Stage 2, **Ottawa LRT**

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MMM GROUP

Ottawa

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EXECUTIVE SUMMARY

The City of Ottawa, currently home to almost one million residents, is projected to have the fastest growth in Eastern Ontario between 2013 and 2041. Most of the growth, in terms of housing and employment, is expected to be found outside the City's Greenbelt. Notwithstanding, the area located within the Greenbelt will continue to house the largest proportion of the population (52%) and contain most of the jobs (72%). The City's Central Area concentrates the City's activity, including the City's transit system.

The City is currently served by the Transitway, a bus rapid transit (BRT) network, and the O-Train, a diesel-powered light rail transit (LRT) service, as well as an intricate network of bus routes in mixed traffic. The City is currently expanding its O-Train System to provide a 12.5 km service across the City, known as the Confederation Line. Running from the Transitway at Tunney's Pasture in the West to Blair Station in the East, the LRT line will connect to the Transitway at both terminus stations to allow bus passengers to make quick connections between transit modes.

The Confederation Line will certainly provide partial relief to Ottawa's increasing highway congestion. However, in order to accommodate the City's projected long term growth, support sustainable development and economic growth, further expansion of the service is required. Indeed, an effective, reliable and efficient transit system is necessary to better serve the inner and outer suburbs of the City, and provide a more accessible connection to the Central Area.

Ottawa's Stage 2 LRT Project (henceforth referred to as Stage 2), the subject of this report, is expected to provide for that long term sustainable relief. The LRT expansion builds on the City's Confederation Line investment by extending light rail an additional 30km, bringing 70% of residents to within 5km from a LRT station and connecting the City's communities east, west, and south. Ottawa City Council in their unanimous approval of the 2013 Transportation Master Plan prioritized the implementation of Stage 2. The LRT extension is not only part of an official, integrated land-use plan and the City's Transportation Master Plan, it is also in line with Federal and Provincial commitments for transit expansion.

The benefits of expanded LRT in Ottawa are substantial.

- Increased Ridership: Stage 2 is expected to increase City-wide ridership by nearly 13.5 million trips per year by 2031, or ten percent higher than a scenario in which Stage 2 is not materialized.
- Decreased Congestion: Ottawa would see a reduction of almost one quarter of its total vehicle kilometres travelled (VKT) by 2048 with the implementation of Stage 2.

	Base Case	Affordable	Δ Change
2031			
AM peak hour VKT	2,409,010	2,002,709	-406,301
Annual VKT	3,772,510,270	3,136,242,904	-636,267,366
2048			
AM peak hour VKT	2,409,010	2,002,709	-630,735
Annual VKT	3,772,510,270	3,136,242,904	-987,730,611

Table: Vehicle Kilometre Savings, Stage 2

- Improved Mobility:
    - Travel Time Savings: Stage 2 will reduce travel time by improving speed and reliability of service for transit riders, and providing congestion relief for auto users. Based on the modeled forecasts, it is estimated that auto users will experience an annual savings of over 23 million person-hours by 2048, and transit passengers will experience a savings of almost 13 million person-hours.
    - Improved Access: Stage 2 will improve travel from extended areas of the city to the core, resulting in quicker journey times and providing greater transportation choice and freedom for a greater portion of the population.
- Vehicle Operating Cost Savings: As a result of lower VKT across the City, there will be a substantial savings in the costs of operating vehicles (e.g. fuel, maintenance, etc.). Given an annual reduction of VKT of approximately one billion kilometers in 2048, the total discounted VOC savings resulting from the extension over the 25 year period of analysis is approximately $2.630 billion.[1]
- Environmental Benefits: Perhaps one of the most recognizable benefits of transit investment is the reduction in greenhouse gases (GHGs) and critical air contaminants (CACs), which have direct implications for the overall sustainability of urban growth and direct consequences on the health of residents. It is estimated that Stage 2 would result in over 67 million litres of savings in fuel consumption, and reduce GHG emissions by 155,500 tonnes and CACs by 4,363 tonnes by 2048. The economic value of these reductions will total $635 million between 2023 and 2048.[3]
- Public Health Benefits: The health benefits associated with reductions in harmful emissions are numerous. Exposure to air pollution from road traffic has been linked to a number of other health issues (e.g. heart attack, increased risk of death from respiratory and cardiac conditions), and its reduction can help relieve the pressures on Ontario's healthcare system. The long-term effects of reducing contributors to climate change can help prevent health issues associated with extreme weather events, heat waves, etc. Transit use is also tied to

[1] VOC savings discounted to assumed opening year 2023
[3] Emissions benefits discounted to opening year 2023

active modes of transportation; on average those who take public transit will walk a significant portion of their recommended daily activity in a round trip. Increased transit use also reduces the number collisions. The savings in collision costs resulting from Stage 2 are estimated to be approximately $903 million[5]. Finally, transit provides connectivity and mobility relief to those who are unable to drive (e.g. the elderly, residents with disabilities), including providing access to healthcare.

- Land Use Benefits: A number of land-use benefits can be derived from improved transit. It supports land use intensification and more compact urban form, making infrastructure and service provision more cost effective. Transit creates an "amenity premium" due to the catering of businesses and development towards pedestrian activity, as well spin-off economic activity and agglomeration economies (from increased clustering and accessibility of land use). Finally, LRT can create land-value uplift in the vicinity of stations.
- Economic Development: With a project cost of $2.5 billion (2013$) and an annual savings of $5 million per year (2013$) starting in 2023, the project will result in the creation of nearly 24,000 person-years of employment, or nearly 1,000 full-time jobs; a GDP contribution of $3.8 billion; and a tax contribution of $170 million.
- Benefit-Cost Analysis: Given the quantified benefits outlined above and the capital and operating costs, Stage 2 has a Benefit-Cost Ratio (BCR) of 3.56. Should only half of the benefits manifest themselves, the BCR remains positive at 1.78. Further, a second scenario was also examined – Stage 2, with an extension to the Airport from South Keys as well as an eastern extension from Place d'Orléans to Trim Road. In this scenario, the BCR remains well above 3, suggesting that this project remains highly viable from an economic perspective.

Account	Stage 2 (2023$, million)	Stage 2 + Airport Spur + Trim Ext (million)
Project Capital Cost	$3,302[6]	$3,644
Project Operating Savings	$103	$103[7]
Vehicle Operating Cost Savings	$2,630	$2,658
Travel Time Savings	$7,234	$7,615
Collision Cost Savings	$903	$912
Environmental Benefits	$635	$642
BCR	**3.56**	**3.34**

Table: Benefit-Cost Ratio for Stage 2 and for Stage 2 + Airport + Trim Road Extensions

[5] Reduction in collision cost savings discounted to opening year 2023

[6] Future value of capital cost ($3,302 million in 2023$) equates to $2,475 million in 2013$, at 2.25% to the year of construction. All future costs are discounted to 2023 at 5% at project start

7 For the purposes of this report, the Project Operating Savings for the Airport and Trim extensions are assumed to be nil. While there may be some net costs associated with these two extensions, the effect on the BCR will likely not be material. The capital costs associated with the Airport and Trim Road extensions are $130 million and $135 million (in 2013$), respectively.

PROJECT SCORECARD

Environmental	Reduction of approximately 155,500 tonnes of GHGs and 4,363 tonnes of CACs (including carbon monoxide, nitrous oxides, sulphur oxides and particulate matter) per year by 2048. The economic value of these reductions will total $77 million annually by 2048.
	Reduced fuel consumption by 67 million litres annually by 2048.
Economic	Total economic output from the project is approximately $3.8 billion (2013$) and nearly 24,000 person-years of employment.
	Broadened tax pool will result in increased tax revenue of approximately $170 million.
	$10.8 billion (2023$) in over a 25 year analysis period for commuters from 2023 to 2048, including: • $2.6 billion in vehicle operating savings; • $7.2 billion in travel time savings; and • $903 million in accident avoidance savings.
	$5 million (2013$) in annual operating savings at OC Transpo beginning in 2023.
Public Transit	Implementing Stage 2 is estimated to increase transit ridership by 9.9%.
	The TMP Network including Stage 2 will increase auto trip speed by 14% and increase transit speeds by 10%.
	Faster speeds – due to faster headways, higher reliability, more efficient transfers, and full segregation.
	More efficient boarding and improved levels of comfort and service.
	Will save up to 10 minutes from each rider's daily commute.
Strategic Fit	Meets Provincial objectives to expand the use of public transit and transit-supportive development, and enhance connectivity among transportation modes.
	Provincial and Federal funds available
	Priority project within the City of Ottawa's Transportation Master Plan and supported by the City's Official Plan

ACRONYMS AND ABBREVIATIONS

AZR	Federal Airport Zoning Regulation
BCR	Benefit Cost Ratio
BRT	Bus Rapid Transit
CAC	Critical Air Contaminant
CO_2	Carbon Dioxide
DOTT	Downtown Ottawa Transit Tunnel
EA	Environmental Assessment
EPR	Environmental Project Report
GHG	Greenhouse Gas
km	kilometre
LRT	Light Rail Transit
NBCF	New Building Canada Fund
NPV	Net Present Value
P3	Public Private Partnership
POA	Procurement Options Analysis
pphpd	Passengers per hour per direction
PPS	Provincial Policy Statement
PV	Present Value
RTTP	Rapid Transit and Transit Priority
TMP	Transportation Master Plan
TOD	Transit Oriented Development
TPAP	Transit Project Assessment Process
TTS	Travel Time Savings
VKT	Vehicle Kilometres Travelled
VOC	Vehicle Operating Cost

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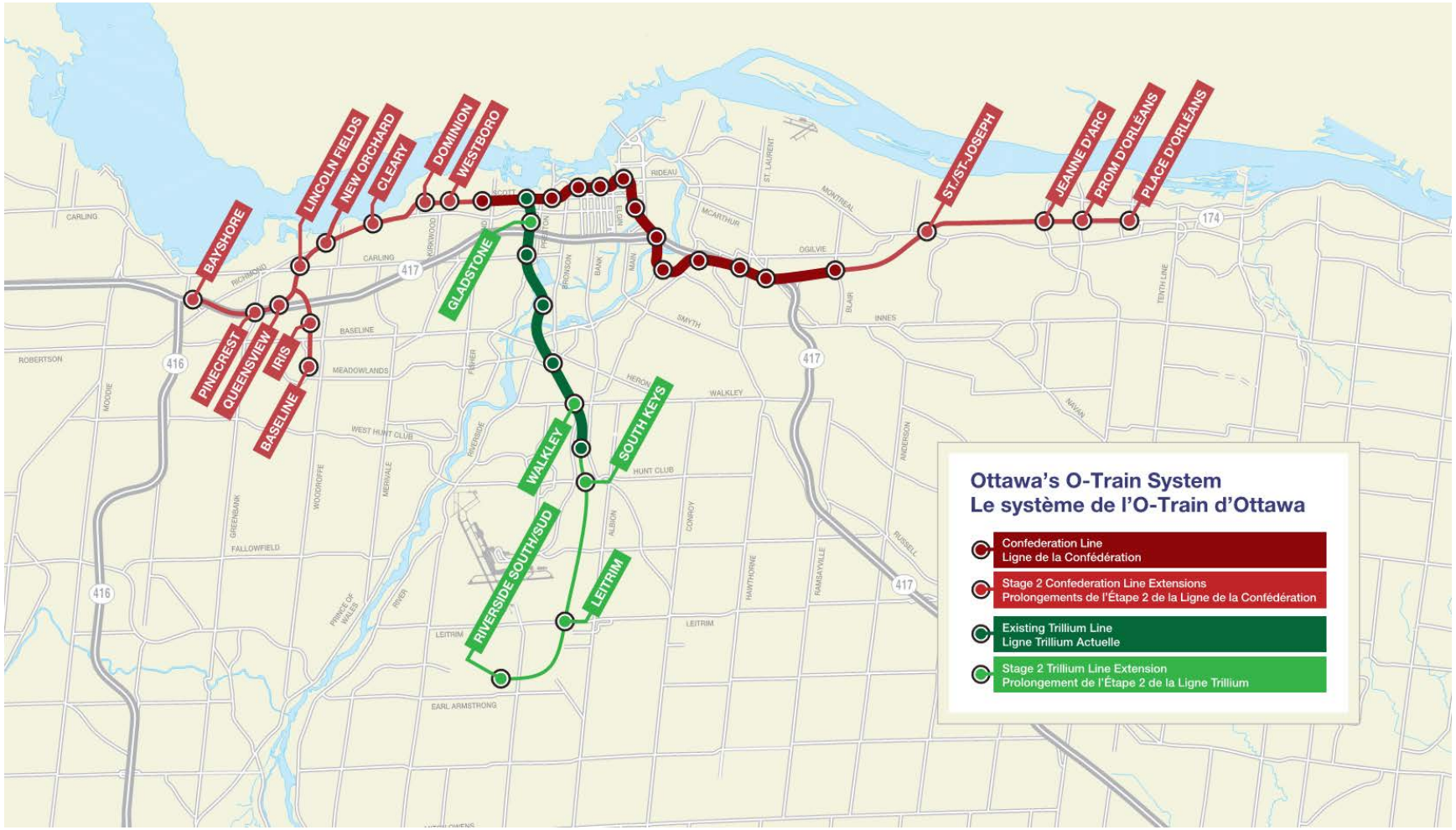

Figure 1: Ottawa Stage 2 LRT
Source: City of Ottawa, June 16 2015.

1. PROJECT CONTEXT

1.1. INTRODUCTION

Between 2006 and 2011, Ottawa-Gatineau was the fourth fastest growing census metropolitan area (CMA) in the country.[8] As the largest municipality in the National Capital Region, the City of Ottawa was home to 923,000 people in 2011. According to the Ministry of Finance, the City is projected to have the fastest growth (43.6 %) in Eastern Ontario in the projection period of 2013 to 2041.[9]

In order to accommodate this growth, and as the City's highways reach capacity during peak hours, the need to expand light rail transit to incorporate the City's inner and outer suburbs (west, east and south) is increasing. The Confederation Line expansion of Ottawa's O-Train System, is currently being constructed. This 12.5 km service will provide partial relief for the congestion, however in order to accommodate the City's projected long term growth, and support sustainable development and economic growth, further expansion of the service is required.

Ottawa's Stage 2 LRT (henceforth referred to as Stage 2), the subject of this report, is expected to provide for that long term sustainable relief. The LRT expansion builds on the City's Confederation Line investment by extending light rail an additional 30km, bringing 70% of residents 5km from a LRT station and connecting the City's communities east, west, and south. Ottawa City Council in their unanimous approval of the 2013 Transportation Master Plan prioritized the implementation Stage 2. The project is not only part of an official, integrated land-use plan and the City's Transportation Master Plan, it is also in line with Federal and Provincial commitments for transit expansion.

1.2. FEDERAL PLANS AND FUNDING COMMITMENTS

Since 2007, the federal government has supported 43,000 infrastructure projects in Canada under The *Building Canada Plan* ($33 Billion) and the stimulus phase of the *Economic Action Plan* (EAP), among other investments.[10] The EAP continues the initiative to provide stable, flexible and predictable funding for infrastructure across Canada, with $75 billion dedicated to public infrastructure for the next ten years, including $53 billion under the *New Building Canada Plan*. The latter is the largest and longest federal infrastructure plan in the country's history, and "continues to

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[8] If the Gatineau half is excluded, Ottawa ranked second fastest in the province in terms of population growth. Statistics Canada. (2015). Focus on Geography Series, 2011 Census. Census Metropolitan Area of Ottawa-Gatineau, Ontario/Quebec. Retrieved from: https://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-cma-eng.cfm?LANG=Eng&GK=CMA&GC=505

[9] Ministry of Finance. (2014). *Ontario Population Projections. 2013-2041 Ontario and Its 49 Census Divisions*. Retrieved May 25, 2015, from: http://www.fin.gov.on.ca/en/economy/demographics/projections/

[10] *Canada's Economic Action Plan*. Retrieved May 26, 2015, from: http://actionplan.gc.ca/en/page/creating-new-building-canada-plan

focus on supporting projects that enhance economic growth, job creation and productivity."[11] One of the funds under this plan, *The New Building Canada Fund*, includes a *Provincial-Territorial Infrastructure Component* ($10 billion),[12] which is applicable to Stage 2 discussed herein.

Under *The New Building Canada Plan*, a number of other funding mechanisms are in place to support infrastructure projects, including the Community Improvement Fund (Gas Tax Fund and the incremental Goods and Services Tax Rebate for Municipalities) and the P3 Canada Fund. The Gas Tax Fund, for instance, is a legislated, permanent source of funding dedicated to infrastructure investment – including public transit – at the municipal level. The establishment and management of these plans and funds point to a focus at the federal level to enhance economic growth and job creation through the support of urban transit infrastructure.

1.3. PROVINCIAL PLANS AND FUNDING COMMITMENTS

The proposal to expand the Ottawa LRT system is also in line with policies and plans in place at the provincial level supportive of enhanced urban transit. The Provincial Policy Statement (PPS, 2014) for Ontario sets the policy guidelines for the development and use of land in the province, and directs transportation decisions towards the efficient and safe movement of people and goods, in ways that match projected needs.[13] The PPS stresses efficient use of existing and planning infrastructure, as well as connectivity within and among transportation systems and modes, with the aim of developing a *multimodal transportation system*. It also promotes the establishment of land use patterns that are "*transit-supportive,* where transit is planned, exists or may be developed" and "minimize the length and number of vehicle trips and support current and future use of transit and *active transportation."*[14] Expanding Ottawa's LRT aligns with the PPS as it will serve the City with a stronger connection between a variety of systems and modes of transportation across the City, and further promote transit-oriented development (TOD).

Since 2003, the Government of Ontario has funded over $100 billion in infrastructure improvements and transit modernization. In 2014, the Provincial Government announced a plan to "build a seamless and integrated transportation network across the province," known as *Moving Ontario Forward*. The fund, totalling $31.5 Billion, is dedicated to building priority transit and transportation infrastructure across Ontario, for which $15.5 billion is available to areas outside the GTHA. Further, the Provincial Gas Tax Program – levying $0.02 on each litre of gas and transferring the funds to the

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[11] *The New Building Canada Plan*. Retrieved May 26, 2015, from: http://www.infrastructure.gc.ca/plan/nbcp-npcc-eng.html

[12] Government of Canada. *The New Building Canada Fund. 2015.* Retrieved from: http://www.infrastructure.gc.ca/plan/nbcf-nfcc-eng.html

[13] Ministry of Municipal Affairs and Housing. (2014). *Provincial Policy Statement*, Government of Ontario. p.17. Retrieved April 20, 2015, from: http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463

[14] Ministry of Municipal Affairs and Housing. (2014).*Provincial Policy Statement 2014.* Government of Ontario. The Lieutenant Governor in Council, Order in Council No. 107/2014. Ottawa, 2014., pp. 7 and 18.

municipal level – seeks to reduce congestion, improve the environment and support economic growth through transit investment.

1.4. LINKAGES WITH MUNICIPAL PLANS

1.4.1. CITY OF OTTAWA, OFFICIAL PLAN

Following the amalgamation of 11 urban and rural municipalities in 2001, the City of Ottawa adopted its first Official Plan in 2003, with the aim of providing a vision for the City's growth and a policy framework to direct the City's physical development into 2031.[15] The Plan holds sustainability as its primary goal, and addresses matters of provincial interest, including the promotion of development that is designed to be sustainable, support public transit and geared towards other sustainable modes of transportation, such as walking and cycling.

In 2013, the City of Ottawa completed its latest 5-year review and update of its Official Plan (as well as its Transportation Master Plan, Infrastructure Master Plan, Cycling Plan and Pedestrian Plan) through the process outlined in *Building a Liveable Ottawa 2031*, which is focused on encouraging the development of a vibrant, healthy and sustainable city. This review was initiated to propose solutions to 12 current planning issues including Transit-Oriented Development, Infrastructure, Public Transit and Sustainable Transportation. The Official Plan was recently updated and the Official Plan Amendment #150 was approved by the Minister of Municipal Affairs and Housing in April 2014. The Official Plan points to a number of new challenges in the 21st century, including a shifting global economy; rising energy costs and the environmental effects of energy consumption; climate change; population change, particularly the aging of baby boomers; health, particularly the rising incidence of obesity; and affordability, including the need "to pursue a more affordable pattern of growth based on higher densities and increased use of transit."[17]

According to the Official Plan, Ottawa's population is expected to grow by over 30% from 2006 to 2031, reaching over 1.1 million residents (see Table 1). The growth in population will result in an increased demand for housing, for which two thirds of new housing is expected to be located outside the greenbelt. Employment is also expected to grow, with most of its growth outside the Greenbelt. However, as indicated in the Plan, "…the area inside the Greenbelt will continue to contain the greatest concentration of people (52%) and jobs (72%). The need to bring people to jobs in and around the Central Area and elsewhere inside the Greenbelt will continue to create the greatest daily demand for travel in the City."[18]

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[15] City of Ottawa. (2003). *City of Ottawa Official Plan.* Retrieved May 26, 2015, from: http://ottawa.ca/en/official-plan-0/volume-1-official-plan/section-1-introduction/11-role-official-plan

[17] City of Ottawa. (2013). *City of Ottawa Official Plan – Draft Amendments – 11 December 2013*, p.1-5. Retrieved on May 26, 2015, from: http://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/annotatedOP_en.pdf

[18] City of Ottawa. (2013). *City of Ottawa Official Plan – Draft Amendments – 11 December 2013*, p.2-4.

