alberta's support for municipal public transportation projects through funding initiatives and GreenTRIP. We are pleased to contribute to the budget deliberations and submit a business case for Calgary's Green Line light rail transit corridor. Calgary Economic Development will work with stakeholders to support a strategy that attracts new and diverse businesses in communities along the Green Line.

Cities are engines of economic growth. Although urban mobility is one of the toughest challenges faced by cities, investment in effective public transit systems supports economic growth, is cost-effective, environmentally friendly and provides enhanced mobility and safety within our communities. According to Canadian Urban Transit Association (2010), municipalities are facing cost pressures due to lagging investment in transit and growth in capital requirements. Critical infrastructure needs are remaining unfunded while ridership grows. Increase in transit ridership has consistently outpaced population growth in Canada, with travel in urban areas expected to triple globally by 2050 (Canadian Urban Transit Association, 2010; Little, 2014).

Public transit is essential in supporting public and private sector services and contributes to reducing our carbon footprint. Calgary is currently experiencing an economic downturn with layoffs of skilled workers in the energy sector estimated at 43,000 between December 2014 and May 2016, negative 2.5 percent GDP growth in 2015 and forecasted contraction of negative 1.0 percent GDP growth for 2016 (Johnson, 2016; Conference Board of Canada, 2016). Numerous studies have found strong links between infrastructure projects and economic growth. A Statistics Canada (2009) study found returns on infrastructure investment as high as 17 percent to 25 percent. The potential of the Green Line to spur economic growth, attract talent, increase real estate values and contribute to diversifying Calgary's economy is considerable.

Economic Gains from Transit Infrastructure

In 1996 the Smart Growth Network created 10 smart growth principles for improving urban competitiveness and economic success for businesses such as increased productivity and innovation, talent attraction and retail sales

growth (United States Environmental Protection Agency, 2013). These smart growth principles include mix land use, compact building design, walkable neighbourhoods (within 400 meters or less from rapid transit stations), distinctive communities and a variety of transportation options available to residents. Infrastructure projects support improving urban competitiveness, business density and economic productivity.

The Conference Board of Canada (2013) found investment in infrastructure contributed to 25 percent of overall labour productivity growth. Creative, educated and talented people are attracted to cities providing a range of employment opportunities with diverse communities and streetscapes that are culturally distinctive, amenity rich and of high quality design (Gertler, M., Florida, R., Gates, G., & Vinodrai, T., 2002). Urban areas that offer these characteristics will be more competitive in attracting/retaining talent and supporting growth of technology-intensive economic activities. Additionally, there are a number of studies linking access to transportation options with increased employee wellness and reduced absenteeism, contributing to improved labour productivity.

The geographic concentration of people and businesses, known as industry clusters, agglomeration economies and city regions, generate important benefits for businesses located within them. A U.S. study found that businesses choose locations in close proximity to other businesses and seek "ways to get people to these places (American Public Transportation Association, 2013)." Concentration of businesses leads to property value uplift and increased footfall to local businesses through construction of larger developments within the area (Webber & Athey, 2007). Benefits for businesses include easier access to suppliers and knowledge spillovers, which leads to increased productivity and innovation, the adoption of more efficient processes and creation of new products and services (Webber & Athey, 2007).

The development of the Green Line provides synergistic opportunities to support creation of innovation districts in non-residential areas along the route. Innovation districts leverage the distinct economic strengths of each metropolitan area (Katz & Wagner, 2014). Economic growth is likely to occur capitalizing on opportunities and supporting development of innovation clusters in already strong sectors. Transportation and logistics is one of Calgary's strongest growth sectors. In the Transportation and Warehousing industry, Calgary experienced 17% and 23% GDP growth over the past 5 and 10 years respectively and in the Wholesale and Retail Trade industry Calgary experienced 20% and 35% GDP growth over the past 5 and 10 years respectively (Calgary Economic Development, 2016b). Additionally, the Transportation and Warehousing industry experienced the highest employment growth rate of all Calgary industries over the past 5 and 10 years. There may be future opportunities to link continued growth in Calgary's transportation and logistics sector with development of the Green Line.

Development of the Green Line could contribute to increasing density of businesses along the Calgary's north east/south east corridor and generating a greater total benefit to productivity. Currently, only 21 percent of Calgarians live within 1 km of existing rapid transit service compared to Toronto at 34 percent and Vancouver at 19 percent. Calgary's census metropolitan area (CMA) population was approximately 1.44 million persons in 2015, including surrounding communities of Airdrie, Beiseker, Chestermere, Cochrane, Crossfield, Irricana, Okotoks and the municipal district of Rocky View County. The Green Line will provide additional transportation options to destinations and business areas within the city to the 270,000 Calgarians living and working along the Green Line corridor and residents of the Calgary CMA - especially the communities of Airdrie and Okotoks located near the planned north and south ends of the Green Line respectively (LRT on the Green Foundation, 2016).

Investing in housing developments along the Green Line will stimulate economic growth and employment. A 2012 Federation of Canadian Municipalities report indicated that 3 full-time jobs and 10 ancillary jobs are created with every $1 million dollars of investment in new construction and housing renovations.

Case Study: Toronto
The Greater Toronto Area (GTA) is Canada's most populated metropolitan area, with a population of 6.13 million persons in 2015 (Statistics Canada, 2015). More residents of Toronto are choosing public transit to commute to work than ever before. A comparison of urban transit systems by the Pembina Institute (2014) found that Toronto has the highest rapid transit ridership per capita of any major Canadian city, with 34 percent of residents living within 1 km of existing rapid transit service and an average of more than 1.6 million commuters each weekday (Pembina Institute, 2014; Toronto Transit Commission, 2015). Access to transit routes contributes to Toronto's standing as one of North America's most competitive office markets, as many employment districts are within walking accessible distance of rapid transit.

While the GTA has high ridership per capita, the average commuter spends more than 80 minutes daily traveling to and from destinations (Jones Lang LaSalle, 2013). The GTA loses approximately $6 billion each year in productivity and 26,000 jobs due to traffic congestion (Jones Lang LaSalle, 2013). Recent Colliers International (2015) research on Toronto found that more than 60% of office space is within walking distance to public transit and confirmed that "there is an increased demand and willingness to pay a premium for office space within walking distance of rapid public transit."

Research conducted by Jones Lang Lasalle (2013) found that the expansion of Yonge-University-Spadina subway in 1973 led developers to focus outside the financial core to lower costs (rent and taxes) for tenants. Virtually all commercial buildings on the North Yonge subway line were constructed after completion of the subway and 83% are within 0.5km of a subway station. Further, direct vacancy of buildings within 0.5km of a subway station was 4.3% compared to 9.8% for other buildings. More broadly, on transit buildings in Toronto had vacancy rates of 5.6% compared to 12.1% of off transit buildings. Finally, on transit buildings were found to command a 38% premium in rental rates. This trend appears to be continuing in Toronto with more than 2.5 million square feet of under construction high quality Class A office space is within walking distance of rapid public transit (Colliers International 2015).

Office employment is shifting away from Downtown Toronto to suburban markets and regions outside of the GTA. With Toronto's expanding transit infrastructure under development in decentralized areas, new business hubs are emerging. Upon completion, the SmartTrack transit system in the GTA would potentially serve Downtown, GTA West, East and North; the Eglinton Crosstown LRT system would serve Central East and is slated for completion in 2020; and, a potential GO Train expansion could serve the entire Kitchener-Waterloo region if the proposed CN North Mainline plan moves forward. Developers are capitalizing on these real estate opportunities, as for example with the sale of Celestica's property near the Eglinton Crosstown LRT to a group of developers planning an office, retail and residential mixed-use community (REMI Network, 2015).

Case Study: Vancouver
Vancouver has built the most rapid transit lines over the last 20 years of major cities in Canada (Pembina Institute, 2014). Vancouver's Canada Line high speed train launched in 2009 and now carries more than 122,000 people on weekdays, equivalent to more than 10 lanes of highway (SNC-Lavalin, 2015). The Canada Line ranks as one of the largest public private partnerships in Canada historically. As of June 2016, Metro Vancouver received additional funding commitments of almost $900 million dollars from all three levels of government to further enhance the city's transit system (Olivier, C & Sinoski, K., 2016).

Vancouver has changed its zoning rules to encourage building density and place more destinations within walking distance of public transit. Developers contributed private funds towards stations and residential projects along the Canada Line. Local and international commercial real estate development followed increasing densification of the area and directly impacting airport growth due to more seamless access.

A recent Wall Street Journal article by Michael Totty (2016) highlighted five cities leading the way in urban innovation, with Vancouver leading the way in improving walkability. According to Walk Score (2016), Vancouver is Canada's most walkable city with its excellent public transit system and very walkable neighbourhoods. Walkable cities provide more mobility choices, benefit from being near other walkable places and perform better economically (Leinberger & Alfonzo, 2012). Increased availability of public transit reduces traffic congestion and health care costs associated with vehicular travel, encouraging a more healthy and active population. Public transit saves $115 million annually in Canadian health care costs (Canadian Urban Transit Association, 2010).

Taxes to the province and to the city

The business case analysis estimates two major categories of revenue to the City and Province. The property taxes realized from increase property values and the income tax generated from the Green Line construction and operations.

Property Taxes to the Calgary and Alberta

Utilizing property value projections and current tax rates (see Table 14), the model calculates additional revenue to both to the City and Province in the first 30 years of operation of the Green Line. Since this projection is based entirely on the models internal property value lift predictions, the same caveats apply. It is based on a case-study approach that looks at similar light rail corridors. As mentioned previously, the future analysis will apply a hedonic model using Calgary's property assessment records to formulate a much more accurate estimate of property lift benefits.

The preliminary analysis of property values along the LRT corridor result in $630 million in present value dollars; approximately $450 million in property taxes will go the City and $180 million will go to the Province between 2016 and 2056. [44]

The timeline of this additional revenue is inextricably tied to property values in the corridor. As such, it is conservatively projected to peak in year 2046 and start during the construction of the project. Appendix I shows a the full projected cash flow of property tax revue for Alberta and Appendix J show the same information for Calgary.

Assessment class	Municipal tax rate (Calgary)	Provincial tax rate (Alberta)	Total tax rate
Residential	0.37%	0.25%	0.62%
Non-residential	1.22%	0.38%	1.59%
Farm land	1.73%	0.25%	1.98%

Table 14: Local Property Tax Rates by Use

Income Tax Revenue

Finally, incorporating Corporate Economics Input-Output projections (Table 15), the model also accounts for how much of the initial investment is recirculated back to both Calgary and Alberta in the form of increased income tax revenue. This portion of the model incorporates increased income cash flow in the Corporate Economics model

[44] Avison Young, *A Commercial Real Estate Perspective on Public Transit &Transportation Infrastructure Investment in Metro Vancouver,* 2015.

along with the current tax structures at a city and province level. This cash flow is marginal, meaning that it is entirely associated with the construction process of the Green Line. It is also discounted to present terms.

	2017-2026	2027-2046	2017-2046
	Accumulated total impact		
Real GDP ($2007 millions)	10,136	4,066	14,202
	Average annual impact		
Total employment (000s)	6.5	0.7	2.6
Construction (000s)	3.0	0.1	1.1
Trade (000s)	0.9	0.0	0.3
Population (000s)	6.6	3.3	4.4
Net In-Migration (000s)	1.1	-0.5	0.0
Personal Income ($Millions)	1,393	464	774

Table 15: Corporate Economics regional impact projections

The model shows that income tax increase alone presents a net benefit of $1.8 billion in increase tax revenue. This is because the increase in regional income presented by Corporate Economics includes not only jobs directly associated with the construction of the Green Line but also the additional service and support jobs necessary to support the increase in population. For a detailed timeline of income tax increases see Appendix K.