Indeed, the Central Area concentrates the City's activity, and represents the heart of its transit system. While the completion of the Confederation Line in 2018 will improve access within and to the Central Area, the Plan envisions light rail extensions to connect this area with centres both within and outside the Greenbelt, as enhanced transit can increase ridership as well as create prospects for high-density, mixed use development.[19]

	2006	2031	# Change	% Change
Population				
Inside GB	533,000	591,000	58,000	10.88%
Outside GB, Urban	252,000	432,000	180,000	71.43%
Rural	86,000	113,000	27,000	31.40%
Total	871,000	1,136,000	265,000	30.42%
Households				
Inside GB	228,000	278,000	50,000	21.93%
Outside GB, Urban	88,000	168,000	80,000	90.91%
Rural	30,000	43,000	13,000	43.33%
Total	346,000	489,000	143,000	41.33%
Employment				
Inside GB	432,000	506,000	74,000	17.13%
Outside GB, Urban	72,000	162,000	90,000	125.00%
Rural	25,000	35,000	10,000	40.00%
Total	530,000	703,000	173,000	32.64%

Table 1: Population, Households and Employment Growth (2006-2011)
Source: City of Ottawa Official Plan – Draft Amendments – 11 December 2013

The links between transit and density, mix of uses and land-use patterns are clearly stated in the Plan, as is the significance of compact and TOD in the creation of sustainable and liveable communities. The provision of transit infrastructure is closely tied with land-use: transit shapes where residents and visitors live, work and engage in other activities and where businesses choose to locate. Transit also creates connections within a city that makes given areas more accessible, convenient and desirable.[20] In turn, land-use has also been shown to be a strong determinant of transit ridership.[21] Ultimately, well-integrated transit and land development shapes urban forms, resulting in the reduction of automobile travel and more sustainable urban development.[22]

[19] City of Ottawa. (2013). *City of Ottawa Official Plan – Draft Amendments – 11 December 2013*, p.2-7.

[20] Suzuki, H., R. Cervero, and K. Iuchi. (2013). *Transforming Cities with Transit. Transit and Land-Use Integration for Sustainable Urban Development*. International Bank for Reconstruction and Development / The World Bank, Washington, D.C.

[21] Chakraborty, A. and M. Sabyasachee. (2013). Land use and transit ridership connections: Implications for state-level planning agencies. *Land Use Policy*, vol. 30, no. 1, pp.458-469.

[22] Suzuki, H., R. Cervero, and K. Iuchi. (2013). *Transforming Cities with Transit. Transit and Land-Use Integration for Sustainable Urban Development*. International Bank for Reconstruction and Development / The World Bank, Washington, D.C.

1.4.2. CITY OF OTTAWA, TRANSPORTATION MASTER PLAN 2013

The City of Ottawa's 2013 Transportation Master Plan (TMP) focuses on the integration of complete streets, updating modal share targets, strategizing ways to enhance walking and cycling within the City, encouraging transit-oriented development, and prioritizing road and transit infrastructure improvements in ways that are in line with patterns of growth, strategic opportunities and evolving issues. It is noteworthy that one of the key areas in which this TMP differs from previous plans is in its focus on affordability.

Thus, in addition to presenting the 2031 Rapid Transit and Transit Priority (RTTP) Network Concept, the Plan also outlines an Affordable RTTP Network. While the former is aimed at accommodating expected demand and delivering service levels capable of attracting the anticipated demand, the latter prioritizes projects under the Network Concept to align with available funds, while maximizing possible benefits (e.g. transit ridership, opportunities for intensification, operating cost savings).

The Affordable RTTP Network includes the Confederation Line LRT currently under construction, as well as the three rail extensions outlined in this business case, namely the Eastern LRT (from Blair to Place d'Orléans stations), the Western LRT (from Tunney's to Baseline and Lincoln Fields to Bayshore stations), and the O-Train (from Greenboro to Bowesville/Riverside South). It also includes a number of (at-grade and grade-separated) BRT extensions, including the West Transitway (from Bayshore Station to west of Moodie Drive, and from March Road to Terry Fox Station), the Baseline Transit Corridor (from Baseline to Heron stations), and the Kanata North Transitway (from Corkstown Road to Solandt Road), as well as a number of transit priority projects. It was determined that rather than phasing the rail extensions through to 2031, these three would be grouped together as "Stage 2" and implemented in advance of the targets proposed in the 2008 TMP.[23]

1.4.3. OTHER CITY INITIATIVES SUPPORTING THE OTTAWA LRT EXTENSION

The development of light rail transit in Ottawa is already underway, with the construction of the Confederation Line, scheduled for revenue service in 2018. The investment in the Confederation Line is supported by a number of City initiatives, as outlined in the 2013 TMP, including a number of BRT extensions (see 1.4.2 above), peak period bus lanes, transit signal priority, double-decker bus acquisition, PRESTO card implementation, and access to real-time customer information. These initiatives are also complemented by other shorter-term transit endeavours, such as enhanced safety and security measures, transit facility upgrades, fleet replacement for Para Transpo, improved accessibility, stronger community partnerships, among others.

From a land-use planning perspective, the City of Ottawa's Official Plan promotes the development of compact, integrated land uses to reduce reliance on the automobile, towards more sustainable choices, including walking, cycling and transit. It aims to create a supportive built environment by increasing intensification in areas where transit can be well served by higher population and

[23] City of Ottawa. (2013). *City of Ottawa Transportation Master Plan*, p.55. Retrieved on May 27, 2015, from: http://documents.ottawa.ca/en/node/5836

employment density, particularly in the Central Area, designated Town Centres and Mixed Use Centres and Main Streets. One such practice will be to establish maximum parking limits and reduced minimum parking requirements for developments situated within an 800 metre radius of rapid transit stations. The City has also established priority areas for the development of TOD plans, of which a number have already been approved (e.g. Tremblay, St. Laurent and Cyrville LRT stations).

1.5. CURRENT TRANSIT USE

As outlined in the TMP, Ottawa outperforms any other Canadian city of similar size in terms of transit ridership. Approximately 325,000 transit trips are made on average in a typical weekday, of which, over half occur during the morning and afternoon peak periods. Annually, this number translates to over 100 million OC Transpo transit trips in 2012, a figure which has generally been on a steady increase since the mid-1990s.[24]

While the sustainable mode share (walking, cycling, transit and automobile passenger) has decreased marginally between 2005 and 2011 during the morning peak period, the mode share for transit use has remained constant at 22.4%. Bafsed on daily, 24-hour data, transit use on its own – as well as sustainable modes of transit as a whole – has increased slightly from 2005 to 2011 (from 15.0% to 15.5%).

Mode share is affected by both age and area of residence. Almost half (46%) of young adults aged 16 to 24 utilize transit, based on morning peak period travel, while this proportion decreases to 19% for the 25-64 year age group, and 10% for those over the age of 65. Residents living in the inner area have the largest proportion of walking and cycling, while those in the inner suburbs have the highest proportion of transit use (25%), and those living in the outer suburbs have the highest proportion of auto use (56% for drivers and 15% for passengers) (Figure 2). It is noteworthy that half of all trips arriving downtown area are using transit, and one third of transit trips in the city are to the downtown area.

The TMP aims to increase the mode share of transit (vs. automobile), from just over 22% in 2011 to 26% by 2031, which will involve continuing efforts to make transit increasingly attractive through enhanced availability, reliability, speed, accessibility and comfort of transit.[25]

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[24] This figure has increased from approximately 65 million OC Transpo trips in 1996.
City of Ottawa. (2013). *City of Ottawa Transportation Master Plan*, p.53. Retrieved on May 15, 2015, from: http://documents.ottawa.ca/en/node/5836

[25] City of Ottawa. (2013). *City of Ottawa Transportation Master Plan*.

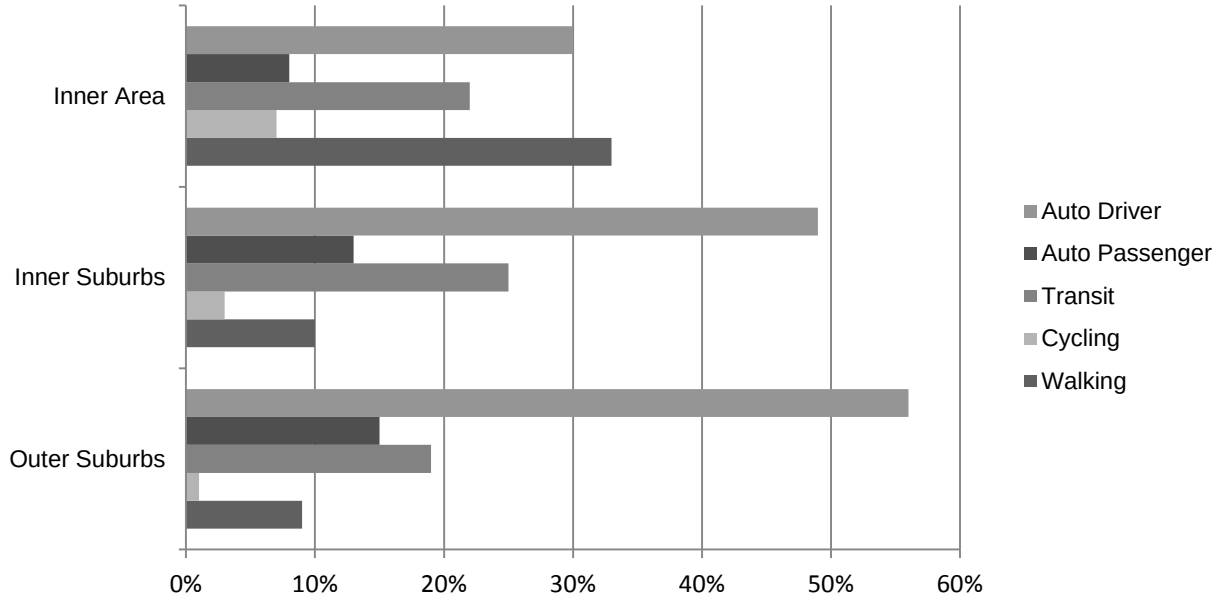

Figure 2: Modal Split, Area of Residence, 2011 Morning Peak Period.
Source: Based on City of Ottawa TMP (2013)

2. PROJECT DESCRIPTION

As part of the TMP Affordable Network, the City of Ottawa has envisioned Stage 2 to extend the Confederation Line – currently in construction – east into Orleans and west to Bayshore Shopping Centre and Baseline Road, as well as the Trillium Line (O-Train) south to Bowesville. These extensions are illustrated in Figure 1 at the outset of this report.

It is noteworthy that this business case also assesses potential extensions that connect the Stage 2 network to the airport (from South Keys) and easterly to Trim Road (from Place d'Orléans). Where costs and benefits are discussed, these two prospective extensions have been treated in a separate analysis.

2.1. FUNCTIONAL DESIGN DESCRIPTIONS

2.1.1. CONFEDERATION LINE WEST

The Confederation Line West extension project will add 13.5 km of rail and ten new or converted rapid transit stations to the City's overall light rail transit (LRT) network at Bayshore, Pinecrest, Queensview, Baseline, Iris, Lincoln Fields, New Orchard, Cleary, Dominion and Westboro.

At Bayshore, the Confederation Line West LRT extension will connect directly to the West Transitway facilitating easy transfers to and from the Transitway.

Moving east from Bayshore, the line continues along the existing bus rapid transit (BRT) corridor to a converted Pinecrest Station, then to a new station at Queensview Drive. It then runs, at grade, parallel to the north side of Highway 417 before entering into a tunnel beneath Connaught Avenue and then crossing above Pinecrest Creek.

Just south of Lincoln Fields, the alignment merges with the branch arriving from Baseline Station along the existing Southwest Transitway with a stop at Iris Station. The line then continues north, passing through Lincoln Fields Station, before shifting east to enter an underground tunnel along Richmond Road. A New Orchard Station will be located under a small section of the Byron Linear Park.

East of Woodroffe Avenue, the line will run beneath the Richmond Road corridor to the new Cleary Station. It will continue beneath the Sir John A. MacDonald Parkway, emerging from the tunnel before reaching Dominion Station on the existing Transitway. Continuing east along the Transitway trench, the line will reach Westboro Station just north of Scott Street, and finally meet with the first-stage Confederation Line at Tunney's Pasture Station.

2.1.1.1. BAYSHORE STATION

Bayshore Station, located at the existing Bayshore Transitway Station, will be the western terminus of the Confederation Line West extension. It will also be the eastern terminus of the West Transitway, a new BRT corridor extending along Highway 417 west of Bayshore to Moodie, and will operate as a major transfer point between LRT and BRT.

The recommended design will reuse much of the existing Bayshore Station infrastructure and occupy generally the same land area.

Existing Transitway roadway and platforms will be converted to accommodate LRT, while the local bus platforms will be reconfigured to serve rapid transit buses and allow for efficient and convenient cross-platform transfers. Station design and layout will be compatible with the new West Transitway Extension (Bayshore to Moodie). Local buses will continue to access the station via Woodridge Crescent, with direct pedestrian access to the station from this street.

The northerly station building will be expanded to accommodate a fare-paid control zone where the existing overhead pedestrian walkway from Bayshore Shopping Centre connects into the station. Based on future mall plans, the overhead walkway may also be modified.

Additional station features include:

- An improved pedestrian/cycle link to Holly Acres Road and to Woodridge Crescent
- Public washroom facilities
- A bus staging area to the west of the station to facilitate short-term layover of buses

Station design remains flexible such that it can be integrated into future development of adjacent commercial and residential lands. Other than a triangular piece of land required to facilitate bus movements at the station, no additional lands beyond those previously identified as part of the West Transitway Extension EA will be required.

Upon the approval of this report, staff will commence the detailed design for the at-grade crossing at Holly Acres, pending the completion of the EA.

To accommodate the bus staging area at the west end of Bayshore Station, the grade-separated Transitway overpass across Holly Acres Road, recommended as part of the previous West Transitway Extension (Bayshore to Moodie) EA, would be deferred as recent updated traffic and transit service analysis has determined that an at-grade crossing of Holly Acres is still viable until post-2031. Therefore, the existing at-grade Holly Acres Road/Bayshore intersection will be maintained with some modifications to permit two-way (east/west) bus traffic and to accommodate the Highway 417 westbound on-ramp from Holly Acres Road. The cost reductions associated with the decision to defer the grade separation were incorporated and reported in the 2015 Budget. This modification to the existing West Transitway Extension (Holly Acres to Moodie) will be documented as part of the Environmental Project Report for the Confederation Line Western Extension.

The City and Ministry of Transportation (MTO) are working on an agreement to construct a segment of MTO-funded noise barrier along the north side of Highway 417 (and the Transitway) from east of Stillwater Creek to west of the existing berm as part of the West Transitway Extension project. Consistent with the Council approved "City of Ottawa Environmental Noise Design Guidelines", the increase in noise attributed to the West Transitway Extension does not warrant noise mitigation. The dominant source of noise is, and continues to be, Highway 417. Installation of the noise barriers are subject to finalization of an agreement with MTO.

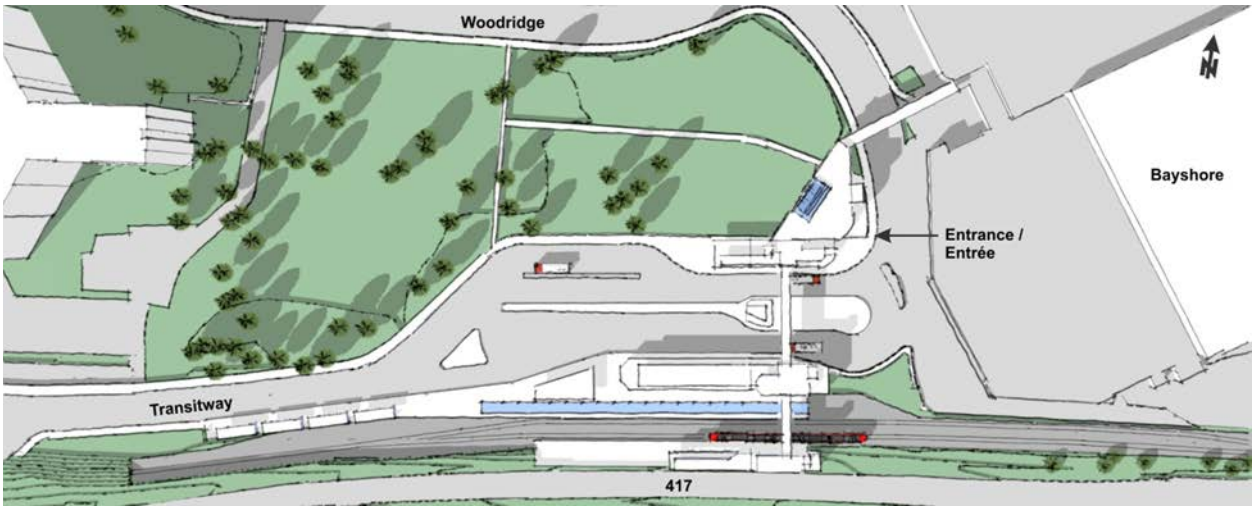

Figure 3: Plan View of Bayshore Station Showing LRT and Bus Platforms and Reuse Of Existing Structures

2.1.1.2. PINECREST STATION

The existing Transitway platforms will be decommissioned and the functional design shows a new LRT station with an open-air centre platform to be constructed in a cut below grade. From east of the station, access will be provided via pathways from the sidewalks and bus stops along Pinecrest Road – the east side pathway curving down and passing under Pinecrest Road along the LRT corridor. To the north and west, pathways to the Foster Farm community will provide pedestrian and cycling access.

Other station features include:

- Enhanced pedestrian and cycling connections from both sides of Pinecrest Road south from Dumarier Avenue and Queensview Drive;
- Improved pedestrian and cycling linkage over Highway 417 can be incorporated into the future replacement of the Pinecrest Road bridge when undertaken by MTO;
- Informal passenger pick-up and drop-off areas on Dumaurier Avenue and in a small turn around accessed from Pinecrest Road.

The City will look for opportunities to coordinate works with MTO plans for widening and renewal of Highway 417. A small area of the provincially owned highway interchange lands will be required for the LRT station and alignment. In addition, the realignment of the intersection of the westbound

highway on ramps at Pinecrest will be required to facilitate bus stops on Pinecrest to provide good connections for riders to the LRT station platforms.

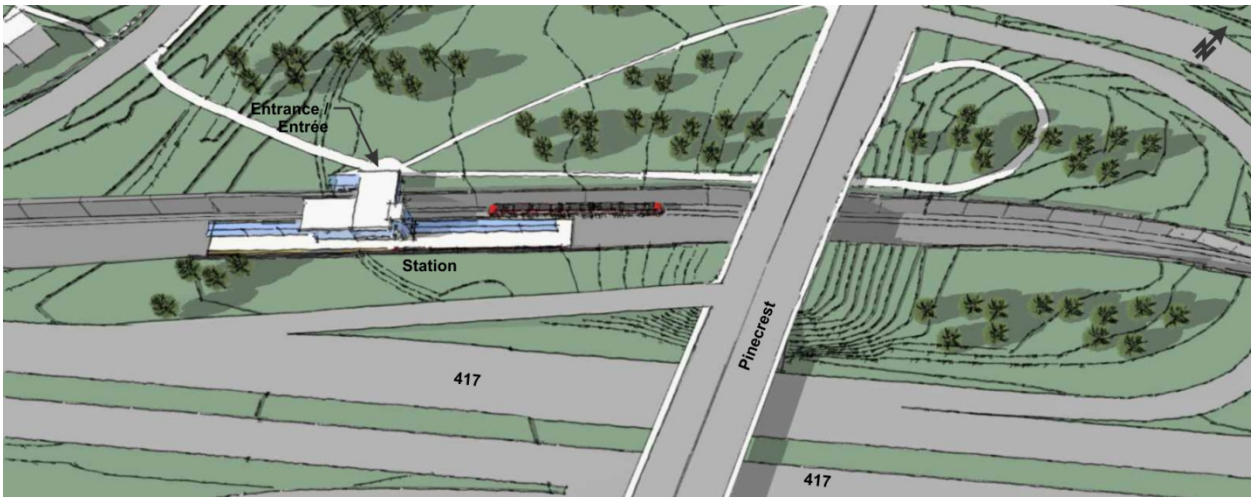

Figure 4: Plan view of Pinecrest Station north of Highway 417 and west of Pinecrest Avenue

2.1.1.3. QUEENSVIEW STATION

Queensview Station will be a new LRT station to serve communities and businesses on the north and south sides of Highway 417. The functional design shows the station with an open-air centre platform with access at grade level via new pathway connections to Queensview Drive and Connaught Avenue.