This projection of analysis assumes that the province of Alberta will absorb the entirety of its income tax rate (of 10 %) without any exemptions or deductions. This is due to the fact that a majority of jobs created by the investment will be regulated construction jobs. Additionally, a uniform income tax rate of 10% is relatively conservative since it assumes that all jobs created will fall under the lowest income tax bracket. As corporate economics explains in their report, the average income for the industry is still $91,000 per year, below the $125,000 per year cut off for the next bracket. It is also not unreasonable to believe that a portion of the increased income in the area will be taxed a higher rate. The current model ignores these potential additional funds so as not to overestimate income tax revenues to the province.

Cumulative Effects of the Light Rail

The result of the model is a framework with which to consider the project made up of three distinct but interconnected types of benefits to the region:

Social Benefits
These are benefits experienced by the public at large and consist of reduction in carbon as well as the benefit of a faster and more reliable form of transportation. These benefits are monetized for the sake of comparison but they are valuable in and of themselves even without the prospect of producing this capital. Without counting the carbon savings, these benefits add up to $340 million in present value terms.

Fiscal Benefits

These are benefits incurred by the state, whether it is the Calgary or Alberta administration in the form of increased property and income tax, or reduction in operation and management of future urban infrastructure. These benefits, once discounted to account for the opportunity-cost of the money, can be considered a direct discount on the initial capital investment of the project. These benefits add up to $2.5 billion in 2016 dollars.

Stimulus Benefits

These benefits are made up of all the indirect ways the Light Rail Line injects and frees capital into the regional economy. These include the increase in consumer spending, the direct and indirect job creation, and value incurred by densifying suburbs. While these benefits do not affect any one party in particular they illustrate economic uplift inherent in the Green Line project. These benefits constitute an economic injection of $750 million at present.

Technical Appendix

Appendix A: Complete Benefits and Costs Cashflow

| | Costs | | Cummulative Benefits | | | | |
| | | | Social Benefits | Fiscal Benefits | | | Stimulus Benefits |
	Capital Construction Costs	Operations	Cummulative Travel Time Savings	Cummulative Increase in Income Tax	Cummulative Increase In Property Tax Calgary	Cummulative Increase In Property Tax Alberta	Cummulative Increse in Household Spending
2016	$20,000,000	$0	$0	$2,500,000	$ -	$ 463,753	$0
2017	$225,000,000	$0	$0	$7,354,369	$ 1,153,984	$ 1,364,245	$0
2018	$382,000,000	$0	$0	$16,780,328	$ 3,394,730	$ 1,364,245	$0
2019	$617,000,000	$0	$0	$39,658,870	$ 6,657,952	$ 2,675,641	$0
2020	$907,000,000	$0	$0	$84,083,222	$ 10,882,188	$ 4,373,240	$0
2021	$897,000,000	$0	$0	$170,344,100	$ 16,008,687	$ 6,433,434	$0
2022	$717,000,000	$0	$0	$295,966,739	$ 21,981,308	$ 8,833,660	$0
2023	$277,000,000	$0	$0	$458,585,041	$ 28,746,413	$ 11,552,362	$0
2024	$51,000,000	$0	$0	$636,202,119	$ 36,252,770	$ 14,568,952	$0
2025	$0	$43,800,000	$0	$846,966,720	$ 44,451,462	$ 17,863,772	$0
2026		$44,676,000	$12,438,245	$1,014,387,851	$ 53,295,789	$ 21,418,055	$0
2027		$70,141,320	$25,053,848	$1,086,629,979	$ 62,741,187	$ 25,213,890	$1,953,145
2028		$1,122,261,120	$37,345,606	$1,161,629,979	$ 72,745,139	$ 29,234,193	$5,821,511
2029		$1,683,391,680	$49,554,846	$1,211,629,979	$ 83,267,095	$ 33,462,666	$11,567,725
2030		$1,683,391,680	$61,675,948	$1,236,629,979	$ 94,268,393	$ 37,883,773	$19,154,958
2031		$1,683,391,680	$76,557,927	$1,251,629,979	$ 105,712,185	$ 42,482,706	$28,546,921
2032		$1,683,391,680	$88,487,461	$1,276,629,979	$ 117,563,361	$ 47,245,355	$39,707,856
2033		$1,683,391,680	$100,314,307	$1,306,880,801	$ 129,788,481	$ 52,158,282	$52,602,528
2034		$1,683,391,680	$112,034,326	$1,342,124,477	$ 142,355,710	$ 57,208,692	$67,196,221
2035		$1,683,391,680	$123,643,707	$1,384,895,929	$ 155,234,747	$ 62,384,409	$83,454,729
2036		$1,683,391,680	$135,138,953	$1,445,800,262	$ 168,396,767	$ 67,673,848	$101,344,349
2037		$1,683,391,680	$146,516,865	$1,521,057,161	$ 181,814,360	$ 73,065,996	$120,831,876
2038		$1,683,391,680	$157,774,524	$1,604,559,961	$ 195,461,473	$ 78,550,381	$141,884,598
2039		$1,683,391,680	$168,909,285	$1,680,563,723	$ 209,313,353	$ 84,117,055	$164,470,286
2040		$1,683,391,680	$179,918,756	$1,729,757,097	$ 223,346,494	$ 89,756,574	$188,557,187
2041		$1,683,391,680	$190,800,788	$1,765,577,515	$ 237,538,587	$ 95,459,970	$214,114,025
2042		$1,683,391,680	$201,553,467	$1,794,558,435	$ 251,868,467	$ 101,218,740	$241,109,985
2043		$1,683,391,680	$212,175,096	$1,817,067,888	$ 266,316,069	$ 107,024,818	$269,514,715
2044		$1,683,391,680	$222,664,186	$1,832,365,574	$ 280,862,377	$ 112,870,563	$299,298,315
2045		$1,683,391,680	$233,019,448	$1,842,974,233	$ 295,489,386	$ 118,748,740	$330,431,334
2046		$1,683,391,680	$243,239,779	$1,842,974,233	$ 310,180,055	$ 124,652,500	$362,884,763
2047		$1,683,391,680	$253,324,255	$1,842,974,233	$ 324,728,096	$ 130,498,942	$396,630,026
2048		$1,683,391,680	$263,272,119	$1,842,974,233	$ 339,134,893	$ 136,288,623	$431,638,982
2049		$1,683,391,680	$273,082,774	$1,842,974,233	$ 353,401,819	$ 142,022,092	$467,883,912
2050		$1,683,391,680	$282,755,773	$1,842,974,233	$ 367,530,231	$ 147,699,897	$505,337,516
2051		$1,683,391,680	$292,290,814	$1,842,974,233	$ 381,521,474	$ 153,322,578	$543,972,909
2052		$1,683,391,680	$301,687,726	$1,842,974,233	$ 395,376,880	$ 158,890,670	$583,763,612
2053		$1,683,391,680	$310,946,466	$1,842,974,233	$ 409,097,767	$ 164,404,702	$624,683,551
2054		$1,683,391,680	$320,067,113	$1,842,974,233	$ 422,685,442	$ 169,865,200	$666,707,049
2055		$1,683,391,680	$329,049,854	$1,842,974,233	$ 436,141,198	$ 175,272,684	$709,808,819
2056		$1,683,391,680	$337,894,988	$1,842,974,233	$ 449,466,315	$ 180,627,668	$753,963,963

Appendix B: Time Travel Assumptions with the Green Line

	Catchment	Stops	Vehicle Commuter Modeshare		Vehicle Commuters Baseline		
			Baseline	Option 1	2026	2041	2056
1	Stoney Tr Catchment	160 Ave N			1,148	3,313	18,993
		144 Ave N	100%	80%	-	-	-
2	Beddinton Blvd Catchment	North Pointe			8,150	11,841	17,156
		96 Ave N	85%	75%	-	-	-
3	McKnight Catchment	Beddinton Blvd			5,267	6,278	6,963
		72 Ave			-	-	-
		64 Ave N	77%	65%	-	-	-
4	24th Ave Catchment	40 Ave N			7,913	9,318	11,322
		28 Ave N	65%	54%	-	-	-
5	Bow River	16 Ave N			12,389	16,255	21,867
		9 Ave N	55%	33%	-	-	-
6	Downtown	2 Ave SW			75,836	110,038	124,261
		7 Ave N			-	-	-
		Centre Street	33%	25%	-	-	-
7	Dartmouth Rd SE	4 Street SE			4,396	9,797	12,090
		Inglewood/Ramsay	33%	33%	-	-	-
8	Deerfoot - HW251	26 Ave SE			4,126	7,353	10,308
		Highfield	85%	80%	-	-	-
9	Glenmore Tr SE	Lynnwood/Milican			350	3,896	4,469
		Ogden	85%	75%	-	-	-
10	130 Avenue SE	South Hill			6,469	12,964	18,724
		Quarry Park			-	-	-
		Douglas Glen			-	-	-
		Shepard	85%	77%	-	-	-
11	Auburn Bay Ave SE	Prestwick			1,593	1,643	4,365
		McKenzie Towne	90%	85%	-	-	-
12	Seton Catchment	Auburn/Mahogany			432	3,175	6,461
		Hospital			-	-	-
		Seton	92%	80%	-	-	-
	Corridor Total	**29**	Green Line Baseline Character Area Projections		**128,068**	**195,868**	**256,980**

Appendix C: Time Travel Assumptions with the Green Line

	Catchment	Stops	Vehicle Commuter Modeshare		Vehicle Commuters Option 1			Daily Vehicle Reduction
			Baseline	Option 1	2026	2041	2056	2056
1	Stoney Tr Catchment	160 Ave N			918	2,650	15,194	3,799
		144 Ave N	100%	80%	-	-	-	-
2	Beddinton Blvd Catchment	North Pointe			7,191	10,448	15,138	2,018
		96 Ave N	85%	75%	-	-	-	-
3	McKnight Catchment	Beddinton Blvd			4,446	5,299	5,878	1,085
		72 Ave			-	-	-	-
		64 Ave N	77%	65%	-	-	-	-
4	24th Ave Catchment	40 Ave N			6,574	7,741	9,406	1,916
		28 Ave N	65%	54%	-	-	-	-
5	Bow River	16 Ave N			7,433	9,753	13,120	8,747
		9 Ave N	55%	33%	-	-	-	-
6	Downtown	2 Ave SW			57,452	83,362	94,137	30,124
		7 Ave N			-	-	-	-
		Centre Street	33%	25%	-	-	-	-
7	Dartmouth Rd SE	4 Street SE			4,396	9,797	12,090	-
		Inglewood/Ramsay	33%	33%	-	-	-	-
8	Deerfoot - HW251	26 Ave SE			3,883	6,920	9,702	606
		Highfield	85%	80%	-	-	-	-
9	Glenmore Tr SE	Lynnwood/Milican			309	3,437	3,944	526
		Ogden	85%	75%	-	-	-	-
10	130 Avenue SE	South Hill			5,860	11,744	16,962	1,762
		Quarry Park			-	-	-	-
		Douglas Glen			-	-	-	-
		Shepard	85%	77%	-	-	-	-
11	Auburn Bay Ave SE	Prestwick			1,505	1,551	4,123	243
		McKenzie Towne	90%	85%	-	-	-	-
12	Seton Catchment	Auburn/Mahogany			376	2,761	5,618	843
		Hospital			-	-	-	-
		Seton	92%	80%	-	-	-	-
	Corridor Total	**29**	Green Line Baseline Character Area Projections		**100,342**	**155,463**	**205,312**	**51,669**

Appendix D: Time Travel Savings Cash Flow

	LRT Option 1			
	Daily Hours Saved	Yearly Hours Saved	Valu of Time Saved	Discounted Injenction
2016				
2017				
2018				
2019				
2020				
2021				
2022				
2023				
2024				
2025				
2026	6,191	1,485,863	$ 16,715,961	$ 12,438,245
2027	6,341	1,521,825	$ 17,462,945	$ 12,615,603
2028	6,491	1,557,787	$ 17,525,108	$ 12,291,758
2029	6,641	1,593,749	$ 17,929,681	$ 12,209,240
2030	6,790	1,629,711	$ 18,334,254	$ 12,121,102
2031	6,940	1,665,674	$ 23,185,639	$ 14,881,979
2032	7,090	1,701,636	$ 19,143,401	$ 11,929,534
2033	7,240	1,737,598	$ 19,547,974	$ 11,826,846
2034	7,390	1,773,560	$ 19,952,547	$ 11,720,019
2035	7,540	1,809,522	$ 20,357,120	$ 11,609,381
2036	7,690	1,845,484	$ 20,761,694	$ 11,495,246
2037	7,839	1,881,446	$ 21,166,267	$ 11,377,911
2038	7,989	1,917,408	$ 21,570,840	$ 11,257,660
2039	8,139	1,953,370	$ 21,975,413	$ 11,134,761
2040	8,289	1,989,332	$ 22,379,987	$ 11,009,470
2041	8,439	2,025,294	$ 22,784,560	$ 10,882,033
2042	8,589	2,061,256	$ 23,189,133	$ 10,752,679
2043	8,738	2,097,218	$ 23,593,707	$ 10,621,628
2044	8,888	2,133,180	$ 23,998,280	$ 10,489,090
2045	9,038	2,169,142	$ 24,402,853	$ 10,355,262
2046	9,188	2,205,105	$ 24,807,426	$ 10,220,331
2047	9,338	2,241,067	$ 25,212,000	$ 10,084,476
2048	9,488	2,277,029	$ 25,616,573	$ 9,947,864
2049	9,637	2,312,991	$ 26,021,146	$ 9,810,655
2050	9,787	2,348,953	$ 26,425,719	$ 9,673,000
2051	9,937	2,384,915	$ 26,830,293	$ 9,535,041
2052	10,087	2,420,877	$ 27,234,866	$ 9,396,912
2053	10,237	2,456,839	$ 27,639,439	$ 9,258,741
2054	10,387	2,492,801	$ 28,044,012	$ 9,120,646
2055	10,537	2,528,763	$ 28,448,586	$ 8,982,742
2056	10,686	2,564,725	$ 28,853,159	$ 8,845,133
			Net Present Value	**$ 337,894,988**

Appendix E: Current Cumulative Property Value Along Corridor

				Property Value Projections						
	Catchment	Stations	Development Potential According to Character Area Summary	Potential Value Appreciation			2016 Property Values			
				RETAIL	RESIDENTIAL	OFFICE	Cummulative Value of RETAIL Properties in Station Radius 2016	Cummulative Value of RESIDENTIAL Properties in Station Area 2016	Cummulative Value of OFFICE Properties in Station Area 2016	
1	Stoney Tr Catchment	160 Ave N	High	55.0%	18.0%	25.0%	$ -	$ -	$ -	
		144 Ave N		55.0%	18.0%	25.0%	$ -	$ -	$ -	
2	Beddinton Blvd Catchment	North Pointe	High	55.0%	18.0%	25.0%	$ 162,580,000.00	$ 369,954,000.00	$ -	
		96 Ave N		55.0%	18.0%	25.0%	$ 70,060,000.00	$ 349,155,500.00	$ 57,420,000.00	
3	McKnight Catchment	Beddinton Blvd	Medium	33.0%	13.0%	25.0%	$ 96,620,000.00	$ 392,753,000.00	$ -	
		72 Ave		33.0%	13.0%	25.0%	$ -	$ -	$ -	
		64 Ave N		33.0%	13.0%	25.0%	$ 95,466,500.00	$ 391,751,500.00	$ -	
4	24th Ave Catchment	40 Ave N	Medium	33.0%	18.0%	25.0%	$ 4,908,500.00	$ 381,092,000.00	$ 4,275,000.00	
		28 Ave N		33.0%	18.0%	25.0%	$ 44,507,500.00	$ 894,100,110.00	$ 6,101,000.00	
5	Bow River	16 Ave N	Medium	33.0%	18.0%	25.0%	$ 211,192,000.00	$ 653,113,050.00	$ 119,024,500.00	
		9 Ave N		33.0%	18.0%	25.0%	$ 25,586,500.00	$ 432,398,935.00	$ 26,168,500.00	
6	Downtown	2 Ave SW	Low	11%	8%	1%				
		7 Ave N		11%	8%	1%				
		Centre Street		11%	8%	1%				
7	Dartmouth Rd SE	4 Street SE	High	55.0%	18.0%	5.0%	$ 33,477,000.00	$ 147,212,500.00	$ 558,000,500.00	
		Inglewood/Ramsay		55.0%	18.0%	5.0%	$ 130,213,500.00	$ 427,995,500.00	$ 106,586,500.00	
8	Deerfoot - HW251	26 Ave SE	Medium	33.0%	13.0%	25.0%	$ 5,476,000.00	$ 44,591,500.00	$ 6,160,000.00	
		Highfield		33.0%	13.0%	25.0%	$ 25,979,500.00	$ 836,500.00	$ 9,898,500.00	
9	Glenmore Tr SE	Lynnwood/Milican	Low	11.0%	8.0%	5.0%	$ 3,806,000.00	$ 101,624,500.00	$ 470,000.00	
		Ogden		11.0%	8.0%	5.0%	$ 13,326,000.00	$ 185,096,500.00	$ -	
10	130 Avenue SE	South Hill	Medium	33.0%	13.0%	25.0%	$ 19,120,000.00	$ 31,374,500.00	$ 12,780,000.00	
		Quarry Park		33.0%	13.0%	25.0%	$ 42,980,000.00	$ 32,189,000.00	$ 460,630,000.00	
		Douglas Glen		33.0%	13.0%	25.0%	$ 109,660,000.00	$ 99,580,500.00	$ 118,644,500.00	
		Shepard		33.0%	13.0%	25.0%	$ 237,010,000.00	$ -	$ -	
11	Auburn Bay Ave SE	Prestwick	Low	33.0%	13.0%	5.0%	$ 163,250,000.00	$ 571,424,000.00	$ -	
		McKenzie Towne		33.0%	13.0%	5.0%	$ 136,350,000.00	$ 427,538,000.00	$ -	
12	Seton Catchment	Auburn/Mahogany	High	55.0%	18.0%	25.0%	$ 6,470,000.00	$ 351,625,180.00	$ -	
		Hospital		55.0%	18.0%	25.0%	$ 28,550,000.00	$ 82,834,500.00	$ 16,540,000.00	
		Seton		55.0%	18.0%	25.0%	$ 25,900,000.00	$ -	$ -	
	Corridor Total	29	-	36%	14%	18%	$ 1,692,489,000	$ 6,368,240,775	$ 1,502,699,000	

Appendix F: 2046 Property Value Surplus Along Corridor

				Property Value Projections						
	Catchment	Stations	Development Potential According to Character Area Summary	Potential Value Appreciation			2046 Light Rail Corridor Property Values Surplus			
				RETAIL	RESIDENTIAL	OFFICE	2046 Light Rail Corridor Property Surplus RETAIL	2046 Light Rail Corridor Property Surplus RESIDENTIAL	2046 Light Rail Corridor Property Surplus OFFICE	
1	Stoney Tr Catchment	160 Ave N	High	55.0%	18.0%	25.0%	$ -	$ -		
		144 Ave N		55.0%	18.0%	25.0%	$ -	$ -		
2	Beddinton Blvd Catchment	North Pointe	High	55.0%	18.0%	25.0%	$ 217,043,383	$ 161,635,583	$ -	
		96 Ave N		55.0%	18.0%	25.0%	$ 93,529,705	$ 152,548,568	$ 34,843,353	
3	McKnight Catchment	Beddinton Blvd	Medium	33.0%	13.0%	25.0%	$ 77,392,293	$ 123,930,900	$ -	
		72 Ave		33.0%	13.0%	25.0%	$ -	$ -	$ -	
		64 Ave N		33.0%	13.0%	25.0%	$ 76,468,343	$ 123,614,883	$ -	
4	24th Ave Catchment	40 Ave N	Medium	33.0%	18.0%	25.0%	$ 3,931,692	$ 166,501,856	$ 2,594,137	
		28 Ave N		33.0%	18.0%	25.0%	$ 35,650,357	$ 390,638,816	$ 3,702,182	
5	Bow River	16 Ave N	Medium	33.0%	18.0%	25.0%	$ 169,164,077	$ 285,349,823	$ 72,225,926	
		9 Ave N		33.0%	18.0%	25.0%	$ 20,494,700	$ 188,918,227	$ 15,879,454	
6	Downtown	2 Ave SW	Low	11%	8%	1%	$ -	$ -	$ -	
		7 Ave N		11%	8%	1%	$ -	$ -	$ -	
		Centre Street		11%	8%	1%	$ -	$ -	$ -	
7	Dartmouth Rd SE	4 Street SE	High	55.0%	18.0%	5.0%	$ 44,691,606	$ 64,318,208	$ 67,720,684	
		Inglewood/Ramsay		55.0%	18.0%	5.0%	$ 173,834,288	$ 186,994,335	$ 12,935,671	
8	Deerfoot - HW251	26 Ave SE	Medium	33.0%	13.0%	25.0%	$ 4,386,257	$ 14,070,586	$ 3,737,984	
		Highfield		33.0%	13.0%	25.0%	$ 20,809,492	$ 263,953	$ 6,006,564	
9	Glenmore Tr SE	Lynnwood/Milican	Low	11.0%	8.0%	5.0%	$ 1,016,198	$ 19,733,547	$ 57,041	
		Ogden		11.0%	8.0%	5.0%	$ 3,558,027	$ 35,942,223	$ -	
10	130 Avenue SE	South Hill	Medium	33.0%	13.0%	25.0%	$ 15,315,055	$ 9,900,039	$ 7,755,104	
		Quarry Park		33.0%	13.0%	25.0%	$ 34,426,835	$ 10,157,050	$ 279,517,478	
		Douglas Glen		33.0%	13.0%	25.0%	$ 87,837,289	$ 31,422,041	$ 71,995,336	
		Shepard		33.0%	13.0%	25.0%	$ 189,844,208	$ -	$ -	
11	Auburn Bay Ave SE	Prestwick	Low	33.0%	13.0%	5.0%	$ 130,762,697	$ 180,309,484	$ -	
		McKenzie Towne		33.0%	13.0%	5.0%	$ 109,215,889	$ 134,907,103	$ -	
12	Seton Catchment	Auburn/Mahogany	High	55.0%	18.0%	25.0%	$ 8,637,414	$ 153,627,589	$ -	
		Hospital		55.0%	18.0%	25.0%	$ 38,114,089	$ 36,190,993	$ 10,036,730	
		Seton		55.0%	18.0%	25.0%	$ 34,576,354	$ -	$ -	
	Corridor Total	29	-	36%	14%	18%	$ 1,590,700,247	$ 2,470,975,804	$ 589,007,643	