Other features of this station include:

- A new multi-use pathway bridge crossing of Highway 417 to Baxter Road to provide residents in this area near Iris Street and the Pinecrest and Baxter Road business districts with access to the LRT station
- Provision of accessible ramps, stairs and elevators from the station platform level to the pathway overpass
- Provision of passenger pick-up and drop-off along Queensview Drive and Baxter Road

Some narrow widths of lands will be required from adjacent commercial properties along Queensview Drive that back onto Highway 417. Property requirements in this area have been identified in previous environmental assessment studies for the West Transitway (Woodroffe to Bayshore). On the south side, the land requirements for the pathway overpass and access along Baxter Road can be accommodated within the right-of-way.

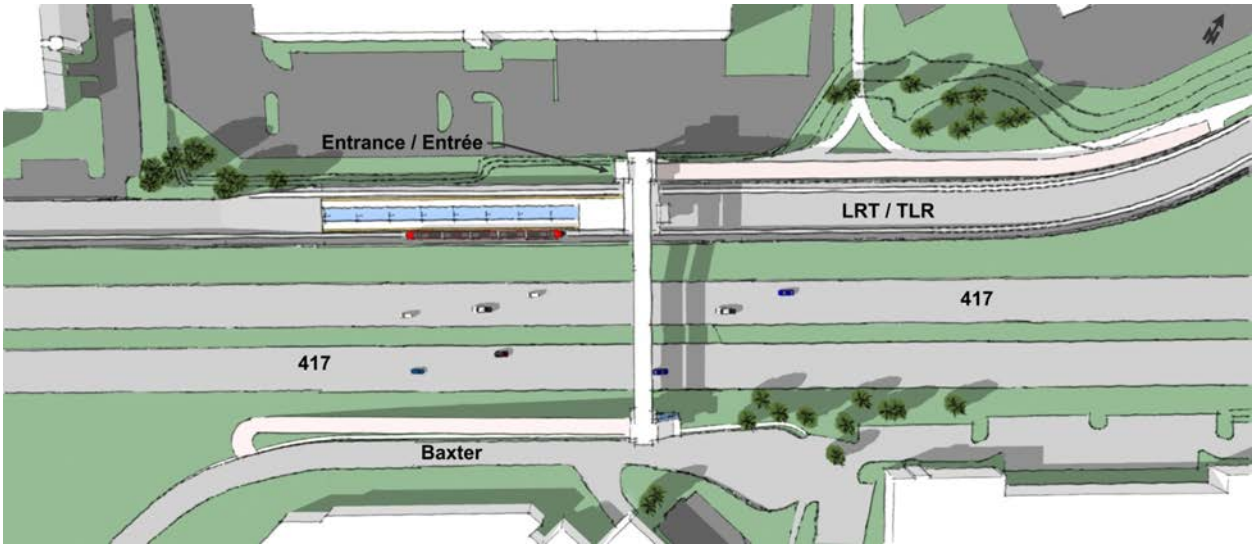

Figure 5: Plan view of Queensview Station showing pathway bridge over Highway 417

2.1.1.4. BASELINE STATION

Baseline Station is the southwest terminus of Stage 2's Confederation Line West extension and is adjacent to the Algonquin College Campus in the Centrepointe neighbourhood. As the northern terminus of the Southwest Transitway from Barrhaven, the station will operate as a major BRT/LRT transfer terminus.

A central LRT platform will be located below-grade in the existing tunnel structure between Navaho Drive and College Avenue, underneath the open plaza situated immediately west of the Algonquin College ACCE Building. An upper level bus terminal for the Southwest Transitway BRT/LRT transfer terminus will be constructed on the south side of College Avenue, and will provide access to the lower level LRT platforms via stairs, escalators and elevators. Other key station features include:

- A new pathway connection along the east side of the LRT alignment north of Navaho Drive and under the Baseline Road overpass that will provide access between open spaces and mixed use development areas
- Public washroom facilities
- Creation of a new bus loop to facilitate bus connections to LRT. Buses will enter the bus loop from College Avenue and move in a clockwise direction at grade level. From this loop, passengers can take the stairs/escalators/elevators to the train platforms located below-grade in the Baseline Station tunnel.
- As part of a much larger urban intensification area, Baseline Station will support the Mixed-Use Centre designation and opportunities to create Transit-Oriented Development
- The underground structure has the capacity to not only serve as an LRT station but as a vehicle storage and staging area. This would allow for storage of several LRT vehicles in a covered facility so they can be ready for early service start up for the peak periods

Based on the Rapid Transit Network identified in the City's 2008 Transportation Master Plan (TMP), the existing below-grade tunnel structure was designed and constructed to ultimately incorporate both BRT and LRT operations. An early outcome of the Western LRT EA saw the removal of the need to accommodate BRT operations in the below-grade tunnel in the long term, and further, with the accelerated Stage 2 program any interim bus solution was recognized to have a limited lifespan, and was therefore not advanced beyond the functional planning stage.

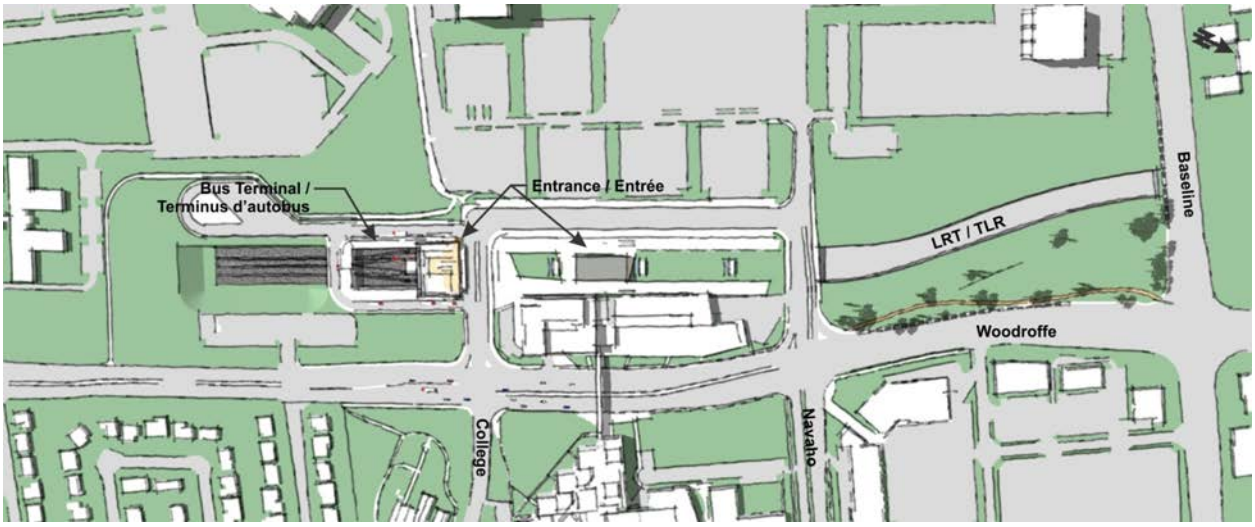

Figure 6: Plan View Baseline LRT Station

2.1.1.5. IRIS STATION

Iris Station is an existing Transitway station with basic platforms and shelters to the south and north of Iris Street between Parkway Drive and Adirondack Drive. The current at grade Southwest Transitway crossing at Iris Street will be eliminated as part of the conversion to LRT, and a new Iris Street overpass will replace the at grade crossings. The station and bridge design will make use of the natural terrain and elevations, creating a low impact design that fits into the natural and community context. The bridge design will feature open air platforms in the creek valley slightly below street level and a new long low Iris Street bridge passing over the LRT. Ramps will provide access to the station rather than elevators to minimize the station's visual impact, as well as construction and on-going operating costs.

Other station features include:

- Side platform configuration, with station entrances on both sides connected to Iris Street via ramps and stairs
- Reduced overall footprint for the bridge design, with no property acquisition requirements
- Bridge structure that will serve many modes and maintain pedestrian and cycling continuity along Iris Street, and to the Capital Pathway, and community links along the creek valley.
- Better definition of existing informal passenger pick-up and drop-off areas along Iris Street

- Provision of local bus interchange with LRT at on-street stops at the east and west ends of the bridge
- Re-alignment and relocation of Pinecrest Creek to create a longer length of open and naturalized creek channel that will flow along the east side of the LRT corridor before passing under the LRT track. The creek is currently entombed in a long pipe under the Iris-Transitway intersection.

2.1.1.6. QUEENSWAY STATION DECOMMISSIONING

Queensway Station is an existing station located where the Southwest Transitway crosses under Highway 417. It is a two level station, with Transitway services on the lower level and the cross-town bus service, such as route 101, on the upper level. The lower level platforms will be decommissioned as part of the LRT project due to limits in track curve design and geometry, challenges to providing a long straight segment for the LRT platforms, as well as the proximity to Iris Station (approximately 380 metres away). Retaining the upper level bus platforms, existing elevators and stairs from the creek side pathways up to the Queensway bus platforms would permit pedestrians using the pathway along the LRT corridor to cross the LRT corridor at this location. They could also continue to provide access to transit service for large-scale sporting or special event. Although Queensway Station would be closed, the new Iris and Queensview stations will continue to provide convenient LRT access to local communities.

2.1.1.7. LINCOLN FIELDS STATION

The existing Transitway station at Lincoln Fields is adjacent to the nearby public roads and is served by pathways and pedestrian bridges. The station consists of BRT platforms adjacent and parallel to the Sir John A. Macdonald Parkway and local bus platforms running east-west adjacent to the north side of Carling Avenue.

The future LRT station will be constructed south of the existing BRT station underneath the existing Carling Avenue Bridge over the Parkway and rapid transit route. This compact station design shows a centre platform configuration to provide pedestrian access from street level on Carling Avenue down to the LRT platforms below.

Lincoln Fields Station will act as a significant transfer hub to accommodate direct transfer from on-street buses to LRT below (Carling is designated as a Transit Priority Corridor in the 2013 Transportation Master Plan Affordable Network).

Other stations features include:

- Improved connections to adjacent neighbourhoods and pathways in the Pinecrest Creek Corridor
- Decommissioning of significant portions of existing Transitway infrastructure
- Maintaining of existing passenger pick-up and drop-off area to the northeast of the station
- Maintaining OC Transpo Sales and Information Centres

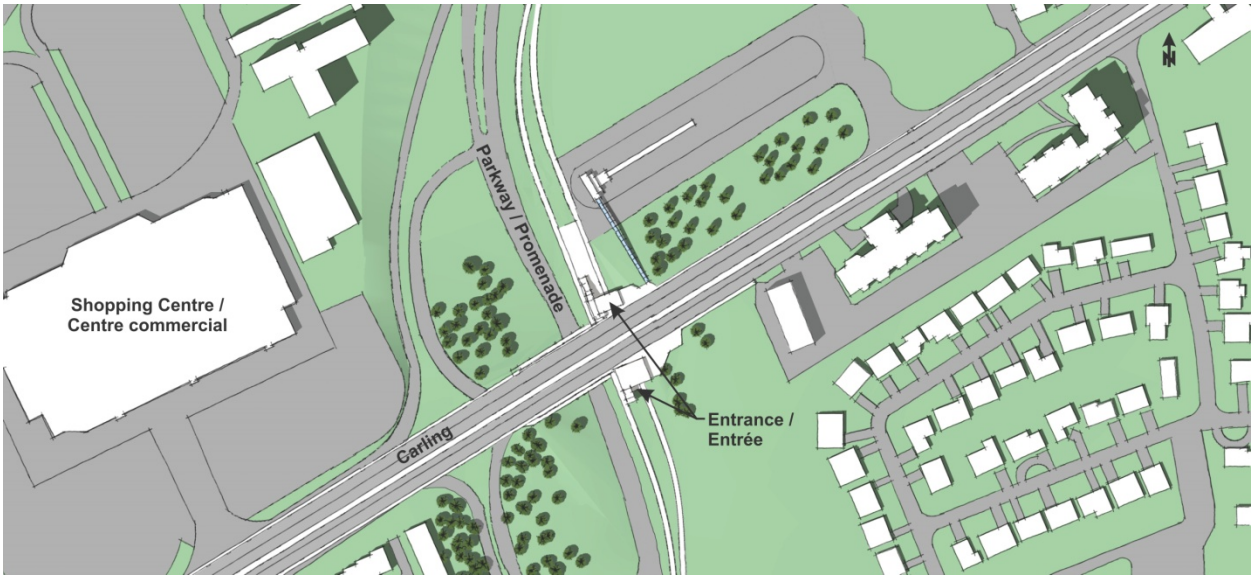

Figure 7: Plan View of Lincoln Fields Station

An LRT junction will be located immediately south of Lincoln Fields Station and is the point at which Confederation Line will join/split with tracks running south to Baseline Station and west to Bayshore Station.

2.1.1.8. NEW ORCHARD STATION

New Orchard Station will be a new LRT station serving the communities of Woodroffe North and Woodpark. While the LRT will be in a tunnel under the Byron Linear Park, the station will be below grade and open to the air in the Byron Linear Park between New Orchard and Harcourt Avenues. A compact, one-storey station house will provide pedestrian access to grade level from sidewalks and pathways on Richmond Road, Byron Avenue and within the linear park. The station design will minimize the area it occupies in the linear park and facilitate pathway connectivity.

Other station features include:

- Provision of better cycling and pedestrian access to the station through the reconstruction of Richmond Road to provide a “complete street” with dedicated cycling facilities and improved pedestrian amenities.
- Adjacent pathways, trees and landscape amenities when Byron Linear Park is restored after construction
- Improved crosswalks at Richmond and New Orchard
- Limited and well defined passenger pick-up and drop-off opportunities along Richmond Road and/or Byron Avenue

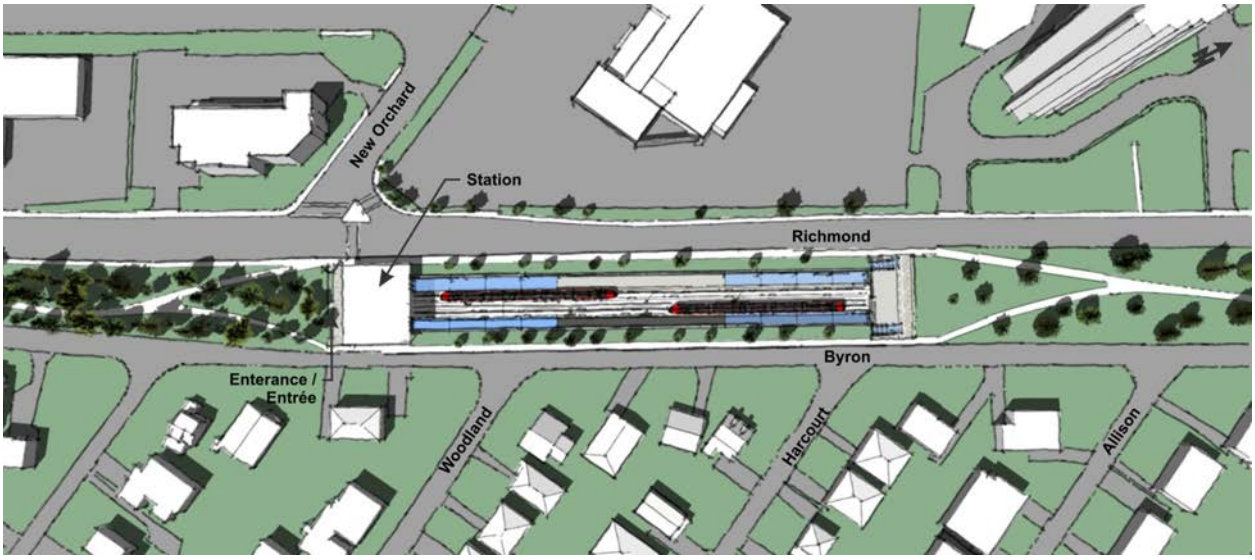

Figure 8: Plan view of New Orchard Station

2.1.1.9. 100-DAY WORKING GROUP

On November 27, 2014, Mayor Watson and then Minister responsible for the National Capital Commission (NCC), John Baird, met and directed that a mutually acceptable solution for the future Confederation Line west extension LRT alignment between Dominion and Cleary stations be identified within 100 days. A Working Group composed of NCC Board Members, City Councillors and executive staff from both organizations subsequently.

This evaluation process included the identification of key principles, and the evaluation of two new alignment options between Cleary and Dominion stations from the following perspectives: transit operations, cost and constructability, operations and maintenance, community impacts and benefits, ridership and station functionality, as well environment and greenspace.

On March 6, 2015, the 100-Day Working Group announced an agreement in principle for a solution that is outlined in a Memorandum of Understanding. The 100-Day Solution recommends running a portion of the Confederation Line West extension under rebuilt and realigned lanes of the Sir John A. Macdonald Parkway between Dominion and Cleary stations. The resulting solution and Memorandum of Understanding was posted, for public information, to the NCC and City webpages and is attached as a separate document to this report

This solution meets the NCC's criteria, while protecting the Byron Linear Park and Rochester Field, and respecting the City of Ottawa's affordability envelope. The solution also:

- Maximizes greenspace by re-instating existing parkway lanes of traffic closer together, with the LRT stacked beneath
- Develops a park of national significance along the shoreline
- Protects the trees and landscaped buffer between the Parkway and adjacent urban area

- Enhances and creates new pathways and two new pathway crossings under Sir John A. Macdonald Parkway
- Reduces annual bus trips on the Sir John A. Macdonald Parkway by over 450,000
- Increases useable shoreline park space by 38 per cent (equivalent to almost 40 football fields)

On March 30, 2015 City of Ottawa followed up the announcement of the 100-Day Solution with a Public Open House, at City Hall. At the Open House the public had the opportunity to review and provide feedback on the preferred solution between Dominion and Cleary Stations. It also advances the creation of a waterfront linear park.

April 22, 2015, the NCC Board approved the Memorandum of Understanding approving the jointly developed solution for the portion of the alignment between Dominion and Cleary Stations.

Further details on both Cleary and Dominion stations are included in the descriptions below.

2.1.1.10. CLEARY STATION

Cleary Station is a new station, located to serve the McKellar Park community. It is within the Sir John A. Macdonald Parkway Corridor adjacent to the east of Cleary Avenue where the City right-of-way ends at the private entrance to the Unitarian Church grounds. With the exception of a station house to provide accessible at-grade access from Cleary as well as the Parkway pathways, the station will be fully buried with a "green roof" to blend into the surrounding landscape and topography. The design is a result of the 100-day solution and responds to NCC and local community concerns. It has such features as:

- Final station location, size and design that will fit into the open space and community context
- Access to the waterfront from the station and the community by maintaining existing pathways and providing a new multi-use pathway crossing under the Parkway
- Direct pedestrian access to the station from Richmond Road via a broad walkway integrated into the streetscape
- Provision of limited and well defined passenger pick-up and drop-off opportunities along Richmond Road and Byron, and discouraging these activities on Cleary

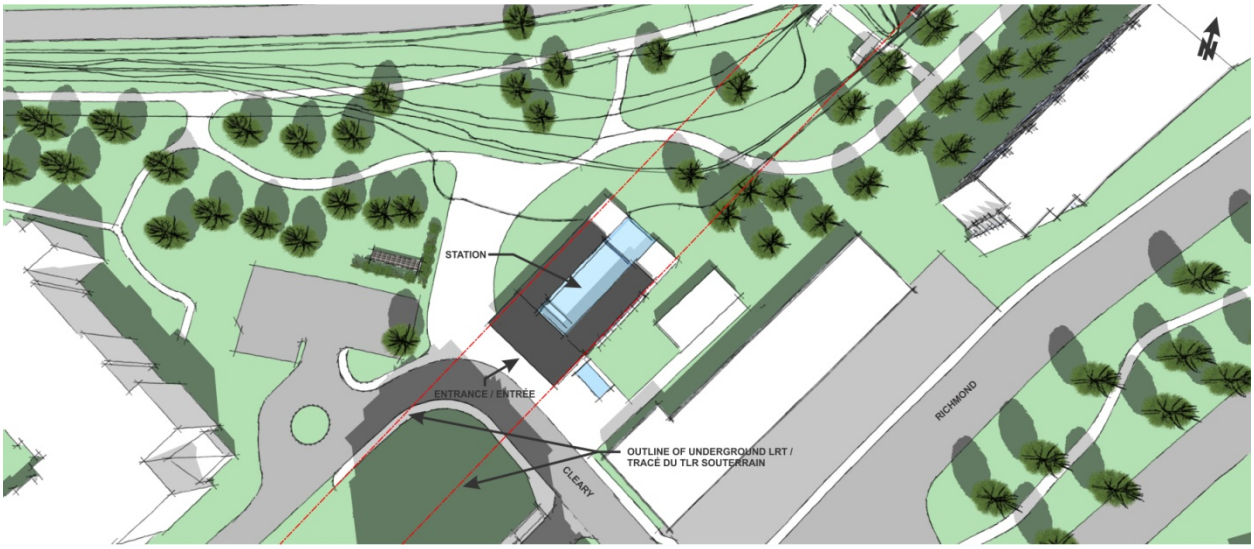

Figure 9: Plan View of Cleary Station

2.1.1.11. DOMINION STATION

Dominion Station is an existing Transitway station located northwest of Dominion Avenue with basic open-air platforms and shelters adjacent to where the Transitway trench rises to meet the Sir John A Macdonald Parkway. Currently, pathways provide access from Dominion and Berkley Avenues to the south and Workman Avenue to the north.

The LRT station will be located in the existing Transitway trench to take advantage of the higher land with open air LRT platforms below grade in the existing Transitway trench on City property. A compact, one-storey station house will provide fully accessible, direct access from Berkley Avenue at street level on the south side of station. From the north side, passengers will be able to access the station via Parkway level pathways and ramped pathways down from Workman Avenue. Neighbourhood sensitivity, as well as the protection of green space and river views will inform the final station house location, size and design.

Other stations features include:

- Improved unimpeded access to the waterfront from the station and the community by maintaining existing pathways and providing a new multi-use pathway crossing under the Sir John A MacDonald Parkway;
- A new multi-use pathway bridge over the LRT connecting pathways and communities on the south side to the pathway on the north side;
- Reduced impact on the existing landscape by shifting the alignment to the north;
- Improvements to reorganize and contain the existing informal passenger pick-up and drop-off to better serve and fit into the community, and;
- Improved pathway and sidewalk neighbourhood connections.

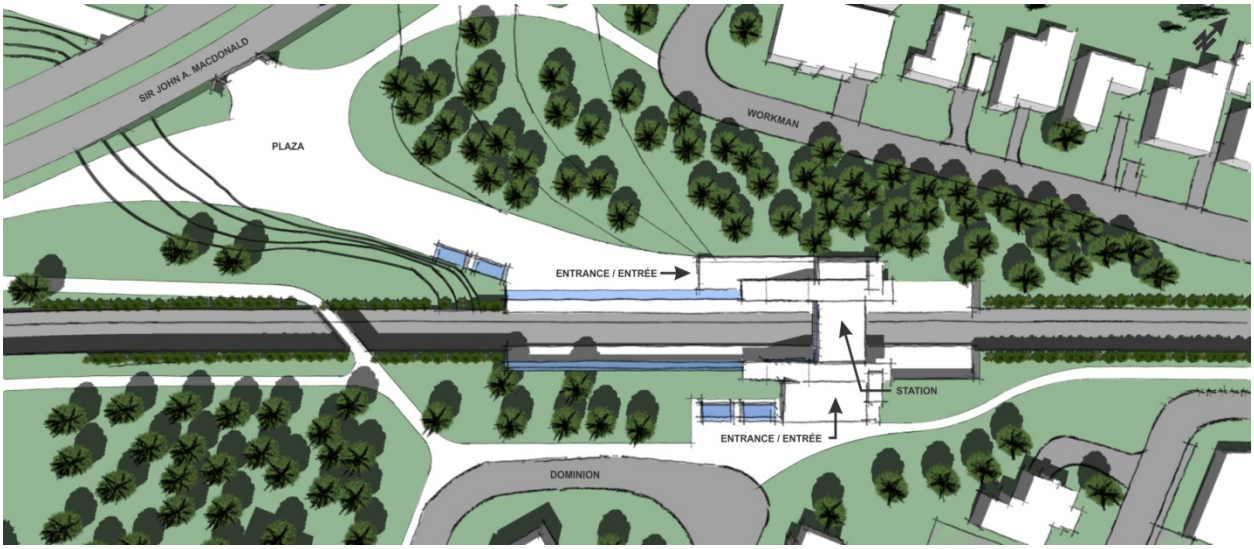

Figure 10: Plan View of Dominion Station

2.1.1.12. WESTBORO STATION

Westboro Station is located on the north side of Scott Street, between Athlone and Tweedsmuir Avenues. It is an existing Transitway Station, which will be rebuilt within the existing Transitway trench with open air LRT platforms on the lower level and local bus platforms at street level. The existing bus loop will also be maintained to facilitate local transfers.

To improve accessibility and implement a fare control zone, the existing overhead bridge structure will be decommissioned and a new, wider structure will be constructed with a new station entrance along the west side of the existing upper level bus loop.

As part of the station conversion, the southern portion of the bus loop which currently separates the station from Scott Street will be eliminated to create a large plaza and an on-road bus lay-by. This will maintain the east-west multi-use pathway connectivity through the station area similar to what occurs at Tunney's Pasture Station.

Other stations features include:

- Signalized crossings at both Athlone and Tweedsmuir to maintain pedestrian access from Scott Street and the adjacent community
- Expanded area for bicycle parking
- Improved east-west pedestrian and cycling linkages on Scott Street and to the multi-use pathway along the linear park
- Improved passenger pick-up and drop-off area along Scott Street.

Westboro Station currently has local transit connections to OC Transpo routes, which can be maintained as Richmond Road, Churchill Avenue and Scott Street will continue to provide local access to the station.

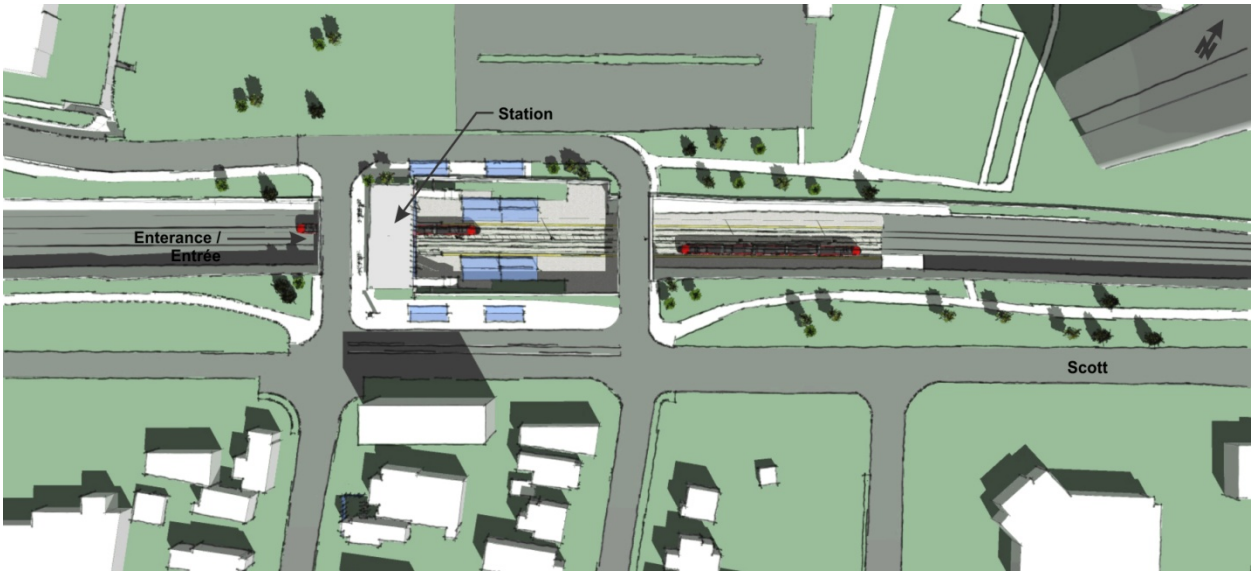

Figure 11: Plan View of Westboro Station

2.1.2. CONFEDERATION LINE EAST EXTENSION

The Confederation Line East Extension project will include 10 kilometres of rail and four new stations. The extension is being proposed in the median along the highway to contain costs, minimize community impacts and land requirements, and provide excellent connectivity to surrounding communities by offering stations that are equidistant to neighbourhoods on either side of the highway. This particular extension will improve transit service to major mixed-use centres and numerous residential communities, as well as to other destinations including the Bob MacQuarrie Recreation Complex and Place d'Orléans Shopping Centre.

Overall, the alignment will be north of Highway 174 between Blair Station and Montreal Road; it will extend directly east and bypass the existing Transitway alignment, passing under Blair Road and the interchange ramps. To accommodate the LRT alignment, new bridge structures are required to carry Blair Road and the Highway 174 on and off ramps over the LRT. The rail line will cross over the westbound highway lanes immediately east of Montreal Road and transition into the median of the highway at this location. East of the NCC Greenbelt, the LRT remains at grade in the median.

The dual LRT tracks will offer stops at four new stations: Montreal Road Station, situated on the north side of Highway 174; as well as Jeanne d'Arc station, Orléans Boulevard, and Place d'Orléans, which will all be located within the median.

The rail EA study was integrated with the Highway 174 widening environmental assessment to achieve better design outcomes, ensure efficiencies of scale, and maximize benefits both to the community and to the environment.

2.1.2.1. BLAIR STATION

From Blair Station, the line will continue along the north side of Highway 174 to Montreal Road Station. A future continuous pathway from Blair Station to Montreal Road Station is also proposed as

part of the project and could be placed alongside the LRT alignment or through the local neighbourhood. The alignment (shown in pink) will extend directly east and bypass the existing Transitway alignment, passing under Blair Road and the interchange ramps. To accommodate the LRT alignment, new bridge structures are required to carry Blair Road and the Highway 174 on and off ramps over the LRT.

The area (shown in red dashed line) is being protected for the future Cumberland Transitway, as identified in the August 2011 Hospital Link and Cumberland Transitway Westerly Environmental Project Report, as well as the 2013 TMP. Although the Cumberland Transitway is shown as being outside of the affordable funding envelop of the 2013 TMP, the project still holds importance and its corridor remains protected in the 2013 Official Plan. The Cumberland Transitway was identified as a necessary part of the transportation network solution when the East Urban Community was expanded south of Innes Road.

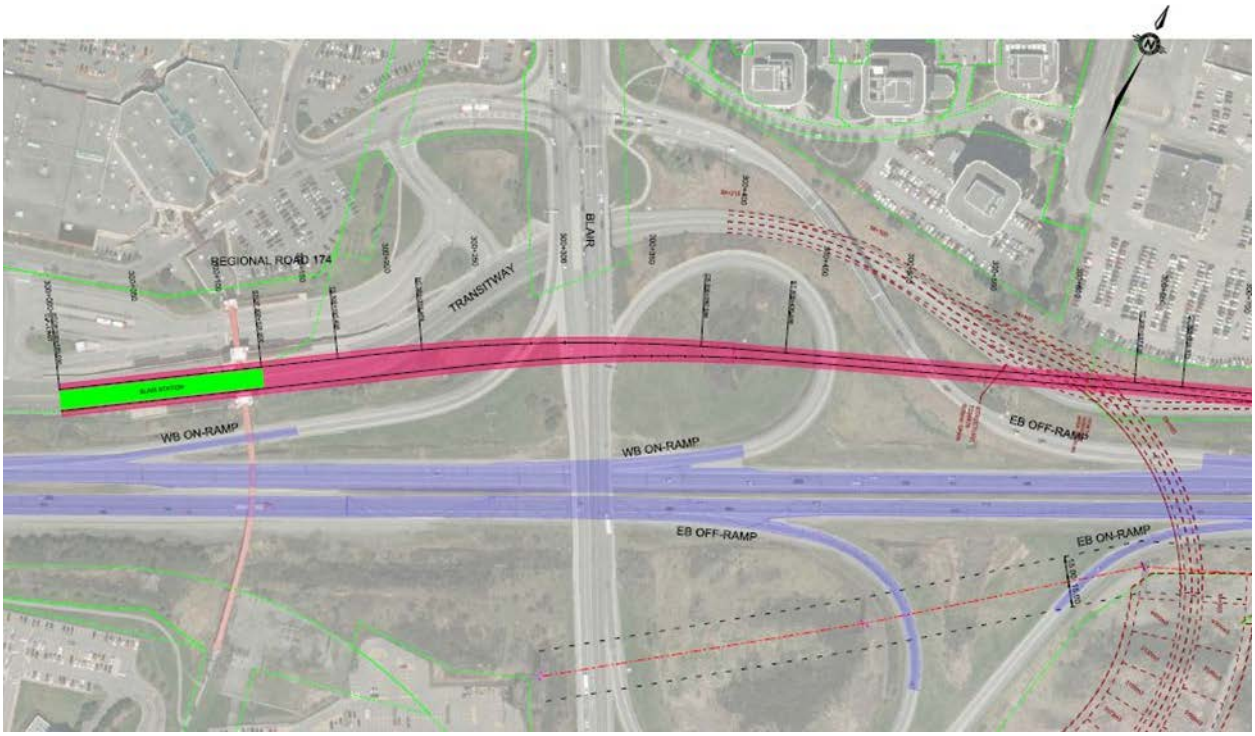

Figure 12: Blair Station

Proceeding east for 800 metres, protection for a possible future station (post-2031) is proposed in the vicinity of Gloucester High School, in response to public comments expressing desire for a station between Blair and Montreal. The station would have to be implemented in cooperation with the adjacent land owner(s), as access to the station would need to be provided via adjacent properties. Future transit-oriented development (TOD) potential in the area, good station spacing, and convenient access to Gloucester High School, the adjacent community centre and recreational facility would support eventual construction of this station.

2.1.2.2. MONTREAL ROAD STATION

Montreal Road Station will be situated on the north side of Highway 174 and will serve the nearby Beacon Hill community and Canotek Business Park, in contrast to the Greenbelt lands south of Highway 174. Ramps at the Montreal Road interchange will be modified to allow easy pedestrian and cyclist access.

The station will be situated in the northwest quadrant of the interchange, with stairs and elevators concentrated at the end of the platform. The platform connects to a lower level concourse to provide easy access to the west side of Montreal Road. The Highway 174 structures will be widened to suit the new configuration and future additional lanes.

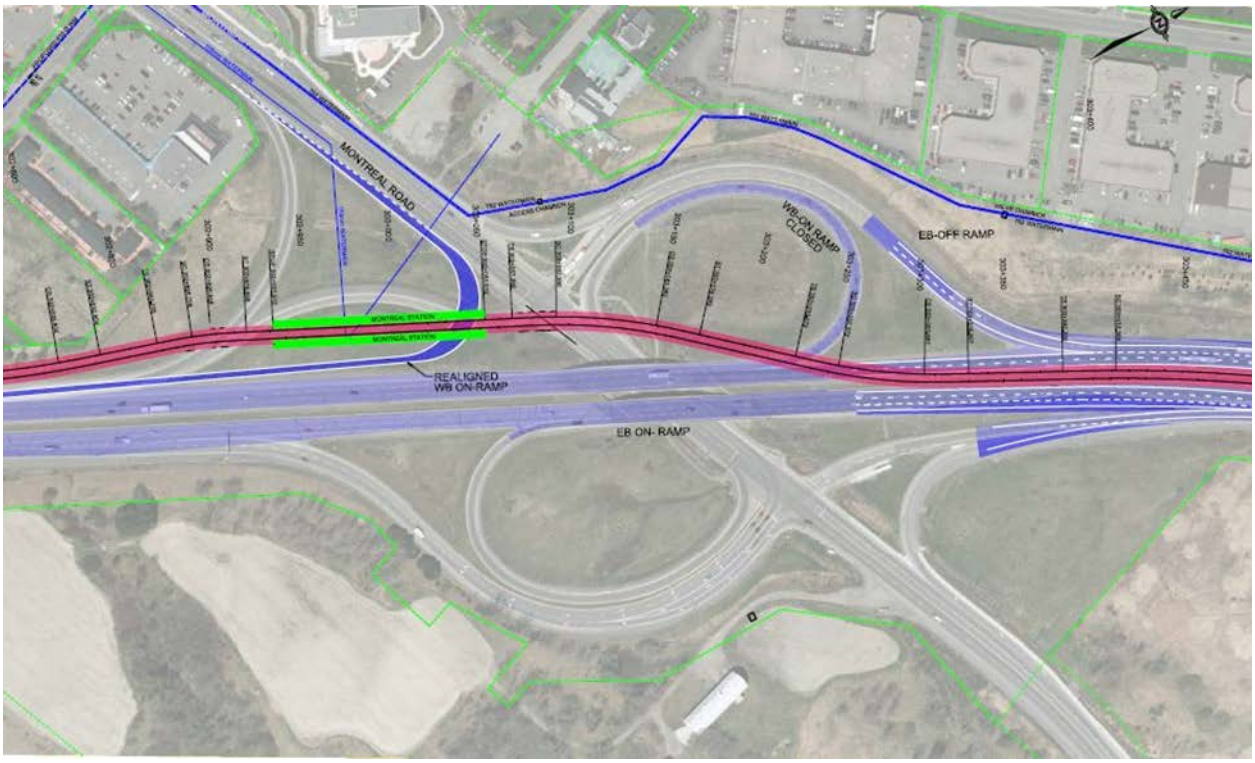

Figure 13: Montreal Road Station

2.1.2.3. JEANNE D'ARC STATION

Jeanne d'Arc Station will be the first Confederation Line stop east of the NCC Greenbelt. The station spans under the existing bridge structure with a design resembling Cyrville Station on the Confederation Line. There will be a station house on either side of the roadway to allow direct access to the station for passengers transferring to and from buses or the pedestrian plaza. The interchange will be modified to remove the free-flow ramp for northbound to westbound traffic to improve bus, pedestrian and cycling accessibility.

This station ultimately requires widening of Jeanne d'Arc Boulevard and the bridge structure to accommodate bus lanes, cycling facilities, and wider sidewalks for station access. Bus connections may be limited to through routes, as there is no space to accommodate a bus layup or turnaround on

the bridge but there may be nearby opportunities to accommodate these uses. Potential pathway connections to adjacent communities would require property acquisition for pathway corridors between existing homes to shorten the walking distance. In the short term, the existing four-lane bridge will provide adequate space for station access, although one lane in each direction will be converted to a transit priority lane to accommodate space for local bus connections. Existing travel demand is adequately provided by the one general purpose lane in each direction, with future widening opportunities identified post 2031.