Appendix H: Economic Injection due to Transportation Savings

	LRT Option 1			
	Commuters Taking Green Line LRT	Commuting Money Saved	Regional Economic Injection	Discounted Injenction
2016				
2017				
2018				
2019				
2020				
2021				
2022				
2023				
2024				
2025				
2026	-	$ -	$ -	$ -
2027	1,722	$ 10,602,392.62	$ 2,703,610.12	$ 1,953,145.47
2028	3,445	$ 21,204,785.23	$ 5,515,364.64	$ 3,868,365.79
2029	5,167	$ 31,807,177.85	$ 8,438,507.90	$ 5,746,213.26
2030	6,889	$ 42,409,570.46	$ 11,476,370.74	$ 7,587,233.04
2031	8,611	$ 53,011,963.08	$ 14,632,372.69	$ 9,391,963.23
2032	10,334	$ 63,614,355.70	$ 17,910,024.18	$ 11,160,934.95
2033	12,056	$ 74,216,748.31	$ 21,312,928.77	$ 12,894,672.42
2034	13,778	$ 84,819,140.93	$ 24,844,785.54	$ 14,593,693.05
2035	15,501	$ 95,421,533.54	$ 28,509,391.41	$ 16,258,507.55
2036	17,223	$ 106,023,926.16	$ 32,310,643.59	$ 17,889,619.96
2037	18,945	$ 116,626,318.78	$ 36,252,542.11	$ 19,487,527.76
2038	20,667	$ 127,228,711.39	$ 40,339,192.31	$ 21,052,721.96
2039	22,390	$ 137,831,104.01	$ 44,574,807.51	$ 22,585,687.15
2040	24,112	$ 148,433,496.62	$ 48,963,711.63	$ 24,086,901.61
2041	25,834	$ 159,035,889.24	$ 53,510,342.00	$ 25,556,837.35
2042	27,557	$ 169,638,281.86	$ 58,219,252.09	$ 26,995,960.23
2043	29,279	$ 180,240,674.47	$ 63,095,114.45	$ 28,404,730.00
2044	31,001	$ 190,843,067.09	$ 68,142,723.61	$ 29,783,600.39
2045	32,723	$ 201,445,459.70	$ 73,366,999.09	$ 31,133,019.18
2046	34,446	$ 212,047,852.32	$ 78,772,988.49	$ 32,453,428.27
2047	36,168	$ 222,650,244.94	$ 84,365,870.68	$ 33,745,263.76
2048	37,890	$ 233,252,637.55	$ 90,150,958.95	$ 35,008,956.02
2049	39,613	$ 243,855,030.17	$ 96,133,704.41	$ 36,244,929.76
2050	41,335	$ 254,457,422.78	$ 102,319,699.30	$ 37,453,604.07
2051	43,057	$ 265,059,815.40	$ 108,714,680.51	$ 38,635,392.55
2052	44,779	$ 275,662,208.02	$ 115,324,533.08	$ 39,790,703.32
2053	46,502	$ 286,264,600.63	$ 122,155,293.89	$ 40,919,939.11
2054	48,224	$ 296,866,993.25	$ 129,213,155.31	$ 42,023,497.34
2055	49,946	$ 307,469,385.86	$ 136,504,469.08	$ 43,101,770.16
2056	51,669	$ 318,071,778.48	$ 144,035,750.13	$ 44,155,144.52
			Net Present Value	$ 753,963,963

Appendix I: Alberta Tax Revenue Increase Associated with Green Line

	LRT Option 1		
	Expected GROSS Tax Revenue Increase Along LRT Corridor	Expected NET Tax Revenue Increase Along LRT Corridor	Discounted NET Tax Revenue Increase Along LRT Corridor
2016	$ 44,191,163	$ -	$ -
2017	$ 45,994,563	$ 477,666	$ 463,753
2018	$ 47,837,736	$ 955,332	$ 900,492
2019	$ 49,721,874	$ 1,432,997	$ 1,311,396
2020	$ 51,648,206	$ 1,910,663	$ 1,697,600
2021	$ 53,617,998	$ 2,388,329	$ 2,060,194
2022	$ 55,632,554	$ 2,865,995	$ 2,400,226
2023	$ 57,693,217	$ 3,343,661	$ 2,718,702
2024	$ 59,801,369	$ 3,821,327	$ 3,016,591
2025	$ 61,958,436	$ 4,298,992	$ 3,294,820
2026	$ 64,165,886	$ 4,776,658	$ 3,554,282
2027	$ 66,425,228	$ 5,254,324	$ 3,795,836
2028	$ 68,738,021	$ 5,731,990	$ 4,020,302
2029	$ 71,105,868	$ 6,209,656	$ 4,228,473
2030	$ 73,530,420	$ 6,687,322	$ 4,421,107
2031	$ 76,013,379	$ 7,164,987	$ 4,598,933
2032	$ 78,556,496	$ 7,642,653	$ 4,762,649
2033	$ 81,161,578	$ 8,120,319	$ 4,912,927
2034	$ 83,830,481	$ 8,597,985	$ 5,050,410
2035	$ 86,565,122	$ 9,075,651	$ 5,175,717
2036	$ 89,367,472	$ 9,553,317	$ 5,289,440
2037	$ 92,239,562	$ 10,030,982	$ 5,392,147
2038	$ 95,183,486	$ 10,508,648	$ 5,484,385
2039	$ 98,201,397	$ 10,986,314	$ 5,566,675
2040	$ 101,295,515	$ 11,463,980	$ 5,639,518
2041	$ 104,468,127	$ 11,941,646	$ 5,703,397
2042	$ 107,721,587	$ 12,419,312	$ 5,758,769
2043	$ 111,058,321	$ 12,896,977	$ 5,806,078
2044	$ 114,480,827	$ 13,374,643	$ 5,845,746
2045	$ 117,991,679	$ 13,852,309	$ 5,878,177
2046	$ 121,593,525	$ 14,329,975	$ 5,903,760
2047	$ 125,098,031	$ 14,616,574	$ 5,846,442
2048	$ 128,704,807	$ 14,908,906	$ 5,789,680
2049	$ 132,416,862	$ 15,207,084	$ 5,733,470
2050	$ 136,237,297	$ 15,511,226	$ 5,677,805
2051	$ 140,169,303	$ 15,821,450	$ 5,622,681
2052	$ 144,216,168	$ 16,137,879	$ 5,568,092
2053	$ 148,381,274	$ 16,460,637	$ 5,514,032
2054	$ 152,668,106	$ 16,789,850	$ 5,460,498
2055	$ 157,080,251	$ 17,125,647	$ 5,407,484
2056	$ 161,621,402	$ 17,468,160	$ 5,354,984
		Net Present Value	$ 180,627,668
		Av. Yearly Benefit	$ 4,405,553

Appendix J: Calgary Tax Revenue Increase Associated with Green Line

	Baseline			LRT Option 1		
	Expected Tax Revenue Increase Along LRT Corridor			Expected GROSS Tax Revenue Increase Along LRT Corridor	Expected NET Tax Revenue Increase Along LRT Corridor	Discounted NET Tax Revenue Increase Along LRT Corridor
2016	$ 44,191,163		2016	$ 44,191,162.58	$ -	$ -
2017	$ 45,516,897		2017	$ 46,705,501.09	$ 1,188,604	$ 1,153,984
2018	$ 46,882,404		2018	$ 49,259,611.64	$ 2,377,207	$ 2,240,746
2019	$ 48,288,877		2019	$ 51,854,687.40	$ 3,565,811	$ 3,263,222
2020	$ 49,737,543		2020	$ 54,491,957.32	$ 4,754,415	$ 4,224,236
2021	$ 51,229,669		2021	$ 57,172,687.23	$ 5,943,018	$ 5,126,500
2022	$ 52,766,559		2022	$ 59,898,180.93	$ 7,131,622	$ 5,972,621
2023	$ 54,349,556		2023	$ 62,669,781.33	$ 8,320,225	$ 6,765,105
2024	$ 55,980,043		2024	$ 65,488,871.64	$ 9,508,829	$ 7,506,357
2025	$ 57,659,444		2025	$ 68,356,876.54	$ 10,697,433	$ 8,198,691
2026	$ 59,389,227		2026	$ 71,275,263.49	$ 11,886,036	$ 8,844,327
2027	$ 61,170,904		2027	$ 74,245,543.93	$ 13,074,640	$ 9,445,398
2028	$ 63,006,031		2028	$ 77,269,274.68	$ 14,263,244	$ 10,003,952
2029	$ 64,896,212		2029	$ 80,348,059.24	$ 15,451,847	$ 10,521,956
2030	$ 66,843,098		2030	$ 83,483,549.23	$ 16,640,451	$ 11,001,298
2031	$ 68,848,391		2031	$ 86,677,445.81	$ 17,829,054	$ 11,443,792
2032	$ 70,913,843		2032	$ 89,931,501.18	$ 19,017,658	$ 11,851,176
2033	$ 73,041,258		2033	$ 93,247,520.10	$ 20,206,262	$ 12,225,121
2034	$ 75,232,496		2034	$ 96,627,361.48	$ 21,394,865	$ 12,567,228
2035	$ 77,489,471		2035	$ 100,072,939.99	$ 22,583,469	$ 12,879,037
2036	$ 79,814,155		2036	$ 103,586,227.75	$ 23,772,073	$ 13,162,020
2037	$ 82,208,580		2037	$ 107,169,256.03	$ 24,960,676	$ 13,417,593
2038	$ 84,674,837		2038	$ 110,824,117.06	$ 26,149,280	$ 13,647,113
2039	$ 87,215,082		2039	$ 114,552,965.80	$ 27,337,883	$ 13,851,880
2040	$ 89,831,535		2040	$ 118,358,021.90	$ 28,526,487	$ 14,033,141
2041	$ 92,526,481		2041	$ 122,241,571.57	$ 29,715,091	$ 14,192,093
2042	$ 95,302,275		2042	$ 126,205,969.63	$ 30,903,694	$ 14,329,880
2043	$ 98,161,344		2043	$ 130,253,641.51	$ 32,092,298	$ 14,447,601
2044	$ 101,106,184		2044	$ 134,387,085.45	$ 33,280,902	$ 14,546,308
2045	$ 104,139,369		2045	$ 138,608,874.59	$ 34,469,505	$ 14,627,009
2046	$ 107,263,551		2046	$ 142,921,659.30	$ 35,658,109	$ 14,690,669
2047	$ 110,481,457		2047	$ 146,852,727.99	$ 36,371,271	$ 14,548,041
2048	$ 113,795,901		2048	$ 150,894,597.12	$ 37,098,696	$ 14,406,798
2049	$ 117,209,778		2049	$ 155,050,448.07	$ 37,840,670	$ 14,266,926
2050	$ 120,726,071		2050	$ 159,323,554.81	$ 38,597,484	$ 14,128,412
2051	$ 124,347,853		2051	$ 163,717,286.62	$ 39,369,433	$ 13,991,243
2052	$ 128,078,289		2052	$ 168,235,110.88	$ 40,156,822	$ 13,855,406
2053	$ 131,920,637		2053	$ 172,880,595.99	$ 40,959,959	$ 13,720,887
2054	$ 135,878,257		2054	$ 177,657,414.28	$ 41,779,158	$ 13,587,675
2055	$ 139,954,604		2055	$ 182,569,345.13	$ 42,614,741	$ 13,455,756
2056	$ 144,153,242		2056	$ 187,620,278.08	$ 43,467,036	$ 13,325,117
					Net Present Value	$ 449,466,315
					Av. Yearly Benefit	$ 10,962,593

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A2. Economic Impact Analysis
City of Calgary

Economic Impact Analysis of the Green Line LRT

Corporate Economics

City of Calgary

August 5, 2016

Contents

1. Introduction

The following analysis is prepared at the request of The City of Calgary's Transportation Infrastructure business unit. Corporate Economics was asked to analyze the impacts of the construction of the Green Line on the regional economy (Calgary Economic Region or CER).

The proposed Green Line will be an important piece of Calgary's LRT network and is the highest public transit infrastructure priority for The City. With its estimated cost of $4 to $5 billion in today's dollar, the investment in this project will bring short-term stimulus and long-term economic benefits to the local economy.

2. Methodology

The calculations for the project are prepared with the aid of a multi-sector economic forecast model of the Calgary economy (C4SE) and an Input-output (IO) model for the CER (Corporate Economics). From the forecast model the impact of the Green Line on the economy is estimated by comparing two almost identical economic scenarios for the CER: (A) base case scenario that the Green Line will not be built; and (B) a shock scenario that the Green Line will be built. The differences between the base and shock scenarios are the impacts of the Green Line project on the regional economy; represented by changes to GDP, employment, population, and personal income levels over time (2017-2046).

The regional IO model is an open model which means that only direct and indirect effects[1] are measured using industry multipliers[2]. The economic impacts during construction phase (2017-2026) are estimated as direct and indirect jobs[3] created by Green Line investment, and the increases in Gross Output, GDP and regional income excluding induced effects.

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[1] There are three types of effects measured with a multiplier: the direct, the indirect, and the induced effects. The direct effect takes place only in the industry immediately affected. The indirect effect is the business-to-business transactions required to satisfy the direct effect. Induced effects measure the effects of the changes in household income and are derived from local spending on goods and services by people working to satisfy the direct and indirect effects.

[2] Multipliers are a numeric way of quantifying the secondary impacts stemming from a change such as building the Green Line project.

[3] Direct jobs are the jobs immediately created by constructing the Green Line LRT. Indirect jobs are the jobs added in other industries that supply goods and services to the construction industries.

3. Assumptions[4]

Spending assumptions for the construction of the Green Line are presented in table 1 and were provided by the consulting firm Hatch.

Table 1. Green Line construction investment assumption	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Distribution of Investment less Land Purchases (in $2016 millions)	20	30	207	567	907	907	897	717	277	72.8	4,602
Inflated Investment Costs (2% per year) ($million, 2016 as base year)	20	31	220	614	1,001	1,021	1,030	840	331	89	5,198
Construction investment distribution over time (%)	0.4%	0.7%	4.5%	12.3%	19.7%	19.7%	19.5%	15.6%	6.0%	1.6%	100%
Machinery & equipment (M&E) Purchases (in $2016 million)				190	190	190	180				750
M&E Inflated ($million, 2016 as base year)				206	210	214	207				836
M&E share of total investment											16%

In Table 1, the construction costs include expenditures on non-residential construction, engineering construction and machinery and equipment purchases, but exclude land purchases[5].

Construction of the project starts in 2017 and ends in 2026. Full operation of the Green Line will start in 2026. The total cost in construction phase is $4,602 million in $2016 dollars and $5,198 million in nominal dollar values. The construction investment distribution is the ratio of annual expenditure to the total construction costs (between 2017 and 2026). Machinery and equipment (M&E) purchases ($750 million in $2016) should account for 16 per cent of the total construction budget.

The Green Line project is categorized as government owned investment in the transportation and warehousing industry. Following the North American Industry Classification System (NAICS) code, the expenditures are allocated to three categories: non-residential building construction, engineering construction, and machinery and equipment purchase.

As no project specific information was available, industry standards were used to arrive at values for variables such as construction price deflator, productivity and labour/cost ratios. For example, the construction and operation employment numbers are estimated using the labour/capital ratios in the industry. The share of building construction is taken from the industry

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[4] Some investment assumptions are provided by Hatch and others are taken from industry standards wherever project specific data is not available.
[5] Land sales do not count as part of GDP.

standard (5 per cent) and thus the engineering construction share is calculated as 79 per cent. These assumptions are summarized as follow:

Investment industry	Construcvtion employment (total)	Labour/capital ratio (LKC) during construction	Operations employment (annual)	Labour/capital ratio (LKO) in annual operation	M&E share of investment	Building construction share of investment	Engineering share of investment	M&E depreciation rate	Building/structure depreciation rate
Transportation & ware housing	11,919	2.59	230	0.05	16%	5%	79%	0.05	0.02

Other important assumptions include average weekly wage rates for Alberta's engineering construction ($94,000) and non-residential building construction ($84,000) taken from Statistics Canada Survey of Employment, Payrolls and Hours (SEPH) data[6]. Profit rate and tax rate for construction companies are assumed as 8% and 5% respectively. Overhead fee is set as 2% of investment plus GST taxes.

[6] Statistics Canada CANSIM 281-0027, numbers also reflect overtime pay of workers

4. Results

The calculations from the forecast model show that the Green Line project will have a positive net economic impact (shock – base) on the city's economy over a 30 year period. In summary, investment in the Green Line will provide short-term stimulus in the construction phase, and generate long-term economic benefits to the region due to higher capital stock built through the project.

Specifically, all shock-minus-base indicators show a three phase pattern:

1) Overshoot phase; positive level difference from base case: when spending on the Green Line construction ramps up, the local economy will achieve a positive multiplier effect[7]. GDP, employment, net-in migration, population and personal income all increase during this period. Also, due to the cost inflation introduced to the system through the construction phase of the shock – higher wage inflation and wage rate due to tighter labour markets would be experienced. This would support higher level consumer spending and overall economic activity.

2) Undershoot phase; negative level difference from base case: as the construction investment phase ends and transitions to the operations phase, the local economy will experience a negative multiplier effect[8]. The completion of the construction will see workers leaving the region for new jobs elsewhere. This would relieve pressure on labour markets and wage inflation would be reduced and this has a negative effect on consumer spending.

3) Smaller positive level differences from base case: over the longer term economic activities (GDP and employment) cycle up and down as the operation of the line begins

The calculations from the IO model show that excluding the induced effect on household sector, the Green Line project will create more than 20,200 direct and indirect jobs from 2017 to 2026. The other economic impacts of the project are as follows; $6.7 billion increase in regional gross

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[7] The multiplier effect refers to the increase in final income arising from any new injection of spending.
[8] In other words, the ramping down of the project begins to displace workers from the region, as fewer resources are required and corresponding reducing incomes as well.

output, $2.8 billion increase in regional GDP, and $1.9 billion increase in regional income, over the next ten years (2017-2026). The gross regional multiplier is defined by the ratio of regional gross output divided by the total capital expenditure, generating a multiplier value of 1.556.

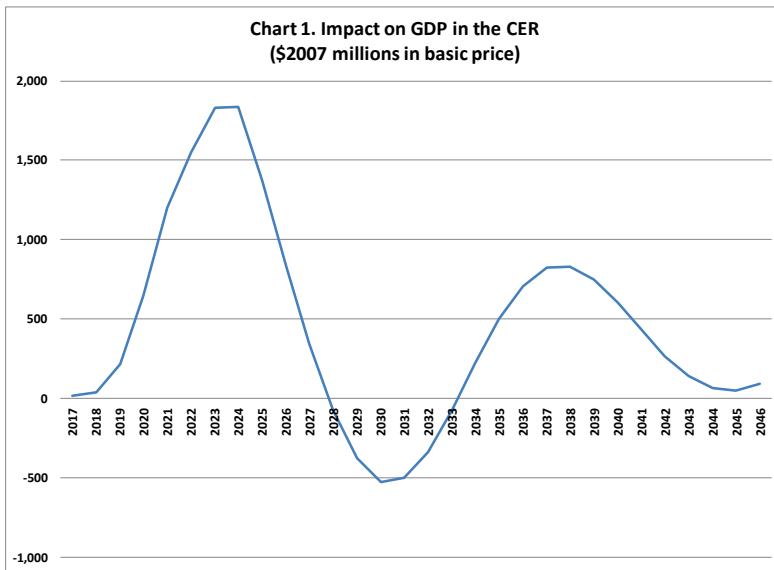More detailed results are shown in the following charts and tables.

a. Impact on GDP

Chart 1. Impact on GDP in the CER
($2007 millions in basic price)

Chart 1 shows the Green Line's impact on real GDP from 2017 to 2046. Real GDP increases during the construction phase and immediately after the construction is completed GDP is adversely affected, and then increases again in the longer term.

The accumulated net impact on real GDP at basic prices due to the Green Line project is shown in table 1. In the construction period (2017-2026), the real GDP in $2007 will be larger by $10,136 million than the base scenario, driven by direct investments in construction, plant and equipment, and followed by induced effects of increasing consumer expenditures. The total impact on GDP in the operation phase (2027-2046) is positive ($4,066 million in $2007). Overall, the accumulated increase in real GDP from 2019 to 2046 is $14,202 million ($2007), about 15 per cent of the region's total GDP in 2015.

Table 2. Accumulated total impact on real GDP at basic prices			
	2017-2026	2027-2046	2017-2046
Real GDP (millions in $2007)	10,136	4,066	14,202

b. Impact on Employment

The immediate impacts on employment from the Green Line project are the new jobs created in the building and engineering construction industries during the construction phase (2017-2026). It is estimated that, a total of 12,049 (person years) direct jobs will be created in the construction industry, and 8,150 (person years) indirect jobs will be created in the supporting industries. In other words, it is estimated that over the next ten years, on average every year there will be 1,205 workers directly in construction and 815 workers in the supply chain.
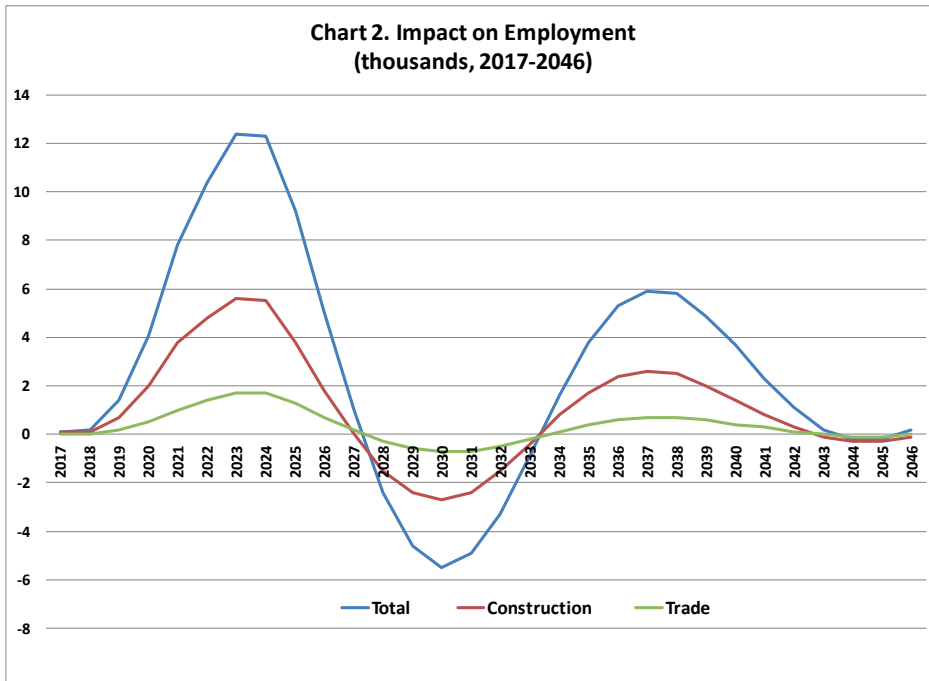

Chart 2. Impact on Employment
(thousands, 2017-2046)

Chart 2 shows the total impact of Green Line investment on employment in the CER, including direct jobs, indirect jobs, and induced jobs[9]. The project will bring more jobs to the region mainly in the construction phase, benefiting mostly the construction and trade industries. After the project is completed, some workers would leave the region and this would result in a lower level of employment. However, total employment will ramp up again with the higher capital stock built in the region requiring more workers.

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[9] Induced jobs are those jobs not related directly to Green Line.