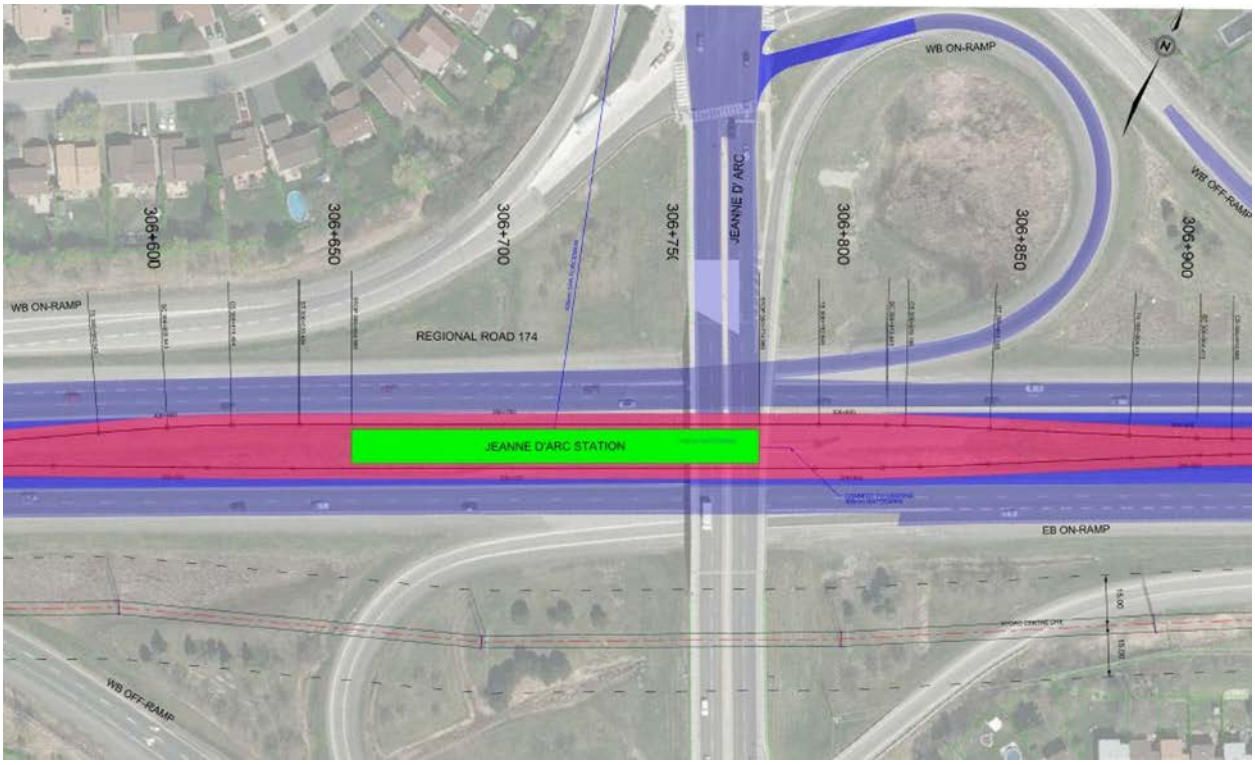

Figure 14: Jeanne d'Arc Station

2.1.2.4. ORLÉANS BOULEVARD STATION

Orléans Boulevard Station will be a smaller volume station similar to Jeanne d'Arc Boulevard Station. It will be centered under the existing bridge structure, with station access from both sides of the bridge. With no Highway 174 access to/from Orléans Boulevard, this station will be closer, more compact, and more accessible to the adjacent communities.

Orléans Boulevard is currently four general purpose lanes. Converting one lane in each direction for buses, in the vicinity of the station, will provide space for local bus connections at curbside in front of the station. Existing pathways in the southeast and southwest provide good connectivity to the proposed location of Orléans Boulevard Station. Pathway opportunities in the northeast and northwest would require property acquisition to establish corridors into the community and are noted as future opportunities.

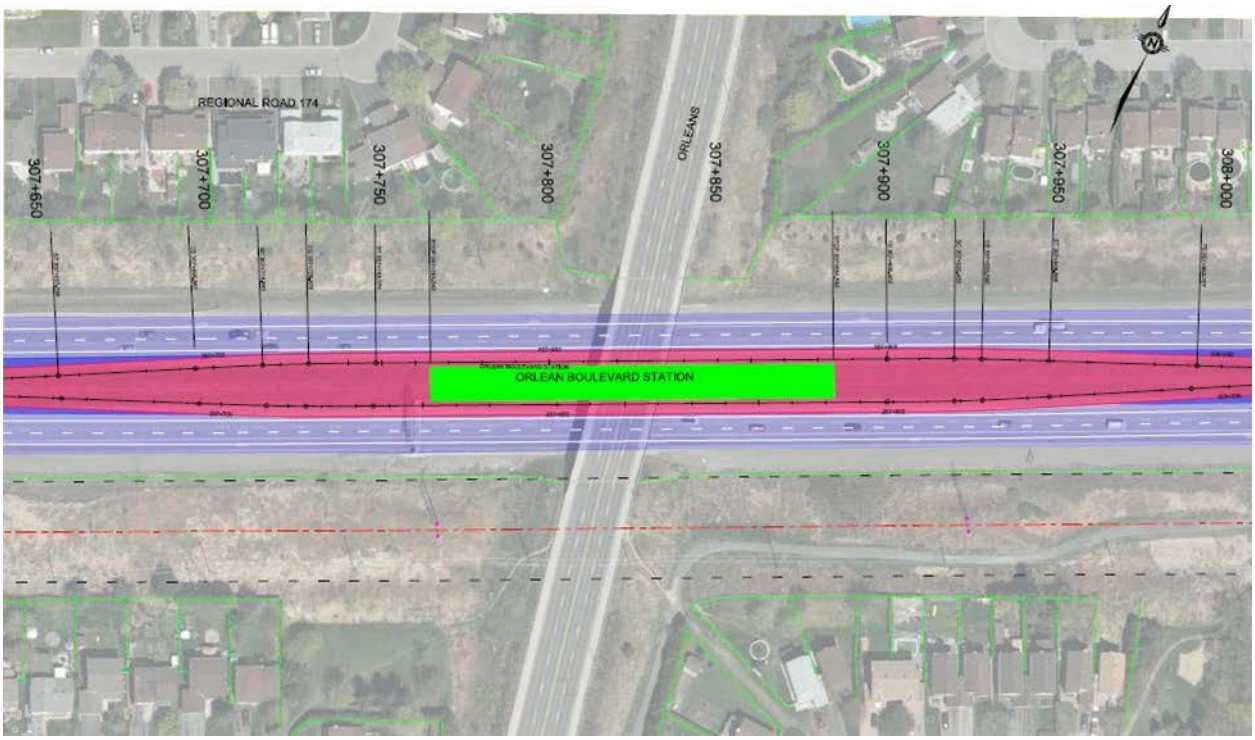

Figure 15: Orléans Boulevard Station

2.1.2.5. PLACE D'ORLÉANS STATION

Place d'Orléans Station will serve as the terminus for the Stage 2 Confederation Line East Extension to Orléans. It will connect to the existing Transitway station north of Place d'Orléans (immediately south of Highway 174), and to the Park & Ride lot (to the north) via an existing pedestrian bridge.

The new station will be deliberately placed west of Champlain Street, as this bridge structure can accommodate the construction of LRT tracks in the short term. A new structure will eventually be required to accommodate future highway widening. The station will also align more directly with the bus platforms and the centre of the Park & Ride lot. A future connection from the east end of the platform directly to Champlain Street is recommended as the area becomes more urbanized. The station will include public washroom facilities, and there is some limited capacity to expand the Park & Ride lot but any significant increase would require a multi-storey structure.

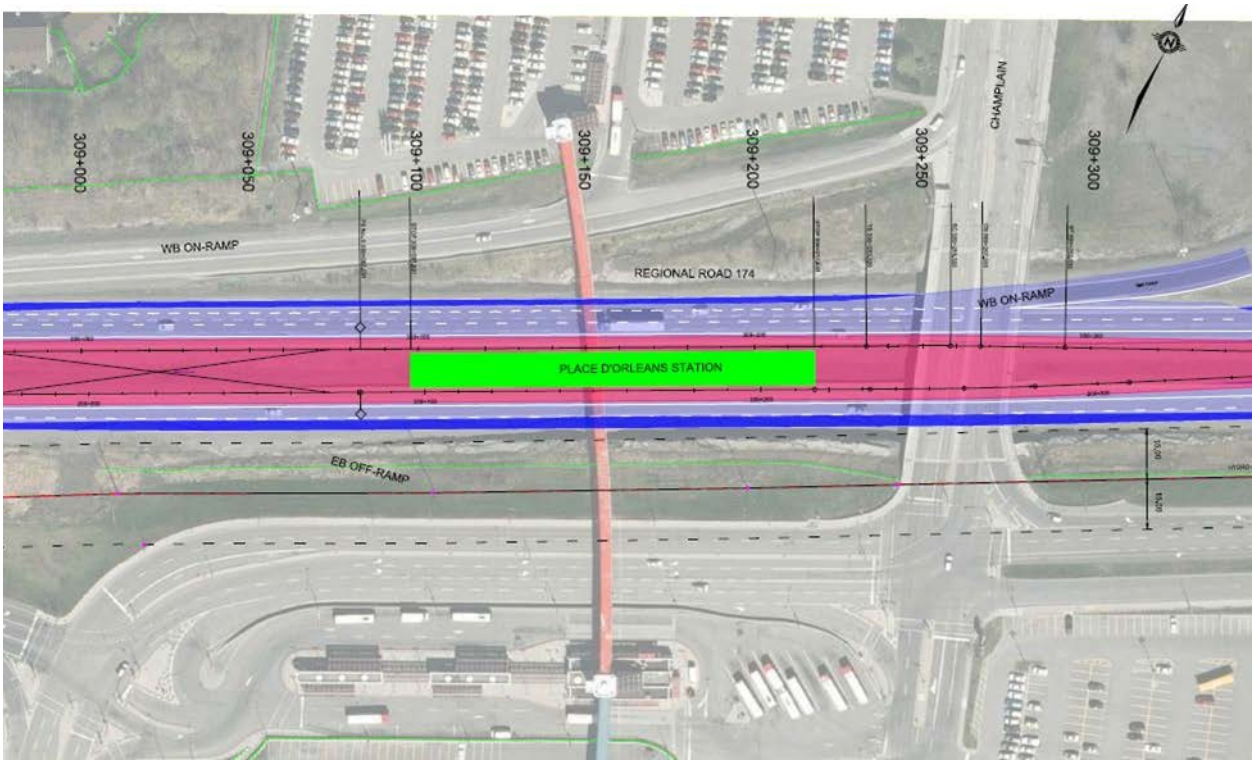

Figure 16: Place d'Orléans Station

2.1.3. TRILLIUM LINE

The Trillium Line extension includes five new stations and eight additional kilometres of single track from Greenboro to Bowesville in Riverside South, with passing tracks at South Keys and south of Leitrim, and grade separations at Lester and Leitrim to separate the tracks from the road crossings in these areas. The proposed plan would extend the City's LRT reach to Leitrim and Bowesville in Riverside South, bringing southern communities such as Manotick, Findlay Creek, Greely and Osgoode much closer to this high quality transit service. The overall alignment for the most part follows the existing CPR alignment, which was the same envisioned for the North-South Light Rail Transit Project to Bowesville (ACS2006-PGM-ECO-0014).

Three of the five new stations will be located along the extended line, south of the existing Greenboro Station. These stations include: a station at South Keys, with connections to the existing Southeast Transitway station; a station south of Leitrim Road, adjacent to the existing Leitrim Park & Ride lot, and; a Riverside South station and Park & Ride lot approximately 150 metres east of Bowesville Road.

In addition, the Trillium Line extension includes two new stations along the existing line: one at Gladstone Avenue, and a second on the south side of Walkley Road, adjacent to the existing hotel/condominium development.

All of the stations will include pedestrian connections to nearby roadways and/or MUPs.

The extension of the Trillium Line, new stations and structures for grade separation will allow for future conversion to twin-track electric LRT and will be built to accommodate the implementation of the Airport Rail Link as well as the planned widening of both the Airport Parkway and Lester Road.

2.1.3.1. GLADSTONE STATION

A new grade-separated station will be constructed on the north side of Gladstone Avenue, on the existing Trillium Line between Bayview and Carling Stations. Options to provide access from a future pedestrian plaza proposed in the Gladstone Community Design Plan, as well as from the existing multi-use pathway on the east side of the tracks and a proposed multi-use pathway on the west side will be developed.

This station will consist of two side platforms below grade, accessed from street level via station houses containing redundant elevators and staircases. Fare Gates will delineate a fare-paid zone within the station.

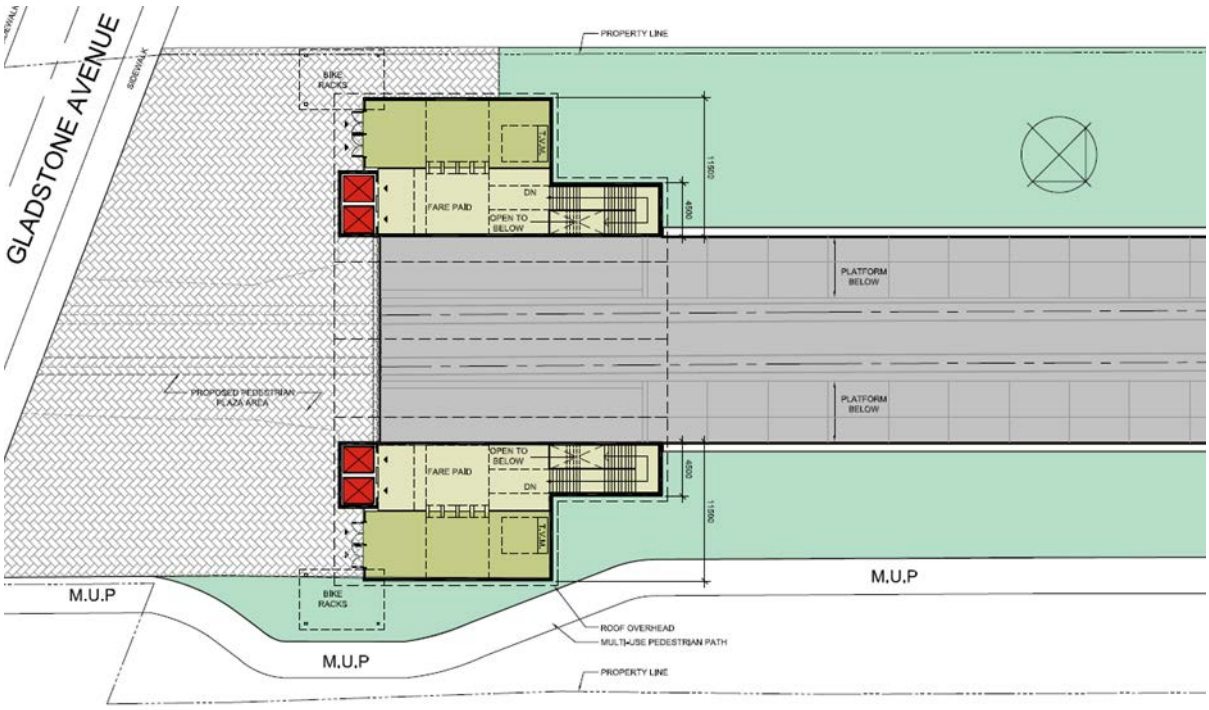

Figure 17: Gladstone Station Base Design

2.1.3.2. WALKLEY STATION

A new grade-separated station is planned for the south side of Walkley Road, adjacent to the existing hotel/condominium development. This station will fall between the existing Confederation and Greenboro stations. The configuration will be similar to Gladstone and Confederation stations, with only one station house and platform built. The station will have elevators and a staircase providing access to Walkley Road, local bus routes and the existingTransitway station houses. There are opportunities for pathway connections to the adjacent development and other nearby land uses to

the south to be explored during future phases of design. This station will also include a fare-paid zone and a weather-protected platform.

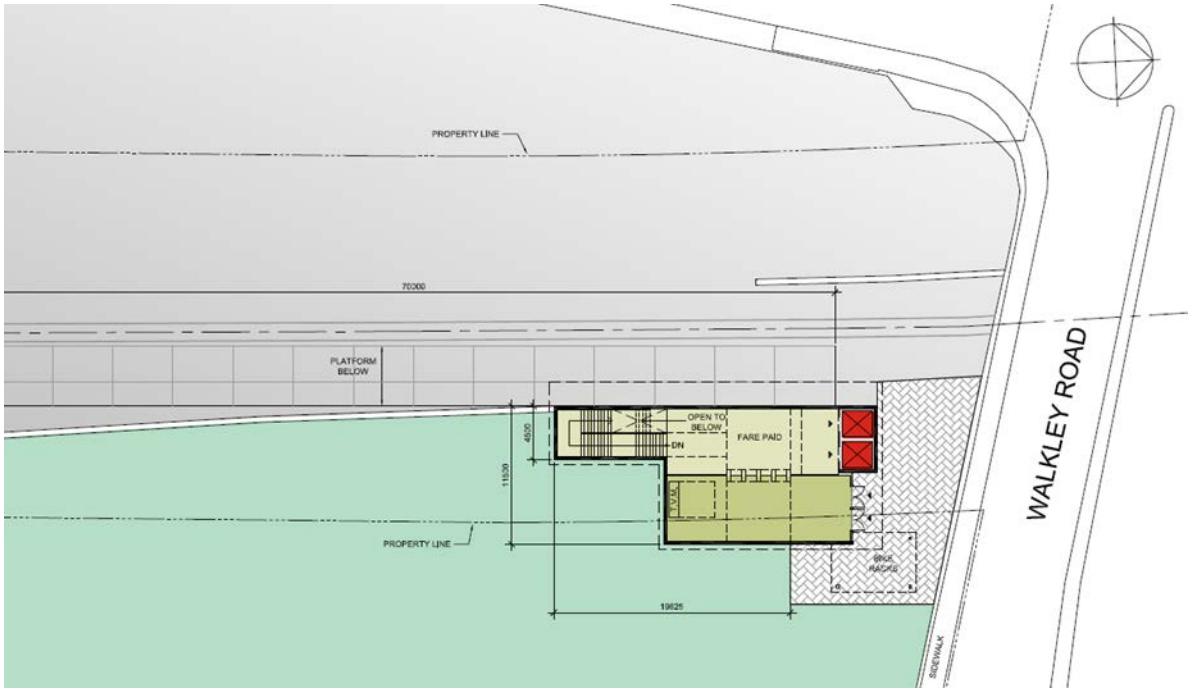

Figure 18: Walkley Station

2.1.3.3. SOUTH KEYS STATION

A new station will be built at South Keys, adjacent to the existing Transitway station. This station will be located within a passing siding and may incorporate a centre platform and pocket track to serve as the future transfer station to/from the Airport Rail Link. It will be accessible via redundant elevators and a staircase from the existing pedestrian underpass, and will provide a connection, via the underpass, to the adjacent existing Transitway Station.

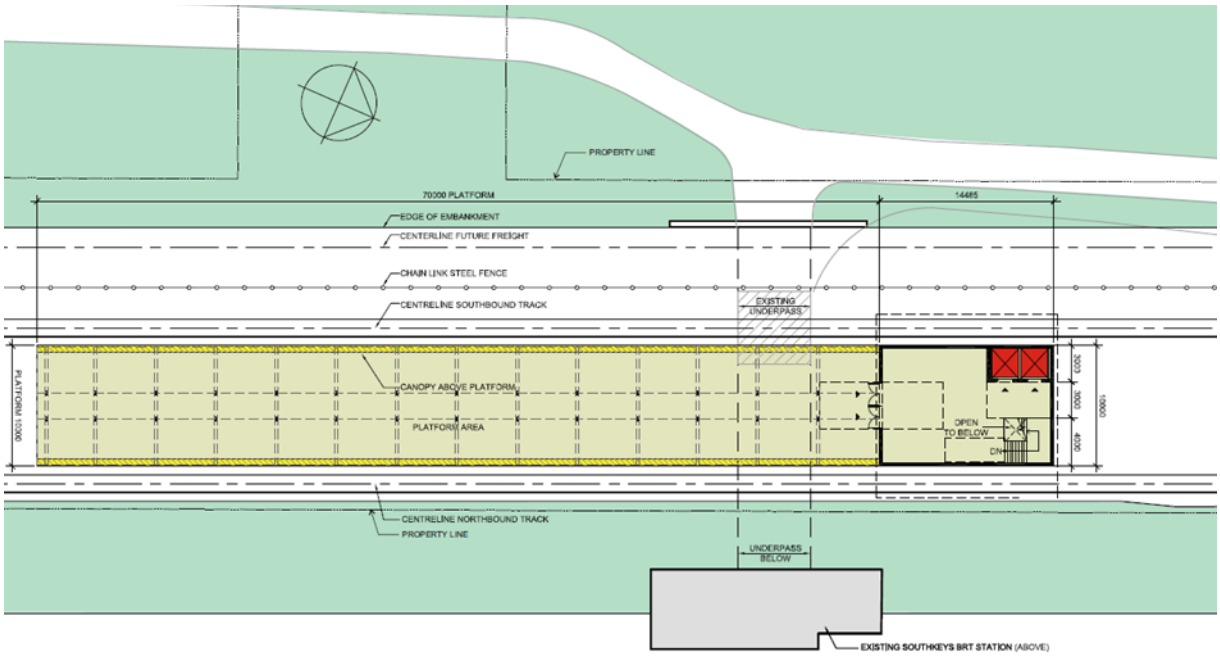

Figure 19: South Keys Platform Design

2.1.3.4. LEITRIM STATION

A new at-grade station is to be constructed south of Leitrim Road, adjacent to the existing Leitrim Park & Ride lot. The design of this station reflects its rural context and will include a small station house, and a covered walkway across the bus lanes to the rail platform. The fare-paid zone at this station will include both bus and rail platforms, which will be oriented north-south. A loop at the northwest corner of the Park & Ride will provide turnaround and lay-by space. The Park & Ride lot will be expanded to 460 spaces for opening day with 925 spaces planned for the ultimate configuration.