On average, the Green Line project will create 6,500 jobs per year in all industries during the construction phase, including 1,205 direct jobs, 815 indirect jobs and 4,480 induced jobs. From 2017 to 2046, an annual average of 2,600 jobs will be added in the CER with the Green Line investments.

c. Impact on Net-migration and Population

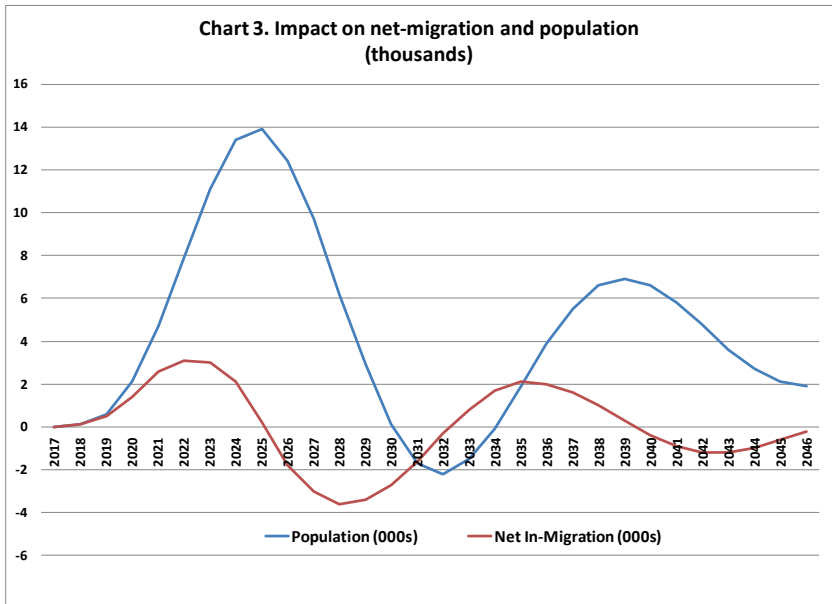Chart 3. Impact on net-migration and population (thousands)

Chart 3 shows that Green Line investment will attract more migration to the region (as job opportunities improve) which will increase the child bearing age cohort and thus increases population through new births. The increase in net in-migration will decline and dip into negative after the construction phase, but return to positive after the economy adjusts to the new balance. The population increases compared to the base case scenario follows the pattern of the net in-migration, albeit with a time lag.

Over all, the Green Line's impacts on population are positive in all phases. But the net in-migration from 2017 to 2046 will be zero. See table 3 for details.

Table 3. Average annual impacts on population (thousands)

	2017-2026	2027-2046	2017-2046
Population (000s)	7	3	4
Net In-Migration (000s)	1	(1)	0

d. Impact on personal income

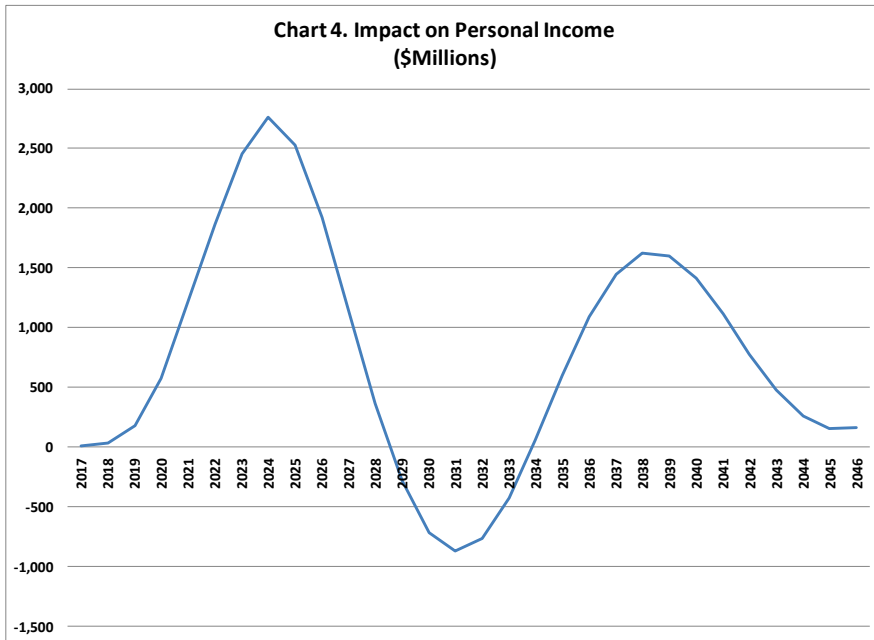Chart 4. Impact on Personal Income ($Millions)

Chart 4 shows that the Green Line's impact on personal income is net positive. The small negative impact is seen for several years after the completion of the construction due to the workers leaving the region.

Personal income will increase by billions of dollars with the investment in Green Line. It can be seen in table 4 that on average there will be $774 million increase annually in personal income over the next thirty years.

Table 4. Averagde annual impact on income ($million)			
	2017-2026	2027-2046	2017-2046
Personal Income ($Millions)	1,393	464	774

5. Conclusion

The shock-minus-base results show that the Green Line project will have positive impacts on Calgary's economy, both during the construction phase and in the long-term, driven by the multiplier effect of the investment. Investment in the Green Line project will bring both short-term stimulus and long-term economic benefits to the Calgary Economic Region, through higher GDP, employment, population, and personal income.

A

A3. Economic Research Briefing
Calgary Economic Development

research **briefing**

primary:	Nicole Mullings, Research Analyst, Research & Strategy, Calgary Economic Development
secondary:	Court Ellingson, Vice President, Research & Strategy, Calgary Economic Development
re:	**Green Line Business Case for Provincial Funding**
deadline:	August 3, 2016
scope:	Qualitative analysis. Show the value of investing in the Green Line and to showcase the potential for the Green Line to have a positive impact on Calgarians.
priorities:	1. Research potential for Green Line to play a role in attracting new and diverse businesses to Calgary. 2. Literature review of case studies showing how other cities have worked to diversify their economies and how transit has played a role in this. Link these case studies to Calgary to show how Green Line could play an important role in Calgary's economic development. 3. Brief summary describing the potential for Green Line to contribute to attracting new & diverse business to Calgary (to be included in the business case). Any existing graphics that could be used for this. 4. City of Calgary summer students are working on a research project related to economic diversification. Share research and identify research gaps that Calgary Economic Development could focus on as well as build upon the work that the students have already completed. 5. If there is time: Look into the potential impacts to property value. Look at comparable Canadian/North American cities to see how transit (especially LRT) has impacted property value. Research into any hedonic modeling work that has been done in comparable cities would be helpful.
keywords:	urban public transportation, light rail transit (LRT), economic development
link:	https://drive.google.com/folderview?id=0B6YdQLMsmqN7Z2JHZlh6enFwZ1U&usp=sharing
file paths:	S:\RS\Library\Infrastructure, Urban Planning\Green Line S:\RS\Research\Green Line

EXECUTIVE SUMMARY

Calgary Economic Development is the steward for **Building on our Energy: 10 Year Economic Strategy for Calgary**. The Economic Strategy provides the road map for economic growth and diversification and shared prosperity for Calgary. Calgary Economic Development acknowledges the Government of Alberta's support for municipal public transportation projects through funding initiatives and GreenTRIP. We are pleased to contribute to the budget deliberations and submit a business case for Calgary's Green Line light rail transit corridor. Calgary Economic Development will work with stakeholders to support a strategy that attracts new and diverse businesses in communities along the Green Line.

Cities are engines of economic growth. Although urban mobility is one of the toughest challenges faced by cities, investment in effective public transit systems supports economic growth, is cost-effective, environmentally friendly and provides enhanced mobility and safety within our communities. According to Canadian Urban Transit Association (2010), municipalities are facing cost pressures due to lagging investment in transit and growth in capital requirements. Critical infrastructure needs are remaining unfunded while ridership grows. Increase in transit ridership has consistently outpaced population growth in Canada, with travel in urban areas expected to triple globally by 2050 (Canadian Urban Transit Association, 2010; Little, 2014).

Public transit is essential in supporting public and private sector services and contributes to reducing our carbon footprint. Calgary is currently experiencing an economic downturn with layoffs of skilled workers in the energy sector estimated at 43,000 between December 2014 and May 2016, negative 2.5 percent GDP growth in 2015 and forecasted contraction of negative 1.0 percent GDP growth for 2016 (Johnson, 2016; Conference Board of Canada, 2016). Numerous studies have found strong links between infrastructure projects and economic growth. A Statistics Canada (2009) study found returns on infrastructure investment as high as 17 percent to 25 percent. The potential of the Green Line to spur economic growth, attract talent, increase real estate values and contribute to diversifying Calgary's economy is considerable.

ECONOMIC GAINS FROM TRANSIT INFRASTRUCTURE

In 1996 the Smart Growth Network created 10 smart growth principles for improving urban competitiveness and economic success for businesses such as increased productivity and innovation, talent attraction and retail sales growth (United States Environmental Protection Agency, 2013). These smart growth principles include mix land use, compact building design, walkable neighbourhoods (within 400 meters or less from rapid transit stations), distinctive communities and a variety of transportation options available to residents. Infrastructure projects support improving urban competitiveness, business density and economic productivity.

The Conference Board of Canada (2013) found investment in infrastructure contributed to 25 percent of overall labour productivity growth. Creative, educated and talented people are attracted to cities providing a range of employment opportunities with diverse communities and streetscapes that are culturally distinctive, amenity rich and of high quality design (Gertler, M., Florida, R., Gates, G., & Vinodrai, T., 2002). Urban areas that offer these characteristics will be more competitive in attracting/retaining talent and supporting growth of technology-intensive economic activities. Additionally, there are a number of studies linking access to transportation options with increased employee wellness and reduced absenteeism, contributing to improved labour productivity.

The geographic concentration of people and businesses, known as industry clusters, agglomeration economies and city regions, generate important benefits for businesses located within them. A U.S. study found that businesses choose locations in close proximity to other businesses and seek "ways to get people to these places (American Public Transportation Association, 2013)." Concentration of businesses leads to property value uplift and increased footfall to local businesses through construction of larger developments within the area (Webber & Athey, 2007). Benefits for businesses include easier access to suppliers and knowledge spillovers, which leads to increased productivity and innovation, the adoption of more efficient processes and creation of new products and services (Webber & Athey, 2007).

The development of the Green Line provides synergistic opportunities to support creation of innovation districts in non-residential areas along the route. Innovation districts leverage the distinct economic strengths of each metropolitan area (Katz & Wagner, 2014). Economic growth is likely to occur capitalizing on opportunities and supporting development of innovation clusters in already strong sectors. Transportation and logistics is one of Calgary's strongest growth sectors. In the Transportation and Warehousing industry, Calgary experienced 17% and 23% GDP growth over the past 5 and 10 years respectively and in the Wholesale and Retail Trade industry Calgary experienced 20% and 35% GDP growth over the past 5 and 10 years respectively (Calgary Economic Development, 2016b). Additionally, the Transportation and Warehousing industry experienced the highest employment growth rate of all Calgary industries over the past 5 and 10 years. There may be future opportunities to link continued growth in Calgary's transportation and logistics sector with development of the Green Line.

Development of the Green Line could contribute to increasing density of businesses along the Calgary's north east/south east corridor and generating a greater total benefit to productivity. Studies conducted of the Dallas Area Rapid Transit (DART) system found that between 1993 and 2013 $225 million of office and $393 million of retail development occurred with 0.25 miles of DART stations. This compares to $45 million of office and $300 million of retail that occurred in other areas of the city (Clower, T. et al., 2014). In addition, the study found offices located within 0.25 miles of DART stations earned 13.9% higher rental rates than other offices. The Wall Street Journal reported that the Los Angeles subway system led to the development of a 640,000 ft2 entertainment retail complex with a 640 room hotel (APTA 2001).

Investing in housing developments along the Green Line will stimulate economic growth and employment. A 2012 Federation of Canadian Municipalities report indicated that 3 full-time jobs and 10 ancillary jobs are created with every $1 million dollars of investment in new construction and housing renovations.

CASE STUDY: Toronto

The Greater Toronto Area (GTA) is Canada's most populated metropolitan area, with a population of 6.13 million persons in 2015 (Statistics Canada, 2015). More residents of Toronto are choosing public transit to commute to work than ever before. A comparison of urban transit systems by the Pembina Institute (2014) found that Toronto has the highest rapid transit ridership per capita of any major Canadian city, with 34 percent of residents living within 1 km of existing rapid transit service and an average of more than 1.6 million commuters each weekday (Pembina Institute, 2014; Toronto Transit Commission, 2015). Access to transit routes contributes to Toronto's standing as one of North America's most

competitive office markets, as many employment districts are within walking accessible distance of rapid transit.

While the GTA has high ridership per capita, the average commuter spends more than 80 minutes daily traveling to and from destinations (Jones Lang LaSalle, 2013). The GTA loses approximately $6 billion each year in productivity and 26,000 jobs due to traffic congestion (Jones Lang LaSalle, 2013). Recent Colliers International (2015) research on Toronto found that more than 60% of office space is within walking distance to public transit and confirmed that "there is an increased demand and willingness to pay a premium for office space within walking distance of rapid public transit."