A passing siding running from just south of the NRC testing facility to just North of Leitrim Road is projected to be required however, the final location and length of this passing siding will be optimized through the design advancement and procurement.

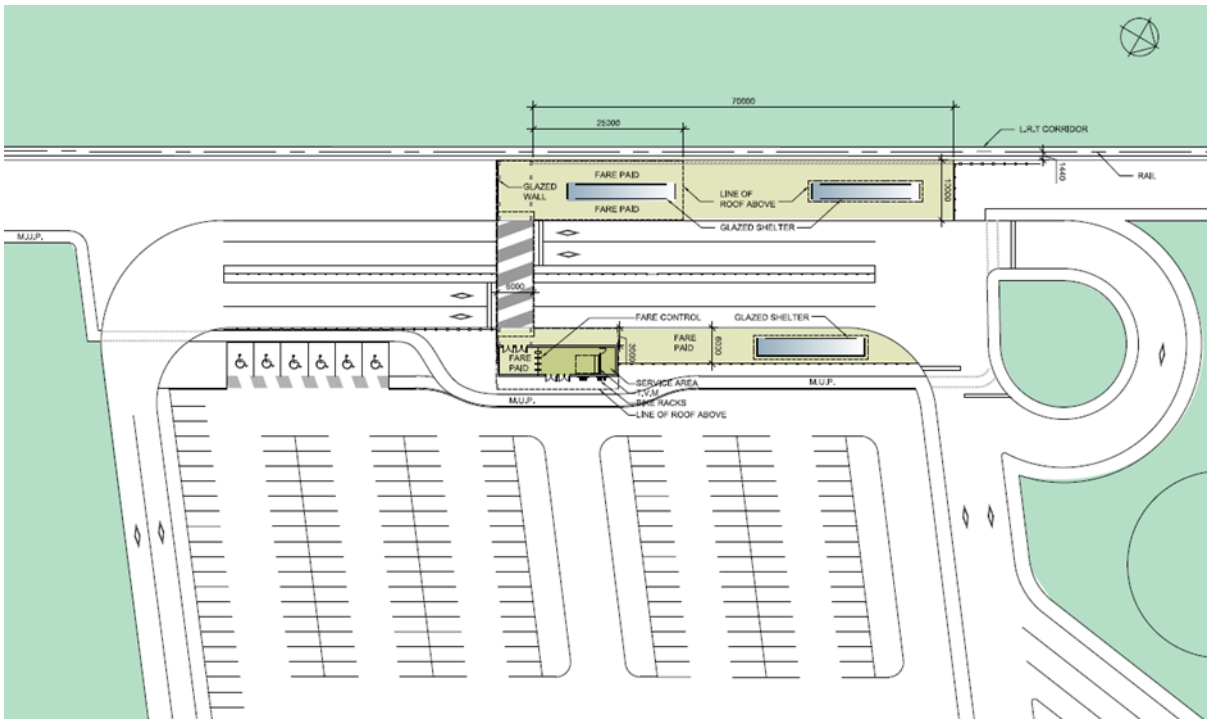

Figure 20: Leitrim Park and Ride Station Design

2.1.3.5. RIVERSIDE SOUTH (BOWESVILLE)

A new at-grade station and Park & Ride lot are to be constructed approximately 150 metres east of Bowesville Road, on land that must be acquired from the Ottawa Macdonald-Cartier International Airport Authority (OMCIAA). Like Leitrim Station, the design of this station reflects a rural context and includes a covered walkway across the bus lanes to the rail platform, and glazed shelters on all platforms. The fare-paid zone at this station also includes both bus and rail platforms. A loop and bus layup area will be located at the east end of the station.

The Park & Ride lot will accommodate 400 spaces on opening day with the potential to accommodate 3,100 spaces.

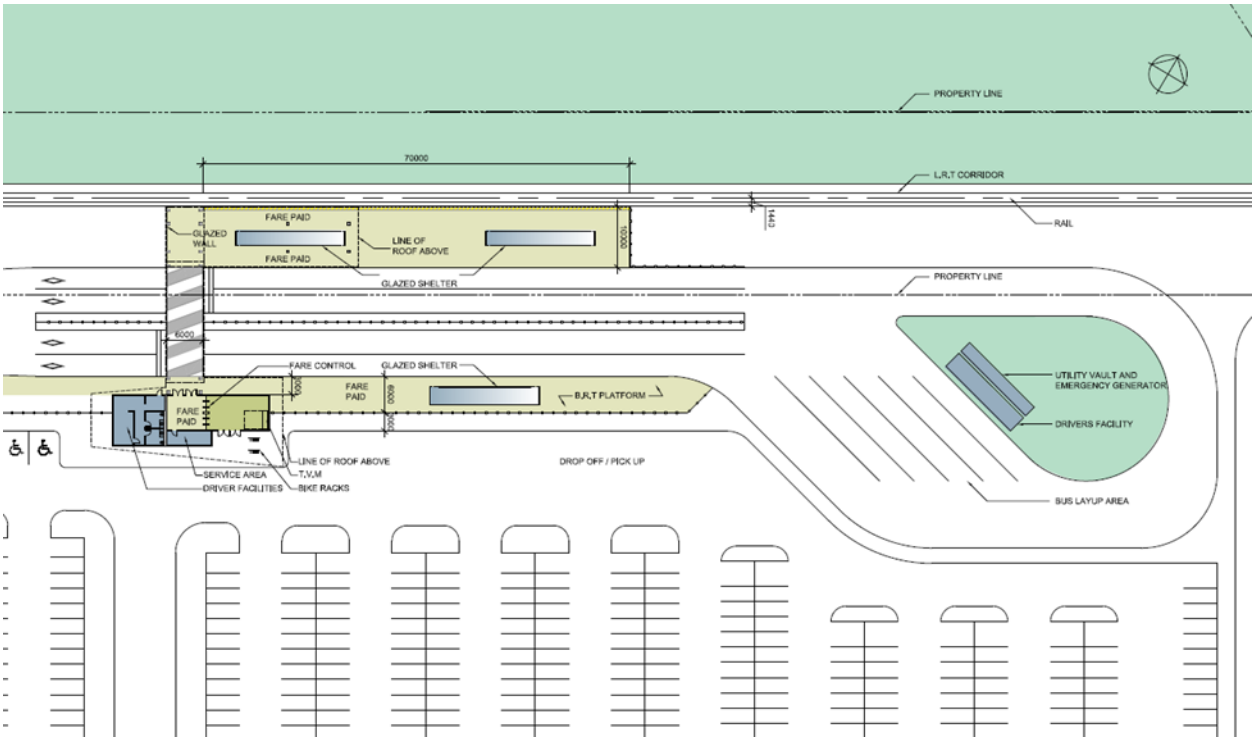

Figure 21: Bowesville Station Park and Ride Design

2.1.4. BEYOND STAGE 2: AIRPORT LINK

2.1.4.1. UPLANDS STATION

Uplands Station will be located along a passing siding, and will be designed as a grade-separated station with two side platforms to reduce property impacts. A station house, designed to accommodate EY Centre event traffic, will incorporate street-level doors on the south side providing access to a bus transfer platform within the fare-paid zone, with staircases and switchback ramps (or redundant elevators, if required) providing access to each rail platform. A street-level connection will be provided from the south entrance of the station to the EY Centre, and a MUP connection will be provided to Uplands Drive.

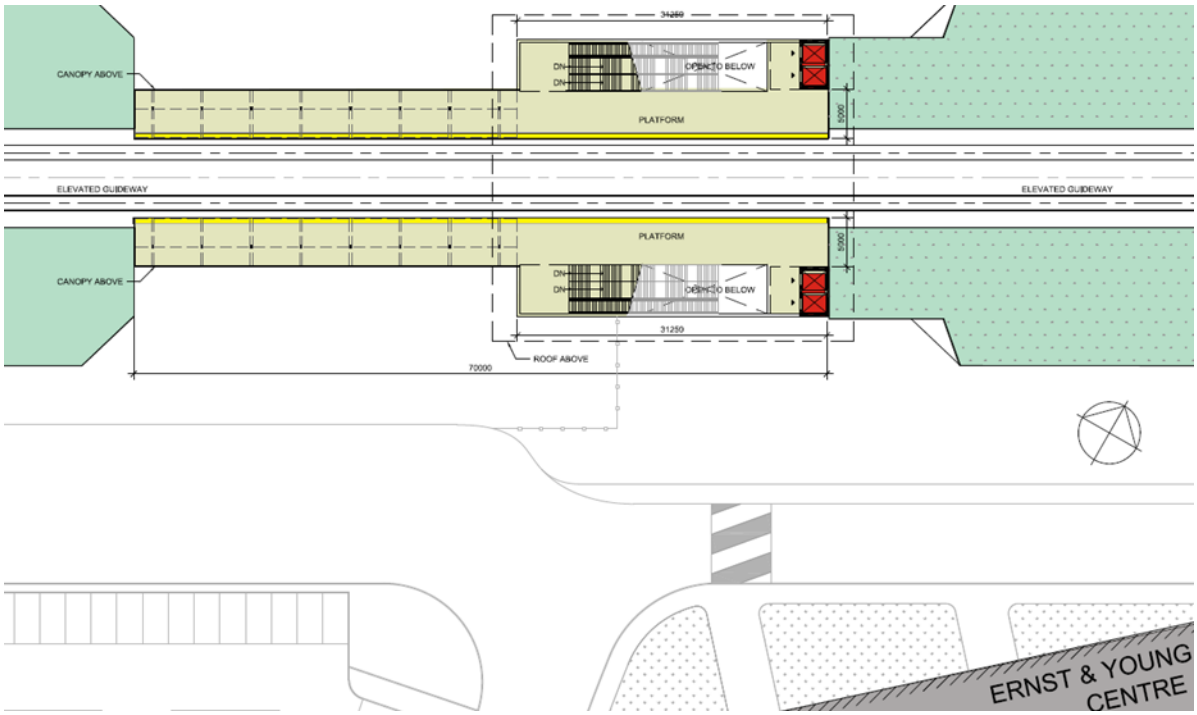

Figure 22: Uplands Station

2.1.4.2. AIRPORT TERMINAL STATION

Airport Terminal Station will be located between the Ottawa Airport terminal and parking garage structures, at the top level of the parking garage. It will consist of a single platform, with a short length of track provided beyond the platform. The station will be connected to existing ramps, elevators and pedestrian walkways to provide weather-protected access to the terminal building. Public washroom facilities for this station will be those within the terminal building.

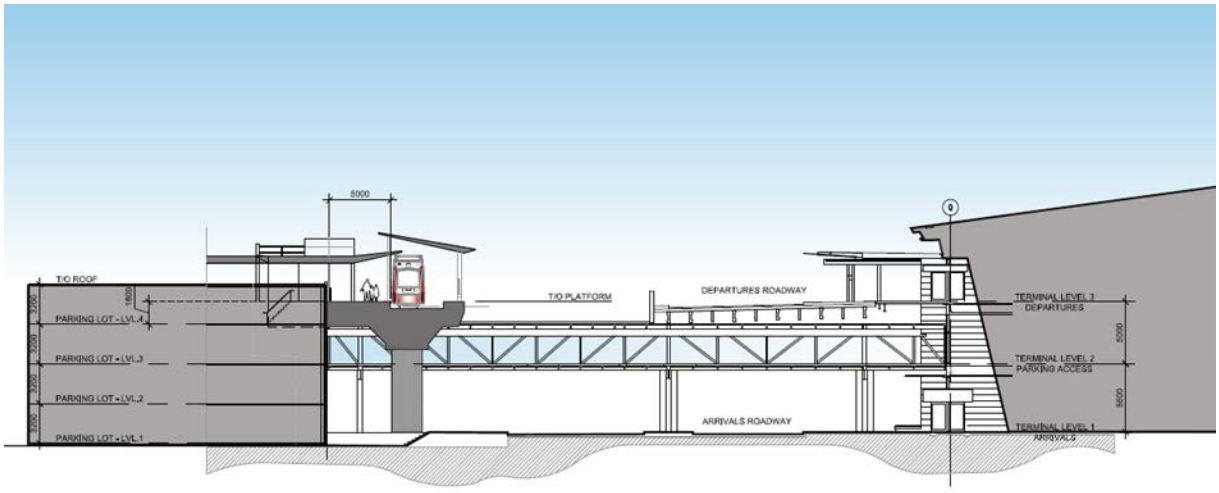

Figure 23: Terminal Station

2.1.5. BEYOND STAGE 2: TRIM ROAD EXTENSION

2.1.5.1. ORLÉANS TOWN CENTRE STATION

This mid-block station sits east of Champlain Street and west of Tenth Line Road. It will serve the Orléans Town Centre, with amenities such as the Shenkman Arts Centre, Peter D. Clark Place, a hotel, restaurants, retail shopping, medical and personal services, as well as existing higher density residential development. A new pedestrian overpass will link the communities from north and south of Highway 174. The station is positioned to allow access from existing pedestrian pathways on the north side that will be upgraded to multi-use pathway standards.

Transit-oriented development, including mixed-use and higher density residential development, is currently under construction directly south of Highway 174 and will be served by Orléans Town Centre Station. As part of the development, a road network has been designed to connect to the LRT station to support passenger drop-off and pickup.

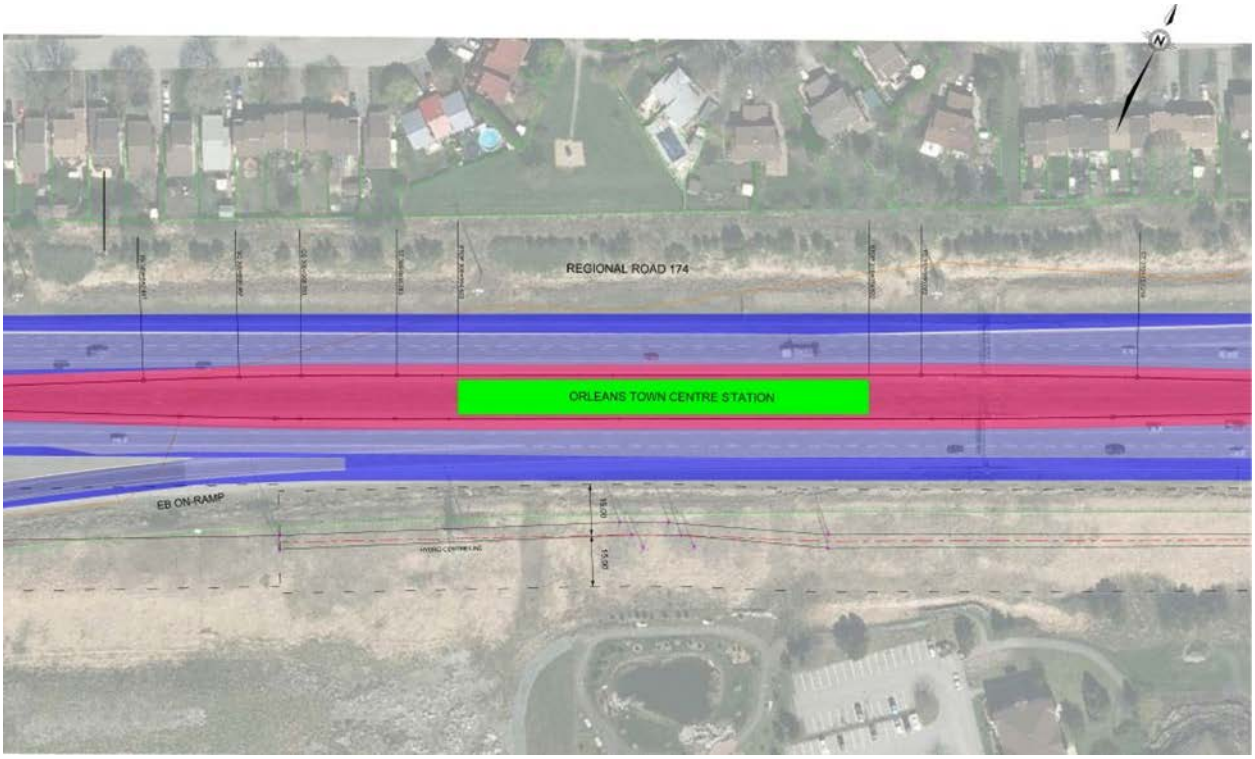

Figure 24: Orléans Town Centre Station

2.1.5.2. TENTH LINE STATION

Although the City's TMP identified a station directly at Tenth Line Road, the Tenth Line Road interchange design with wide ramps poses challenges for station connectivity. For this reason an alternative station location 300 metres east of Tenth Line was considered and is recommended as a mid-block station with a pedestrian overpass.

While the land use is currently vacant, concept development plans are underway on both sides of Highway 174 consisting of high density commercial on the south side and higher density residential on the north. There are opportunities to incorporate bus passenger drop off and pick up during the development phase.

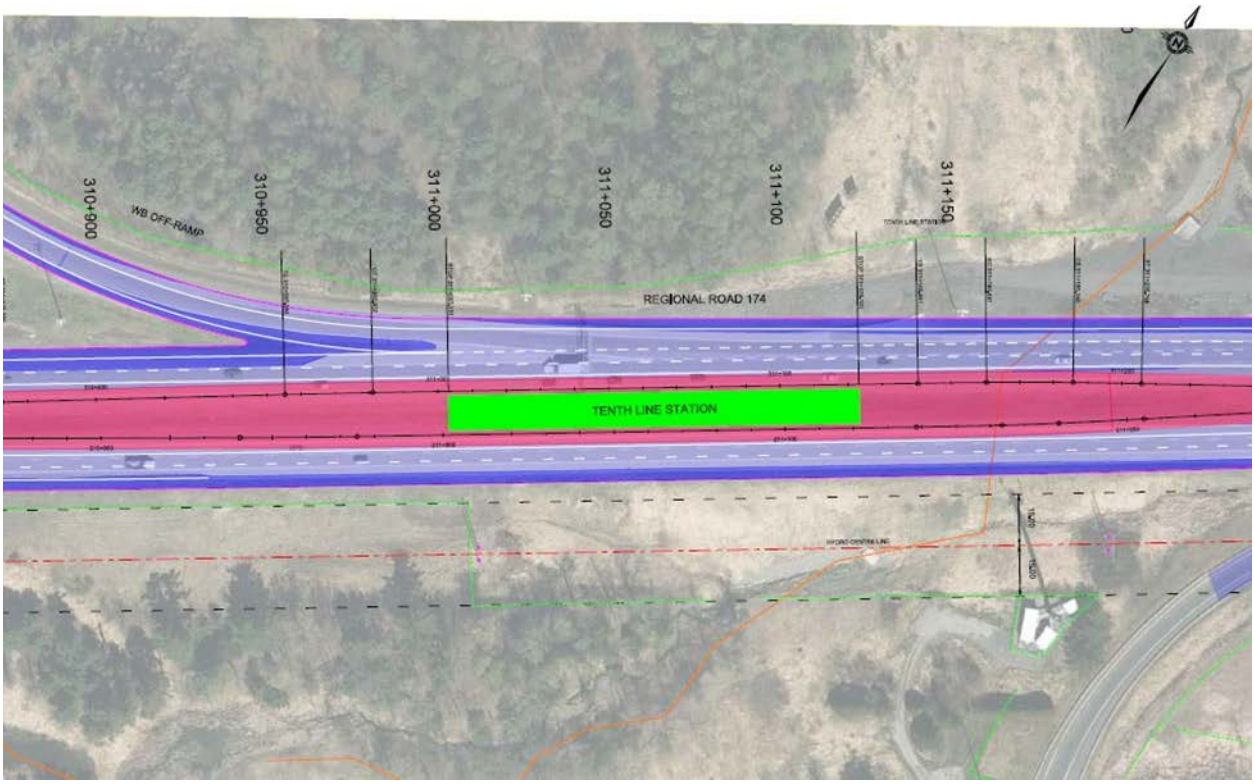

Figure 25: Tenth Line Station

2.1.5.3. TRIM STATION

As the LRT approaches the planned terminus at Trim Road, there are double crossovers immediately in front of the station to manage train operations. Today, Trim Road and Highway 174 is an at-grade signalized intersection. A grade separation would be required to integrate with the new station. Ramps will be provided for all movements, but will be positioned to allow for good access to the LRT station and permit some TOD nearby. This will allow the station to be placed under the Trim Road bridge with a pedestrian connection to the Park & Ride lot. A roundabout at Trim Road and North Service Road is recommended to facilitate local access.

Currently the bus loop is at the south end of the Park & Ride lot and will be relocated closer to the LRT station for greater connectivity. There is TOD potential for the development block on the north side, which is the former MTO works yard.

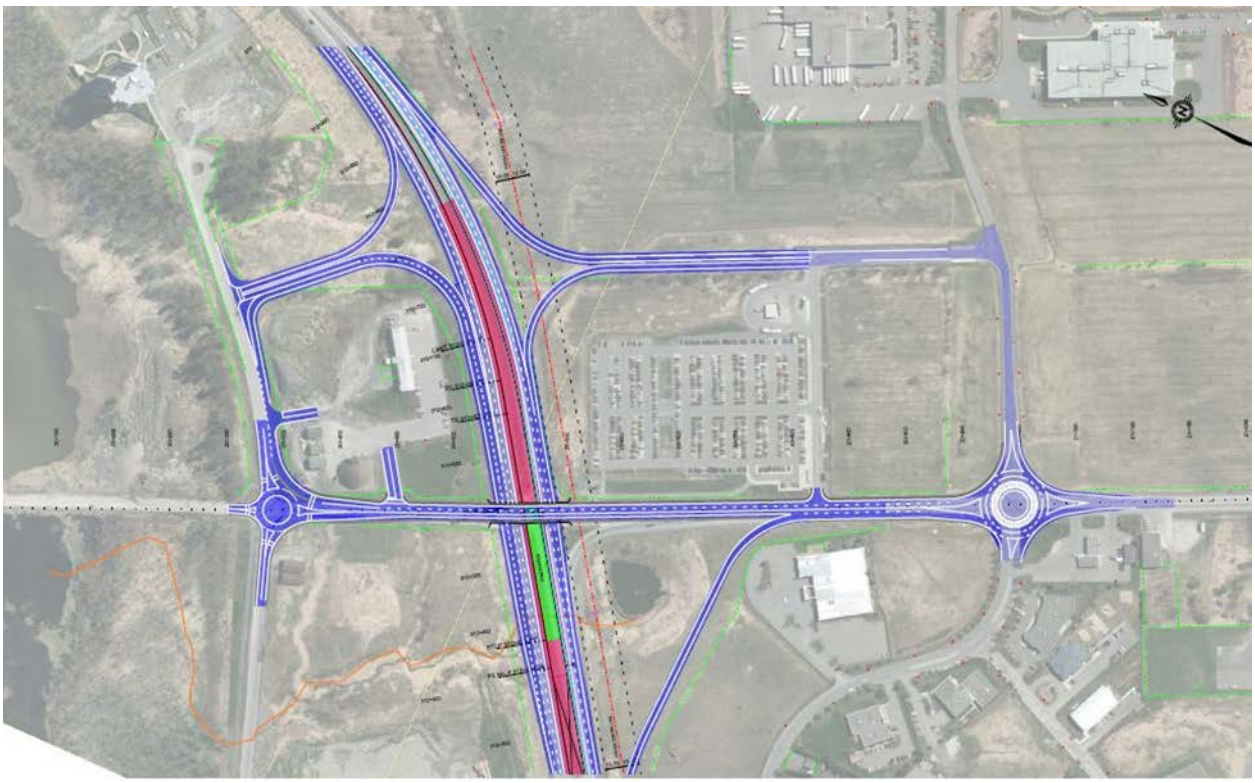

Figure 26: Trim Road Station and Interchange

2.1.6. KEEPING OTTAWA MOVING

Environmental assessment studies provide general information on the types of impacts associated with various types of construction, constraints, and techniques. They do not undertake a detailed look at the potential construction means and methods used. Very often, the actual construction impacts are more limited and the construction footprint required is smaller than those noted in the EAs.

As with most P3/AFP construction projects, the proponent selected to build Stage 2 will be responsible for developing final plans and designs that:

- Address noise, vibration and air quality;
- Provide pedestrian, cycling, traffic and transit access;
- Protect the natural environment;
- Minimize disturbance to communities; and,
- Manage waste, and potential for accidents and spills.

Overall, the Stage 2 design and procurement will be structured similar to the Confederation Line to minimize construction impacts on the City's transit and transportation network, adjacent businesses and communities.

For example, as was the experience with Confederation Line, sensitive receptors will need to be identified along the corridor where thresholds for noise and vibration must be met. In these circumstances, a noise and vibration monitoring plan would be put in place during construction, and pre-construction building surveys would be completed where construction for the LRT alignment runs within close proximity of private property.

Stage 2 will, depending on the procurement model selected use the powerful Net Present Value tools, used during the Confederation Line like the Mobility Matters schedule which institutes a financial incentive/disincentive plan to minimize the number and duration of detours, lane closures and impacts to local landowners.

2.2. LAND REQUIREMENTS

Recognizing the current function design, the environmental assessment process has identified the need for approximately 45 parcels of private and public land along the alignment. Property will be required as needed throughout the project's implementation as per the City's land acquisition policies and bylaws.

2.3. PROJECT TIMELINE

The following table outlines the major activities associated with the planning and construction of Stage 2.

Schedule Element	Timing	
	Start	End
Project Definition Report	Ongoing	September 2015
Procurement Options Analysis including VfM	July 2015	March 2016
Procurement Option Report to Council	Q1 2015	
Preliminary Engineering	July 2015	Q1 2017
Funding Agreement Negotiation	Q1 2016	Q3 2017
Design Update and Authorization for Procurement Report to Council	Q3 2016	
Request for Qualification	Q3 2016	Q1 2017
Request for Proposal	Q1 2017	Q1 2018
Council Approval to Award Contract	Q2 2018	
Contract Award	Q3 2018	
Construction	Q4 2018	Q1 2023
Revenue Service	Q4 2023	

Table 2: Stage 2 Project Schedule

3. PROJECT OUTCOMES AND BENEFITS

The Affordable RTTP Network is based on a complex prioritization exercise, which takes a number of factors into consideration, including the highest ridership gains, opportunities for land use intensification, congestion reduction and operating cost savings. In this process, Stage 2 was selected as a key capital project, providing the maximum number of benefits with a view to reasonably prioritizing those within the City's budgetary constraints. This section outlines the key benefits associated with Stage 2, and quantifies those benefits, where possible.

3.1. INCREASING TRANSIT RIDERSHIP

Transit infrastructure must be developed to support travel demands for economic growth and the needs of the population. While ridership growth is expected, "ridership may be constrained by a lack of growth in the services offered."[26] To achieve healthy ridership gains, expansion projects for public transit systems are necessary to improve the service and reliability of public transportation infrastructure. Increasing ridership, in turn, is critical to sustaining public investment and improving the efficiency of a transportation system overall.[27]

In Ottawa, city-wide transit ridership is expected to reach almost 135,000 AM peak period trips, or 136 million annual trips by 2031. With a compact land use configuration reflective of enhanced transit service, the implementation of Stage 2 would result in nearly 150 thousand AM peak period trips, or 150 million annual trips in that same year. In other words, the increase in ridership resulting from Stage 2 is expected to increase city-wide ridership by approximately ten percent, as expressed in Table 3, below.[28]

	Base Case	Stage 2	Δ Stage 2 - Base	% Increase
2031				
AM peak period trips	134,700	148,000	13,300	9.9%
Annual ridership	136,000,000	149,400,000	13,400,000	9.9%
				2048
AM peak period trips	159,500	175,300	15,800	9.9%
Annual ridership	161,100,000	177,000,000	15,900,000	9.9%

Table 3: Stage 2 Ridership Forecast
Based City-wide TRANS model extraction
Source: IBI Consulting (2015-06-03) *Stage 2 Forecast Summary*

[26] Tweed,M. (Chair). (2012). Study on Transit in Canada. Report of the Standing Committee on Transport, Infrastructure and Communities. Speaker of the House of Commons. Retrieved on June 18, 2015, from: http://www.parl.gc.ca/content/hoc/Committee/411/TRAN/Reports/RP5301556/tranrp01/tranrp01-e.pdf

[27] Transit Research Board (2007). Elements Need to Create High Ridership Transit Systems. Transit Cooperative Research Program, Report 111. Prepared by TranSystems with Planners Collaborative Inc and Tom Cikelair Associates. Retrieved June 18, 2015, from: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_111.pdf

[28] Ridership projections for Stage 2 are based on Ottawa's 2013 TMP Affordable Network. The Base Case represents ridership projections for the City for the years 2031 and 2048, without Stage 2.

3.2. SUPPORTING EFFORTS TO REDUCE URBAN CONGESTION

The ability for Ottawa's road network to accommodate increases in motor vehicle use is rapidly approaching its limit. Congestion reduces quality of life and increases production of GHG through energy wasted in gridlocked traffic. It also causes substantial economic costs related to free flow of goods and people through the city and discourages future investments.[29] A 2009 study by Transport Canada, entitled *Updates to Costs of Congestion Studies*, estimated that the costs of congestion in Ottawa-Gatineau amounted approximately $200 million in 2006. These values were based on the value of time lost by commuters and other drivers in traffic (and do not consider the transportation of goods).[30]

The benefits of transit can extend beyond reduced congestion for drivers to include increased business activity and enhanced urban access (i.e. agglomeration economies). Reduced urban congestion benefits society in broader social returns, allowing people to access jobs that better match their skills, sharing knowledge face-to-face, and creating demand for more business, entertainment and cultural opportunities which benefit all of society.[31]

The savings in VKT resulting from Stage 2 will directly improve Ottawa's roadway congestion – referring to slow travel speeds due to heavy traffic and/or narrow roadways (resulting from a range of causes, including inadequate lane supply).[32] In the absence of Stage 2, projections show that by 2048, well over 4 billion annual vehicle kilometres will be traveled on City of Ottawa roadways. Ottawa would see a reduction of almost one quarter of its total VKT with the implementation of Stage 2 by 2048, as illustrated in Table 4, below. Consequently, those continuing to drive will experience travel time savings, vehicle operating cost savings, and improved road safety, as outlined in subsequent sub-sections of this report.

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[29] Urban Transportation Task Force. (2012, April). The High Cost of Congestion in Canadian Cities. Council of Ministers Responsible for Transportation and Highway Safety. Retrieved June 18, 2015 from: http://www.comt.ca/english/uttf-congestion-2012.pdf

[30] Transport Canada. (2009) Updates to Costs of Congestion Studies – Kriger, D. iTRANS for Transport Canada, Economic Analysis, as cited in Urban Transportation Task Force (2012) and Dachis (2013).

[31] Dachis, B. (2013, July). Cars, Congestion and Costs: A New Approach to Evaluating Government Infrastructure Investment. C.D. Howe Institute.

[32] Defined in Barth, M. and K. Boriboonsomsin. (2008). Real-world carbon dioxide implacts of traffic congestion. *Transportation Research* Record*. Journal of the Transportation Research Board.* No. 2058. Retrieved June 16, 2015, from: http://www.uctc.net/research/papers/UCTC-FR-2010-11.pdf

	Base Case	Affordable	Δ Change
2031			
AM Peak Hour VKT	2,409,010	2,002,709	406,301
Annual VKT	3,772,510,270	3,136,242,904	-636,267,366
2048			
AM Peak Hour VKT	2,715,930	2,076,915	630,735
Annual VKT	4,253,146,479	3,265,415,869	-987,730,611

Table 4: Stage 2 Reductions in Vehicle-Kilometres Travelled
Based City-wide TRANS model extraction and airport-related VKT
Source: IBI Consulting (2015-06-03) *Stage 2 Forecast Summary*

3.3. IMPROVING MOBILITY

3.3.1. TRAVEL TIME SAVINGS

Additional transit infrastructure will reduce travel time by improving speed and reliability of service for transit riders, and providing congestion relief for auto users. Travel Time Savings (TTS) represent the combined time saved for auto users and transit users as a result from implementing this project. Based on the modeled forecasts, it is estimated that auto users will experience an annual savings of over 23 million person-hours by 2048, and transit passengers will experience a savings of almost 13 million person-hours. The economic value of TTS is calculated by multiplying the total time saved (both for vehicle and transit travel times) by the value of time for a traveller. While there are a number of valid methodologies for calculating the value of time,[33] in order to be consistent with the Downtown Ottawa Transit Tunnel (DOTT) business case[34], this report bases its value of time on Transport Canada's 2008 study entitled: *Value of Time and Reliability for Local Trips in Canada*, escalated at 1.8% annually to $14.42 (in 2015 dollars), through to 2048.

The annual person hours saved by auto users and the annual person hours saved by taking transit were linearly extrapolated from 2031 and 2048 data to determine the annual growth rate in person hours from opening year in 2023 to 2048. Based on these inputs, it is estimated that the discounted of TTS for both transit and auto users will be over $7.2 billion (2023$), as a result of implementing Stage 2.

[33] Another practice is to determine the average hourly wage of a worker and multiply this value by 50% (see for instance, BC Ministry of Transportation, Planning and Programming Branch. (2012). Default Values for Benefit Cost Analysis in British Columbia. Retrieved June 10, 2015, from: https://www.th.gov.bc.ca/publications/planning/Guidelines/Business%20Case%20Guidelines/DefaultValues-BenefitCostAnalysis.pdf).

It is also noteworthy that studies have found the value of time to increase with a range of factors, including length of trip in time (see Waters II (n.d.) *Issues in Valuing Travel Time for Calculating the Total Social Costs of Transportation*), and peak period travel, particularly in the AM period (see for instance, HDR. (2008). *The Costs of Road Congestion in the Greater Toronto and Hamilton Area*. Metrolinx, Greater Toronto Transportation Authority, p.A2-6)).

[34] City of Ottawa. (2009). *Downtown Ottawa Transit Tunnel (DOTT) Planning and Environmental Assessment Study – Recommended Plan.* Reference No. ACS2009-ICS-PGM-0214. Retrieved June 22, 2015, from: http://ottawa.ca/calendar/ottawa/citycouncil/occ/2010/01-13/tc/ACS2009-ICS-PGM-0214.htm

3.3.2. IMPROVED ACCESS

Stage 2 will improve travel from extended areas of the city to the core, resulting in quicker journey times and providing greater transportation choice and freedom for a greater portion of the population. The Trillium Line will link one of Ottawa's fastest growing areas (the South Urban Area, including Riverside South, Leitrim and Nepean South) outside the Greenbelt to the light rail system, connecting into the downtown core. The extension will also improve business access to the labour force across the Ottawa-Gatineau region. Improvements in accessibility and the potential to link station accesses directly to adjacent buildings will provide increased mobility in poor weather conditions. Further, the potential airport extension will improve efficient access for seamless multi-modal trips into and out of Ottawa. Extended transit infrastructure gives more transportation options to the young, elderly, disabled and lower-income Canadians who are among the 10 million non-drivers in Canada[35]. This is discussed further in Section 3.6.5 of this report.

3.4. VEHICLE OPERATING COST SAVINGS

Extending the LRT service will result in an overall reduction in VKT and consequently congestion on Ottawa's roads. As a result, those who continue to drive will experience lower vehicle operating costs. For the purposes of this report, Vehicle Operating Costs (VOCs) are calculated by multiplying vehicle kilometers traveled (provided in the Stage 2 Ridership Forecasts) by the typical costs per kilometer to drive a vehicle. VOCs are calculated for the Base Case and Stage 2 networks, and the difference is compared to determine the savings resulting from the implementation of the Stage 2 comprising the LRT extensions.

The vehicle operating cost per km was calculated using CAA's driving costs calculator, based on a number of assumptions outlined in Appendix A. Taking only variable costs into consideration,[36] the cost to operate per kilometer is currently estimated at $0.19 per work km, escalated annually by 1.8% to 2048. Given an annual reduction of VKT of approximately 1 billion km in 2048, the discounted value of total VOC savings resulting from the extension over the 25 year period is approximately $2.6 billion (in 2023$).

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[35] Canadian Urban Transit Association. (2003). Issue Paper 3. *Public Transit and Our Quality of Life: Building Better Communities*. Retrieved June 18, 2015 from: http://www.cutaactu.ca/en/public-transit/publicationsandresearch/resources/IssuePaperNo.3_PublicTransitandourQualityofLife_BuildingBetterCommunities.pdf

[36] This calculation is based on the assumption that reduced VKT does not result in any reductions in car ownership. Often the full VOC – currently $0.46 per km, *ceteris paribus* – is utilized in Benefit Cost Analysis. However, should drivers maintain car ownership, there are a number of fixed costs that will not result in savings from reduced VKT. Rather, only work-related VOC has been taken into consideration. The assumptions can be found in Appendix A.

3.5. ENVIRONMENTAL BENEFITS

Perhaps one of the most recognizable benefits of transit investment is the reduction in greenhouse gases (GHGs) and critical air contaminants (CACs), which have direct implications for the overall sustainability of urban growth and direct consequences on the health of residents.

Traffic congestion directly contributes to harmful emissions;[37] congestion results in "stop-and-go" driving, which has higher emissions and fuel consumption vis-à-vis free flowing traffic.[38] Shifting automobile use to transit could contribute to significant reductions in urban emissions; one study on emissions in the GTA estimates that public transit consumes approximately three times less energy per seat-km than automobiles, and public transit produces approximately ten times less GHG emissions than private transportation.[39] It is estimated that Stage 2 would result in over 67 million litres of savings in fuel consumption. The estimated reductions in GHG emissions and CACs and their associated economic costs related to Stage 2 are presented here below. It is noteworthy that the values are based solely on car VKT, and thus do not account for the economic savings of reduced GHGs and CACs resulting from converting bus VKT to light rail technology.

3.5.1. GREENHOUSE GAS EMISSIONS

Automobile use is one of the main sources of greenhouse gas (GHG) emissions in Canada. Implementing the proposed extension will provide improved environmental performance by shifting even more travel from cars to transit.

The cost of GHG emissions are calculated by multiplying VKT by the amount of GHG emitted in tonnes per km travelled and by the unit cost of GHG per tonne. For the purposes of this analysis, the unit cost of GHG emitted per tonne was $37.38/t CO_2 equivalent based on the Transport Canada study Estimating the Costs of Greenhouse Gas Emissions from Transportation, 2007, and forecasted to grow by 1.8% to 2048. The amount of GHG emitted per km travelled was determined to be 0.00019 tonne/km based on the carbon footprint for operating a mid-sized vehicle. Due to anticipated innovation which will result in improved fuel efficiency, the amount of GHG emitted was forecasted to decrease by 0.5% over the period from 2023 to 2048. Based on these inputs, the discounted value of GHG emission savings resulting from the extension is estimated to be $113 million (in 2023$).

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[37] Transport Research Centre, OECD. (2007). *Managing Urban Traffic Congestion*. European Conference of Ministers of Transport (ECMT). OECD Publishing, Paris.

[38] A number of other factors must also be taken into consideration, e.g. excessive travel speeds can also increase emissions and driving behaviour. Barth, M. and K. Boriboonsomsin. (2008). Real-world carbon dioxide implacts of traffic congestion.

[39] Kennedy, C. A. (2001). A comparison of the sustainability of public and private transportation systems: Study of the Greater Toronto Area. October.

3.5.2. CRITICAL AIR CONTAMINANTS

Critical Air Contaminants are pollutants with a variety of impacts on the environment and human health, and include volatile organic compounds, nitrous oxides, sulfur oxide and particulate matter. The cost of CAC emissions are calculated in the same way as GHG emissions described above. The amount of CACs emitted per km travelled is based on the average CAC emissions for various vehicle classes from passenger cars to diesel trucks. Due to anticipated innovation which will result in improved fuel efficiency, the amount of CAC emitted is assumed to decrease by 0.5% per year to 2048. Based on the CAC emissions calculated, the present value of CAC emissions savings resulting from the extension is estimated to be $522 million.

3.6. PUBLIC HEALTH BENEFITS

The public health benefits associated with public transit have been well studied.[40] According to the World Health Organization's, public health refers to all organized measures (whether public or private) to "promote health and prolong life among the population as a whole."[41] The Canadian Urban Transit Association's (CUTA) 2002 paper, *Promoting Better Health through Public Transit Use*, outlines the main factors that affect public health: air quality, climate change, physical activity, safety, and equity.[42] Stage 2 and the potential health benefits related to these factors are discussed in the following sub-sections.