Research conducted by Jones Lang Lasalle (2013) found that the expansion of Yonge-University-Spadina subway in 1973 led developers to focus outside the financial core to lower costs (rent and taxes) for tenants. Virtually all commercial buildings on the North Yonge subway line were constructed after completion of the subway and 83% are within 0.5km of a subway station. Further, direct vacancy of buildings within 0.5km of a subway station was 4.3% compared to 9.8% for other buildings. More broadly, on transit buildings in Toronto had vacancy rates of 5.6% compared to 12.1% of off transit buildings. Finally, on transit buildings were found to command a 38% premium in rental rates. This trend appears to be continuing in Toronto with more than 2.5 million square feet of under construction high quality Class A office space is within walking distance of rapid public transit (Colliers International 2015).

Office employment is shifting away from Downtown Toronto to suburban markets and regions outside of the GTA. With Toronto's expanding transit infrastructure under development in decentralized areas, new business hubs are emerging. Upon completion, the SmartTrack transit system in the GTA would potentially serve Downtown, GTA West, East and North; the Eglinton Crosstown LRT system would serve Central East and is slated for completion in 2020; and, a potential GO Train expansion could serve the entire Kitchener-Waterloo region if the proposed CN North Mainline plan moves forward. Developers are capitalizing on these real estate opportunities, as for example with the sale of Celestica's property near the Eglinton Crosstown LRT to a group of developers planning an office, retail and residential mixed-use community (REMI Network, 2015).

NEIGHBOURHOOD REVITALIZATION

The Green Line will end-to-end connect North Pointe and Seton to Calgary's downtown core with 40 km of track serving an estimated 41 million passengers annually. The Green Line will bisect Calgary's downtown, with several stations under review near business revitalization zones including Downtown, Chinatown District, Victoria Park and Inglewood. There are many opportunities to identify and regain lost and underutilized spaces within the communities along the Green Line North and South transit ways. In 2002, Boston began a $37.2 million, four station transit system upgrade connecting downtown to the outskirts of the city. Since then, communities along the route have since revitalized with development corporations buying and rebuilding 1,500 housing units, developing 780,000 square feet of commercial space and creating 1,300 jobs (McKinsey & Company, 2013).

Attracting and retaining businesses in non-core business areas and transit corridors requires encouraging mixed-use development, improving streetscapes to encourage walking, capitalizing on assets and investment in transit options for professionals and pedestrians. Gertler (2004) argues city regions must retain authenticity of culturally and historically significant buildings, streets and districts; environment assets are protected; land use mixes

are sufficiently vibrant to support an urban economy; and, alternative transit options are readily available and of high quality. Residents of urban areas are choosing more often to live in places that are "walkable, bike-able, and connected by transit and technology (Katz & Wagner, 2014)."

Walkability is a mechanism influencing a place's triple bottom line, increasing economic, people and environmental performance (Leinberger & Alfonzo, 2012). More walkable places perform better commercially, with increased premiums to office rents, retail rents, retail sales and higher residential rents and property values. A United States study of commercial and retail properties found that on a 100 point scale, a 10 point increase in walkability was associated with a 9 percent increase in property market value and 7 percent increase in net operating income (Fisher & Pivo, 2010).

CASE STUDY: Vancouver

Vancouver has built the most rapid transit lines over the last 20 years of major cities in Canada (Pembina Institute, 2014). Vancouver's Canada Line high speed train launched in 2009 and now carries more than 122,000 people on weekdays, equivalent to more than 10 lanes of highway (SNC-Lavalin, 2015). The Canada Line ranks as one of the largest public private partnerships in Canada historically. As of June 2016, Metro Vancouver received additional funding commitments of almost $900 million dollars from all three levels of government to further enhance the city's transit system (Olivier, C & Sinoski, K., 2016). Vancouver has changed its zoning rules to encourage building density and place more destinations within walking distance of public transit. Developers contributed private funds towards stations and residential projects along the Canada Line. Local and international commercial real estate development followed increasing densification of the area and directly impacting airport growth due to more seamless access.

A recent Wall Street Journal article by Michael Totty (2016) highlighted five cities leading the way in urban innovation, with Vancouver leading the way in improving walkability. According to Walk Score (2016), Vancouver is Canada's most walkable city with its excellent public transit system and very walkable neighbourhoods. Walkable cities provide more mobility choices, benefit from being near other walkable places and perform better economically (Leinberger & Alfonzo, 2012). Increased availability of public transit reduces traffic congestion and health care costs associated with vehicular travel, encouraging a more healthy and active population. Public transit saves $115 million annually in Canadian health care costs (Canadian Urban Transit Association, 2010).

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B

B1. Environmental Benefits
City of Calgary

GREEN LINE LRT – ENVIRONMENTAL BENEFITS

EXECUTIVE SUMMARY

This report outlines Administration's current understanding and quantification of the potential environmental benefits associated with delivery and operation of Green Line, Calgary's third light rail transit (LRT) line. Information presented in this report, and additional information that becomes available in time, may be used in support of business cases being prepared for submission to provincial and federal governments. The Province of Alberta in 2015 released its Climate Leadership Plan and a new carbon tax scheme that would generate revenues potentially used to make investments in energy efficiency including public transit infrastructure.

Key environmental benefits of the Green Line include the following:

- Energy efficiency gains are achieved with only 18 passengers riding an LRT train, which is the "break even" point for LRT to save energy compared with 18 automobiles;
- It presents opportunities to leverage Calgary Transit's past investments and experience gained in energy efficiency, pollution control, and renewable energy;
- The introduction of Green Line would directly reduce greenhouse gas (GHG) emissions by 52,000 tonnes of carbon dioxide equivalent annually;
- Twenty-two million litres of gasoline and diesel fuel consumed annually would be displaced by renewable electricity (or lower carbon energy) used to power Green Line;
- A two per cent reduction of smog-forming tailpipe emissions is projected; and
- Land use densification in transit nodes and corridors will be facilitated by Green Line LRT development resulting in further long-term environmental benefits.

This new line, combined with ongoing transit service enhancements and changes in land use, is projected to result in significantly increased transit ridership on opening day with the benefits continuing to grow beyond 2024. The 3-line LRT network, with feeder buses and cross-town BRT routes that better connect all communities and key areas of employment, will offer Calgarians more accessibility to public transit and more convenience of use than ever before; It will offer not just a viable choice but, for more people, a compelling choice over the automobile for meeting daily needs. Green Line may be the critical catalyst for broader adoption of public transit and greater movement toward the modal split targets of Calgary Transportation Plan.

ADMINISTRATION RECOMMENDATIONS

Administration recommends that Council:
1. Receive this report for information; and
2. Utilize these environmental benefits to support The City's request for Provincial funding support of Green Line.

PREVIOUS COUNCIL DIRECTION / POLICY

At the 2016 January 26 Regular Meeting, Council approved the following as part of Notice of Motion NM2016-03 (Councillor Keating):
"THEREFORE BE IT RESOLVED that Transportation prepare a report that quantifies the benefit the Green Line LRT will make towards greater energy efficiency and a reduction in carbon emissions.

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AND FURTHER BE IT RESOLVED that this information report be presented at the regular Council meeting on February 22, 2016."

BACKGROUND

The Green Line project vision is to create a transit service that improves mobility in existing and new communities in north and southeast Calgary, connecting people and places, and enhancing the quality of life in the city. A quarter of the city's population lives along the 40 km long corridor.

Between 2013 and 2016 considerable work has been undertaken by Administration on both Green Line Southeast and Green Line North that includes:
- Stakeholder engagement;
- Land use planning policy amendment and development;
- Land use re-designations;
- Land acquisition for track, stations, and other associated infrastructure;
- Transit-oriented development (TOD) planning studies; and
- Engineering and environmental studies of the alignment.

By the end of 2016, functional planning for the northern and downtown sections of Green Line will be complete. Following Council approval of the functional plan, preliminary design work will commence. Some construction activities such as utility relocation can begin along the entire Green Line project as soon as 2017. The timeline for detailed design and construction will be influenced by the delivery method chosen for the project.

Attachments to the Green Line Funding, Staging and Delivery report (TT2015-0881) include projections for ridership and transit demand in the corridor, but the potential GHG emission reductions associated with those estimates were not quantified.

INVESTIGATION: ALTERNATIVES AND ANALYSIS

Energy Efficiency
Green Line presents opportunities to achieve greater energy efficiency in at least three ways:
1. It represents a technology shift from the internal combustion engine to an electric engine
2. It will enable more Calgarians to make a travel mode shift, from automobiles to transit
3. It will enable long-term changes in land use patterns by supporting urban intensification.

In general, electricity allows for more efficient use of energy resources for transportation purposes. The technology shift entails the movement of people by light rail vehicles, propelled by electric motors that are 96.5 per cent efficient, versus by automobiles with conventional gasoline internal combustion engines that are typically only 25 to 30 per cent efficient.

Additionally, a shift in travel mode from automobile to LRT (and from diesel bus to LRT) will result in significant energy efficiency gains owing to economies of scale. A person travelling by single occupancy vehicle (SOV) uses on average one kilowatt-hour of energy per kilometre (kWh/km) of travel, compared with a passenger on a lightly loaded (80 passengers/car) train who consumes only 0.07 kWh/km. Accordingly, in that comparison the energy efficiency gains achieved by mode shift would be 93 per cent in absolute terms.

Approval(s): Logan, Malcolm concurs with this report. Author: Askey, Ethan.

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The "break even" point, in terms of energy efficiency per person compared with SOV driving, is reached with only 18 passengers on a 3-car train. Every additional LRT passenger increases that efficiency, and at maximum capacity (approximately 1050 passengers) the LRT is about 58 times more energy efficient than SOV driving on a per person basis.

A further consideration for greater energy efficiency has to do with the design and operation of the LRT system and associated facilities. In 2014 the Transportation department completed The City's first Energy Management Plan to identify opportunities for energy efficiency and conservation, energy supply diversification, and shifting to lower carbon and renewable energy. A scan of technical literature and international industry practice was combined with a review of our own experience gained from the development and operation of Calgary's Red Line and Blue Line over the past 25 years, including pilot applications and innovations in sustainable building, to identify potential energy saving opportunities. The following are examples of energy efficiency measures that have already been applied or explored by Calgary Transit, and are potentially applicable to Green Line for greatest energy efficiency:

- Leadership in Energy and Environmental Design (LEED) standards for facilities;
- Solar photovoltaic (PV) panel array installation at facilities with two-way metering;
- Light emitting diode (LED) lighting at stations, platforms, parking lots and facilities;
- Lighting control systems;
- Combined heat and power (CHP) energy systems at transit facilities and nodes;
- Recovery of train braking energy for reuse in traction power, and capturing that energy for storage on-board trains and/or wayside; and
- Choice of light rail vehicle (LRV) model, weight, and accessories affecting power draw and system efficiency.

Carbon Emission Reductions in 2024 with Green Line
Calgary's CTrain is widely known to be North America's first wind-powered public transit system. The City has been able to claim this credit as a result of various investments and initiatives, most notably its renewable energy supply contract with Enmax Energy Corporation. This renewable energy supply is key to The City being on track to meet its targeted 20 per cent reduction in corporate GHG emissions reduction from a 2005 baseline by the year 2020. However, there remains a wide gap between that target and community-wide emissions, with increasing automobile emissions (in step with population growth) partly accounting for that gap. The addition of Green Line to The City's LRT network would significantly contribute to GHG emissions reduction primarily as a result of travel mode shifting, enabling more people to choose public transit over automobiles.

Quantification of emission reductions to be achieved with delivery and operation of Green Line in 2024 is influenced by several factors and assumptions. Significantly greater emission reductions may be achievable over the long term, as discussed later in this report.

The Forecasting division of The City's Transportation Planning business unit employs a sophisticated travel demand model to perform detailed analysis and test different scenarios. This is a computer simulation of travel behaviour in the city and surrounding region for all travel

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modes. The Regional Transportation Model (RTM) is periodically updated with information collected through household travel and activity surveys, and with independent validation data that include road traffic, transit, bicycle and pedestrian counts. This data is used to develop the equations in the RTM that estimate travel demand and daily choices people make about where, when and how they travel on the transportation network. Many inputs to the model include data on the density and distribution of population and jobs, and other land use information.

The RTM was used to assess two different scenarios in the year 2024: a base scenario (with no new LRT) and a Green Line scenario. Results from the model run indicate that the introduction of Green Line would directly reduce carbon dioxide equivalent emissions by almost 52,000 tonnes annually, with the reduced consumption of approximately:

- 19.5 million litres of gasoline;
- 2.4 million litres of diesel fuel (from all vehicles); and including
- 2.1 million litres of diesel fuel from Transit vehicles.

The full emission reductions can be realized if the Green Line is powered by renewable energy. This includes two assumptions:

1) The City's Electricity Services Agreement with Enmax is renewed in 2026, including a continued renewable electricity commitment for City operations; and
2) A supply of new renewable electricity is available to meet the growth in demand created by Green Line and other City of Calgary infrastructure projects.

If Green Line draws from the provincial grid without being offset through the purchase of renewable electricity, the traction power demand of the new LRT would result in an increase of corporate GHG emissions of about 40,000 tonnes and therefore yield a net reduction of approximately 12,000 tonnes of carbon dioxide equivalent emissions per year. The net reduction would increase over time as coal-fired plants feeding the provincial electricity grid are phased out, and replaced with lower carbon and renewable sources. The quantification of this "greening" of the electricity grid over time would require further investigation.

Longer-term Carbon Emission Reductions
Community and corporate energy consumption both continue to increase in step with population growth, urban expansion, and the resulting extension of services and travel distances. Accordingly, community-wide emissions reductions in absolute terms remain a challenge. To address the challenge a Corporate Energy Plan (to support efficiency gains) and a related Climate Change Program both are currently in development at The City of Calgary.

With Calgary's growth there are cultural and demographic changes occurring and associated shifts in outlook and lifestyles, with further changes in the urban fabric anticipated. Land use densification, both in downtown areas and in transit nodes and corridors within established and suburban areas, is increasing and will be further facilitated by Green Line LRT development. This new line, combined with ongoing transit service enhancements and changes in land use, is projected to result in significantly increased transit ridership; it may be the critical catalyst for "turning the curve" in broader adoption of public transit, and greater movement toward the modal split targets outlined in Calgary Transportation Plan (CTP). Past and projected growth in transit ridership associated with expansion of the CTrain system is illustrated in Attachment 1.

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By 2024 the 3-line LRT network, with feeder buses and cross-town BRT routes that better connect all communities and key areas of employment, will offer Calgarians more accessibility to public transit and more convenience of use than ever before. It will offer not just a viable choice but perhaps a compelling choice over the automobile for meeting daily needs. The GHG emissions reduction and other environmental benefits will continue to grow beyond 2024.

Stakeholder Engagement, Research and Communication
Green Line program engagement is focused on raising awareness of the benefits and alignment with Calgary's strategic objectives and economic opportunities. Southeast leg engagement is ongoing and North leg engagement is discussed in detail in report TT2015-0905 Green Line North Update. The research and analysis reported on herein may be used for the purposes of engaging with stakeholders and for demonstrating the alignment of this infrastructure investment with broader economic and environmental objectives.

Strategic Alignment
Green Line is aligned with the future vision of our city as articulated in the long-range sustainability plan imagineCALGARY. It is aligned with the environmental policy direction and strategic goals of the Municipal Development Plan (MDP) and CTP, the Community GHG Reduction Plan, and Council's Action Plan priorities. Green Line is included in The City's RouteAhead 30-year Strategic Plan for Transit. In quantifying and pursuing GHG emission reductions through Green Line, The City is seeking to prevent pollution and integrate broader environmental considerations into its planning and decision-making relating to growth, infrastructure, transportation and development, which is consistent with its overarching corporate Environmental Policy.

This strategic investment in infrastructure is well aligned with current policy initiatives at other levels of government. In 2015 the Province of Alberta released its Climate Leadership Plan and a new carbon tax scheme, to come into effect in 2017, that would generate revenues potentially used to make investments in energy efficiency including public transit infrastructure.

Social, Environmental, Economic (External)

Social
The Canadian Urban Transit Association (CUTA) has outlined the health benefits of public transit to include improved urban air quality and increased physical activity. With every vehicle removed from the road, the reduced fuel combustion translates to less air pollution from tailpipes. Green Line will result in a 1-3 per cent annual reduction of these air contaminants that contribute to smog: carbon monoxide, non-methane hydrocarbons, nitrogen oxides, and fine particulate matter. This health and environmental benefit is consistent with the objectives of the Calgary Region Airshed Zone management plan for particulate matter and ozone.

The increased physical activity that CUTA attributes to use of public transit can reduce human health risks and in turn reduce public health-related costs to society. Communities that provide a broad range of housing choices and commercial services, supported by high quality transit and transportation choices, allow people to meet many daily needs within their own neighbourhood

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and to access other services and opportunities with reduced automobile dependency.

Reducing automobile dependency also creates opportunities for individuals to reduce their combined housing and transportation costs, helping to increase affordability.

There is a combination of social, economic and environmental benefits that may be attributed to Green Line considering its potential to help alleviate traffic congestion on roadways and thereby facilitate more efficient movement of goods and people in the broader transportation system.

Environmental
A societal shift to greater use of public transit for all-purpose movements is key to achieving community-wide reductions in GHG emissions, as quantified in this report. Additionally, investment in light rail transit yields direct and indirect environmental benefits that extend beyond emission reductions. Considering the alignment of Green Line and current land uses and environmental conditions along the corridor, this particular transit investment presents the opportunity for significant environmental benefits that include:
- Remediation and re-purposing of brownfield sites;
- Enabling more compact forms of urban development, with reduced ecological footprint;
- Anchoring other cross-town and feeder bus transit services, further reducing the need to travel by automobile; and generally
- Enabling long-term changes in land use and mobility that result in lower overall GHG emissions in the City and region.

Economic
Green Line presents opportunities for both new development and redevelopment along the corridor, making use of existing infrastructure and spurring direct and indirect economic activity.

The City stands to lose a small share of grant revenue with the introduction of Green Line. The estimated 22 million litres reduction in gasoline and diesel fuel consumed in the Calgary urban area annually would translate to $1.1 million of provincial gas tax (currently 5 cents per litre) that would not be returned to The City in grant funding delivered through the Municipal Sustainability Initiative, plus approximately half that amount again in federal gas tax funding.

The recently announced introduction of a carbon tax in Alberta is a further economic consideration. The Green Line presents economic benefits to the community in two ways: collectively for SOV drivers who shift modes to ride LRT the avoided carbon tax (as a portion of total fuel costs) could be in the order of $1.35 million annually, based on projected ridership; and The City could save $150,000 annually in avoided carbon taxes on fleet fuel.

Financial Capacity
  Current and Future Operating Budget:
No impacts are associated with these recommendations.

  Current and Future Capital Budget:
No impacts are associated with these recommendations.

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Risk Assessment
There are no significant risks associated with these recommendations.


REASON FOR RECOMMENDATION(S):
Information presented in this report, and additional information that becomes available in time, may be used in support of business cases being prepared for submission to provincial and federal governments.

ATTACHMENT(S)

1. Transit Ridership Growth in Calgary: 1980 - 2040

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Transit Ridership Growth in Calgary: 1980-2040
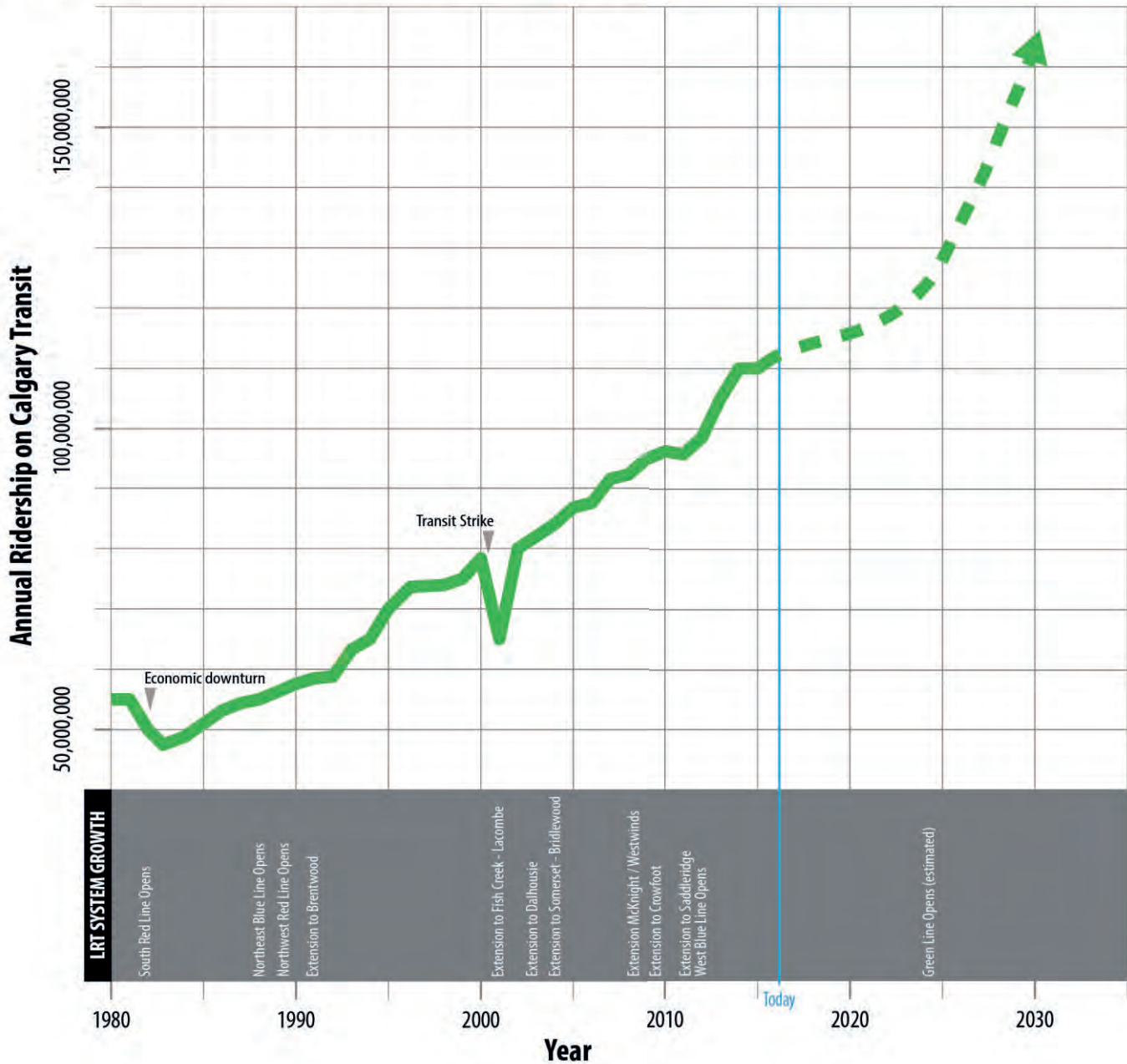
Increases in Ridership:

Calgarians have responded to LRT improvements with exponential growth in ridership as the system has grown. History tells us that for every kilometre of additional track added, Calgary Transit sees an average 3.8 per cent immediate increase in annual ridership. We can anticipate that Green Line and related land use changes will facilitate considerable future growth in ridership, at least 40 million trips more per year.