3.6.1. AIR QUALITY

Reducing vehicle use and thereby reducing emissions of particulate matter and ground-level ozone can greatly improve the respiratory health and the related healthcare burdens. According to Health Canada, exposure to air pollution from road traffic has been linked to a number of other health issues including heart attack, coronary artery disease, and increased risk of death from respiratory and cardiac conditions[43]. Further, approximately one third of Canada's population is directly exposed to traffic-related air pollution (500 m on each side of highways, and 100 m on each side of major urban roads),[44] making it a significant issue for Canadians as a whole. As traffic volumes continue to

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[40] American Public Transportation Association. The Benefits of Public Transportation. *The Route to Better Personal Health.* Retrieved June 17, 2015 from: http://www.apta.com/resources/reportsandpublications/Documents/better_health.pdf

Litman, Todd. (2010). Evaluating Public Transportation Health Benefits. Victoria Transport Policy Institute. Retrieved June 17, 2015 from: http://www.apta.com/resources/reportsandpublications/Documents/APTA_Health_Benefits_Litman.pdf

[41] World Health Organization. (2015). Trade, foreign policy, diplomacy and health. *Public Health*. Retrieved June 16, 2015 from: http://www.who.int/trade/glossary/story076/en/

[42] Canadian Urban Transit Association. (2003). Issue Paper 2. *Promoting Better Health through Public Transit Use*. Retrieved June 16, 2015 from: http://www.cutaactu.ca/en/public-transit/publicationsandresearch/resources/IssuePaperNo.2_PromotingBetterHealthThroughPublicTransitUse.pdf

[43]Government of Canada. (2012). Road Traffic and air pollution. Retrieved June 17, 2015 from: http://healthycanadians.gc.ca/healthy-living-vie-saine/environment-environnement/outdoor-air-exterieur/traf-eng.php

[44] Brauer, M. C. Reynolds and P. Hystad. (2013). Traffic-related air pollution and health in Canada. Commentary. Canadian Medical Association Journal, December, 185 (18).

rise with Ottawa's increasing population, it becomes more important to find ways to reduce vehicular emissions by finding alternative modes of transportation.

3.6.2. CLIMATE CHANGE

Climate change refers to any significant change in the measures of climate lasting for an extended period of time.[45] CO_2 emissions are a main producer of greenhouse gas, which contributes to global warming effects and associated climate change. With vehicle emissions being a major cause of global warming, the transportation sector is being targeted with efforts to reduce CO_2 emissions and prevent negative effects of climate change.[46] A modal shift from vehicle use to transit can be a key contributor to Canada's climate change strategy. Rising global temperatures and continued climate change could have numerous impacts on public health due to extreme weather events, heat waves, air quality deterioration, flooding, etc.[47]

3.6.3. PHYSICAL ACTIVITY

Transit use is closely linked with active modes of transportation, ultimately minimizing the use of the private automobile. The built environment strongly affects health by shaping activity levels and transportation choices (e.g. the use of private automobiles, as opposed to walking between destinations or using public transit). Indeed, it has been found that countries with highest levels of public transit and active transportation experience lower levels of obesity.[48] Transit use promotes a decrease in inactivity levels, providing a more active lifestyle for a greater portion of the population, and ultimately lessoning the overall healthcare costs of the population. Physical activity is important for healthy growth and development, prevention of disease, improved energy and reduction in stress.[49]

It is often difficult for individuals to achieve their daily physical activity requirements; by building physical activity into their daily transportation patterns, travelers can achieve a healthier lifestyle without sacrificing time or finances. In fact, one study shows that, on average, public transit users in Montreal will typically walk approximately 25% of the recommended daily physical activity in a round trip.[50] Ottawa has recognized the importance of walkability in its most recent TMP, emphasizing the

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[45] US Environmental Protection Agency. (2015). Climate Change: Basic Information. Retrieved June 17, 2015 from: http://www.epa.gov/climatechange/basics/

[46] United Nations Economic Commission for Europe. (2015). Climate Change and Sustainable Transport. Retrieved June 17, 2015 from: http://www.unece.org/?id=9890

[47] CUTA. (2005). *Public Transit, a Climate Change Solution*. Retrieved from: http://www.cutaactu.ca/en/public-transit/publicationsandresearch/resources/IssuePaperNo.16_PublicTransit_AClimateChangeSolution.pdf

[48] Medical Officers of Health in the GTHA. (2014). *Improving Health by Design in the Greater Toronto-Hamilton Area*. May. 2nd Edition. Retrieved June 17, 2015, from: http://www.peelregion.ca/health/resources/healthbydesign/pdf/moh-report.pdf

[49] Physical Activity. Public Health Agency of Canada. http://www.phac-aspc.gc.ca/hp-ps/hl-mvs/pa-ap/at-ta-eng.php

[50] Morency, C., M. Trepanier, M. Demers. (2011). Walking to transit: An unexpected source of physical activity. *Transport Policy*, 18, pp. 800-806.

provision of pedestrian facilities to have direct connections to rapid transit stations, bus stops and other major walking destinations. Meanwhile, City's TMP and Cycling Plan focus on providing cycling connections to transit for bike-ride-walk and bike-ride-bike trips.

3.6.4. SAFETY – ACCIDENT AVOIDANCE

The frequency and severity of vehicle accidents imparts a high cost to society, both financially and to overall quality of life. A widespread, state-of-the-art transit system offers the safest mode of public transportation, moving a large number of people without the negative effects of vehicle collisions. The economic benefits of reducing the number of high cost fatal and injury causing accidents through increased transit ridership in Ottawa as a result of Stage 2 were quantified.

Traffic accidents can be categorised as fatal accidents, injury only accidents, and accidents causing property damage. Each incident imposes a significant cost both to individuals and to society, which can be greatly reduced through a modal shift to transit by reducing the number of cars on the road.

The cost of collisions is determined by multiplying the incident rate by the social cost of accidents by VKT. The incident rate[51] and social cost of accidents[52] was determined for each collision type (fatal, injury only, and property damage). For the purposes of this report, the incident rate was considered to be constant over the period of this study; whereas, the social cost of accidents was forecasted to grow by 1.8% per year to 2048. Based on these inputs, the discounted value of collision cost savings resulting from the extension is $903 million.

3.6.5. EQUITY

Most cities struggle with equitable mobility, and increasing the coverage and accessibility of Ottawa's LRT system will help improve transportation options for the population as a whole. Enhanced transit connectivity has a number of positive health implications, particularly for disadvantaged groups, who may be unable to drive or have disabilities, or who face cultural or language barriers. As such, disadvantaged groups can more easily access medical facilities, employment opportunities, education, public amenities, and recreational options.[53] Further, public transit allows families to reallocate funds towards other necessities, such as food, shelter, education and medicine.[54] Given

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[51] Transport Canada. (2013). Canadian Motor Vehicle Traffic Collision Statistics. Retrieved June 16, 2015 from: http://www.tc.gc.ca/media/documents/roadsafety/cmvtcs2013_eng.pdf

[52] de Leur, Paul. (2010). Collision Cost Study. Capital Region Intersection Safety Partnership. Retrieved June 16, 2015 from: http://drivetolive.ca/wp-content/uploads/2014/02/Collision_Cost_Study_Final_Report_Feb_2010.pdf

[53] Manaugh, Kevin. (2012). Chapter 12: Who benefits from new transportation infrastructure? Using accessibility measures to evaluate social equity in public transport provision. K. Geurs, K. Krizek, A. Reggiani. *Accessibility Analysis and Transport Planning.* Edward Elgar Publishing, pp. 211 – 227.

[54] CUTA (2002). *Promoting Better Health through Public Transit Use*. Retrieved from: http://www.cutaactu.ca/en/public-transit/publicationsandresearch/resources/IssuePaperNo.2_PromotingBetterHealthThroughPublicTransitUse.pdf

Ottawa's aging population[55] enhanced transit service – together with a more compact urban form – will offer better accessibility to a growing proportion of the City's populace.

3.7. LAND USE BENEFITS

A range of land use benefits are associated with investment in transit. A 2010 CUTA study[56] outlines four primary land use benefits, which form the basis of the following points:

- Transit supports higher density and compact urban form, and reduces the quantity of land necessary for roads and parking facilities. As it is acknowledged in the City's Official Plan, intensification is the most cost-effective way to develop cities since it results in reduced per capita municipal spending on infrastructure and services. It is noteworthy, however, that the relationship is also inverse – "the right kinds of land use, the combination of uses, and the intensity of activities have a direct relationship to the efficiency of transit."[57] With this end, the City of Ottawa has already made efforts to define TOD zones, direct intensification in designated areas that are supportive of LRT expansion.
- Transit creates an "amenity premium" as a result of pedestrian-centric activity and priority.
- Transit creates economic multipliers through spin-off economic activity surrounding highly accessible locations. This is one of the logics of mobility hubs, "where different modes of transportation – from walking to riding transit – come together seamlessly and where there is an intensive concentration of working, living, shopping, and/or playing;" such hubs enhance the economic vitality and competitiveness of the areas surrounding stations.[58] Further, agglomeration economies – or productivity gains – can be garnered from increased clustering and accessible land use patterns.[59]
- Stage 2 will likely bring additional land value uplift around the existing and new stations. Improved connectivity and accessibility supplied by transit services generates increased land and development value.[60] Locations with higher accessibility, and therefore transportation cost savings, tend to command higher prices for land, with ease of access to places of employment, shopping destinations, entertainment venues, medical facilities, and

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[55] The population over the age of 65 is projected to increase from 12% in 2006 to just over 20% by 2031. City of Ottawa. (n.d.). Growth Projections for Ottawa 2006-2031 [website]. Retrieved June 18, 2015, from: http://ottawa.ca/en/city-hall/get-know-your-city/statistics/growth-projections-ottawa-2006-2031

[56] CUTA. (2010). *Economic Impact of Transit Investment in Canada. A National Survey.* CUTA. Retrieved June 02, from: http://perthhuron.unitedway.ca/wp-content/uploads/2014/01/CUTA-The-Economic-Impact-of-Transit-Investment-A-National-Survey.pdf

[57] City of Ottawa. (2007). Transit-Oriented Development Guidelines. Retrieved June 17, 2015, from: http://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/con029008.pdf

[58] Metrolinx. (2011). *Mobility Hub Guidelines.* Retrieved March 20, 2015, from: http://www.metrolinx.com/en/projectsandprograms/mobilityhubs/MobilityHubGuidelines.pdf

[59] Litman, Todd. (2010). Evaluating Public Transportation Health Benefits. Victoria Transport Policy Institute.

[60] Hazel, G. (2013, August). Land Value Capture (LVC) Discussion Paper. Prepared for Metrolinx. Retrieved June 17, 2015 from: http://www.vtpi.org/smith.pdf

educational institutions.[61] Capturing the increased value of properties (known as land value uplift) close to transit stations can also help offset some transit system capital costs, including the costs of property acquisition. A number of methods exist to capture uplift. Oftentimes these require new legislation and would likely involve the imposition of special levies on land holdings in transit corridors.[62]

[61] Iacono, M., Levinson, D., Zhao (Jerry), Z., Lari, A. (2009, June). Value Capture for Transportation Finance. *Report to the Minesota Legislature.* Centre for Transportation Studies, University of Minnesota. Minneapolis, MN. p. 3.

[62] Smith, J., Gihring, T. (April, 2015). Financing Transit Systems Through Value Capture. *An Annotated Bibliography*. *American Journal of Economics and Sociology*, *Volume 65, Issue 3, July 2006*. p. 751. Retrieved June 17, 2015 from: http://www.vtpi.org/smith.pdf

3.8. ECONOMIC DEVELOPMENT / DIRECT CONSTRUCTION AND OPERATIONS BENEFITS

Stage 2 will contribute to the regeneration of the economy and the creation of new jobs or increased employment in the following ways:

- Jobs associated with constructing, operating and maintaining the LRT system;
- Jobs arising as a result of the improved travel conditions in the downtown and at stations along the line;
- Increased employment in the downtown core, where offices can be more effectively serviced.

Since this is an extension of the LRT project currently under construction, the standard economic impact modelling of the DOTT business case was used to form a basis for the estimated employment that will be generated by the construction of the extension. The total amount of direct, indirect and imputed employment generated associated with the $2.5 billion investment is nearly 24,000 person-years.

From business perspective, the accessibility of a given location (for office, retail, commercial) is critical; for instance, improved transit access will help determine whether a location is more or less attractive for the expansion of an existing business or the establishment of a new one. The relevant factors to consider may include: access to a workplace living within acceptable travel times and costs, access to/by customers, and access to/by suppliers. For these reasons, extending the LRT and constructing additional LRT stations will promote intensification and the clustering of higher density employment uses. Consistent with the City's growth management objectives, the increased access to employment will also allow more of the City's residents to travel to work by transit.

Investment in transit infrastructure and its ancillary projects can create additional spinoff impacts for Ottawa's economy. In the 2010 DOTT business case, input-output models were used to track the impact of the investment into the aggregate demand for goods and services in the economy. The main purpose of input-output models is to measure how changes in industry output impact the economy in terms of total output, Gross Domestic Product (GDP), employment and government revenue.

The DOTT business case findings suggested that the government's $2.1 billion in public transit investment in Ottawa would have an approximate $3.2 billion impact on economic output (GDP), suggesting a multiplier of 1.55.[63] The labour impacts amounted to 20,116 person-years as a result of the investment. Tax revenue impacts amounted to $144 million. Based on these results, GDP,

[63] These results are comparable to results using data presented in a 2010 Canadian Urban Transit Association study, entitled, *The Economic Impact of Transit Investment: A National Survey.* The CUTA report analyzed the national impacts to GDP, employment and government revenues from transit investment for public transit investments across Canada. This report used a similar multiplier of 1.5.

employment and tax revenue impacts were extrapolated for Stage 2 to provide a high level impact assessment for this project. The results for Stage 2 are summarized in Table 5.

Metric	Annual Impact
Investment	$2,500,000,000
Economic Impact (GDP)	$3,822,570,279
Taxes arising from investment	$170,231,391
Direct employment from investment (full time jobs)	948
Employment from investment (person years)	23,708

Table 5: Economic Development (in 2013$)

3.9. BENEFIT-COST ANALYSIS

Utilizing the transportation user benefits, as well as environmental benefits, it is possible to estimate the broad economic impacts to society resulting from Stage 2 implementation. By comparing these quantified benefits with the capital and operating costs of Stage 2, the relative desirability of investing in Stage 2 can be determined. This can be achieved by calculating the project's benefit-cost ratio (BCR); as the ratio increases, so does the investment feasibility. While the BCR includes non-market factors (e.g. the value of time and environmental performance), it is noteworthy that this metric does not account for the qualitative, social and other non-monetized factors (e.g. equity issues, accessibility) that must be taken into account in the planning of urban transport.

For the purposes of this report, the discounted values for the following accounts have been included in the BCR exercise: travel time savings, vehicle operating cost savings, road user savings, CAC and GHG emission savings, and capital and operating costs. The City of Ottawa's discount rate of 5% was utilized, with a base year of 2023. The analysis includes discounted costs and benefits from opening year in 2023 to 2048.

Based on the analysis described herein, and assuming 100% of all benefits are accrued (including the achievement of expected ridership forecasts and travel time savings), the BCR for Stage 2 was determined to be 3.56. Assuming only half of all benefits materialize, a (50%) sensitivity analysis on the benefits results in a BCR of 1.78. Further, the BCR for Stage 2 plus the Airport Spur and Trim Road extension is expected to achieve a BCR of 3.34. With a sensitivity analysis on half the benefits, the BCR decreases to 1.67.

Account	Stage 2 (2023$, million)	Stage 2 + Airport Spur + Trim Ext (2023$, million)
Project Capital Cost	$3,302**	$3,644
Project Operating Savings	$103	$103*
Vehicle Operating Cost Savings	$2,630	$2,658
Travel Time Savings	$7,234	$7,615
Collision Cost Savings	$903	$912
Environmental Benefits	$635	$642
BCR	**3.56**	**3.34**

*For the purposes of this report, the Project Operating Savings for the Airport and Trim extensions are assumed to be nil. While there may be some net costs associated with these two extensions, the effect on the BCR will likely not be material. The capital costs associated with the Airport and Trim Road extensions are $130 million and $135 million (in 2013$), respectively.
** Future value of capital cost ($3,302 million in 2023$) equates to $2,475 million in 2013$, at 2.25% to the year of construction.
All future costs are discounted to 2023 at 5% at project start

Table 6: Benefit-Cost Ratio for Stage 2 and for Stage 2 + Airport + Trim Road Extensions

4. PROJECT ELIGIBILITY

4.1. PROJECT SUBCATEGORY ELIGIBILITY

As a light rail system, the proposed project, entitled "Stage 2" is eligible for *The New Building Canada Fund*, under the Public Transit Category and Transit Infrastructure and Rolling Stock subcategory, which includes light rail transit.

4.2. FUNDING RECIPIENT ELIGIBILITY

As a municipal government under provincial statute, the City of Ottawa is eligible to receive federal funding (i.e. *The New Building Canada Fund*).

5. PROJECT GOVERNANCE

City will own Stage 2 infrastructure and will oversee the design, construction and maintenance of the project, whether it is done by a P3 contractor or through traditional procurement. In either scenario, the City will be the system operator through OC Transpo.

In July 2011, Council approved the constitution of an Executive Steering Committee for the Confederation Line project which was made up of members of the City's Executive Committee and included representatives from Infrastructure Ontario and Metrolinx. It is recommended that Stage 2 report to the same Executive Steering Committee until the Procurement Options Analysis Report is brought to Council in the first quarter (Q1) of 2016, at which point a formal governance structure for Stage 2 will be recommended.

6. MINIMUM FEDERAL REQUIREMENTS

6.1. CATEGORY-SPECIFIC REQUIREMENTS

6.1.1. ECONOMIC ADVANTAGES AND BROADER PUBLIC BENEFITS

Stage 2 provides a range of benefits to Canadians, including reductions in urban congestion, increasing transit ridership, improving safety and improving mobility (e.g. improved access and reduced travel times). A qualitative discussion on the benefits is presented in Section 3. Where possible, these metrics have been quantified. Further, a benefit-cost ratio has been calculating utilizing the transportation user benefits and environmental benefits, as well as Stage 2 capital and operation costs.

6.1.2. COMPATIBLE WITH OFFICIAL TRANSPORTATION PLAN

As a priority project, Stage 2 is central to the City of Ottawa's 2013 Transportation Master Plan, as outlined in Section 1.4.

6.1.3. BASED ON PROJECTED DEMAND

This business case is based on projected ridership demand for 2031 and 2048, upon which the intended results are substantiated. Ridership projections are presented in Section 3.1.

6.1.4. ITS COMPONENT

The project does not include an ITS component or system.

6.2. ACCESSIBILITY

The stations and the system will be fully accessible and will comply with the Accessibility for Ontarians with Disability Act (AODA) and the requirements of the Canadian Standards Association Technical Standard Accessible Design for the Built Environment (CAN/CSA B651-04).

6.3. ENERGY EFFICIENCY

This project involves the construction of an LRT vehicle storage facility; the building will be LEED certified, and as such, exceeds the Model National Energy Code for Buildings requirements.

7. FINANCIAL REQUIREMENTS

7.1. HIGH-LEVEL CAPITAL COST ESTIMATE

The estimated capital costs for the TMP Affordable network extension is $2.5 billion in 2013 dollars.[64] The capital costs associated with the Airport and Trim Road extensions are $130 million and $135 million (in 2013$), respectively.

7.2. HIGH-LEVEL OPERATING COSTS

In terms of operating costs, it is estimated that there would be an annual savings of approximately $5 million per year (in 2013$)[65] as a result of implementing the affordable transit network.[66] The net savings is largely a result of the implementation of LRT and the savings in bus costs. For the purposes of this report, the operating costs associated with the Airport and Trim Road extensions are currently assumed to be nil.While there may be some net costs associated with these two extensions, these are not likely to affect the BCR in any significant way.

[64] The costs of property acquisition are not eligible for federal funding under *The New Building Canada Fund*. It has been assumed that any public lands required for the implementation of Stage 2 will be made available by the respective public entity. Additionally, only 15% of all planning and assessment costs (e.g. environmental planning, surveying, engineering etc.) will be reimbursed by the federal government.

[65] It is assumed that the annual operating savings will commence in 2023.

[66] This is the incremental cost for new infrastructure only.

8. LEGAL REQUIREMENTS

The City is committed to complying with all applicable legislation and ensuring all required permits and authorizations will be granted.

Stage 2 is made up of three distinct extensions, and consequently three separate Environmental Assessment's (EAs), the extensions show best value when consolidated as one project as it maximizes ridership capture, builds on the Confederation Line investments, , and creates economies of scale for the construction program. As a result of this value assessment, for the purposes of this report, the federal and provincial funding requests, the procurement analysis, the project business case and the preliminary engineering will all proceed with Stage 2 as a consolidated project single budget to ensure full value capture and concurrent implementation.

In February 2014, the Transportation Committee approved these Stage 2 composite projects' Statements of Work and changes to study scope as described in the following documents:

1. Trillium Line Extension and Airport Link
2. Confederation Line Extension East (including Trim Road)
3. Confederation Line West Extension

All three planning and environmental assessment studies are following Ontario's Transit Project Assessment Process (TPAP), Regulation 231/08. Upon Council approval of the functional designs, the entire planning process to-date, including consultation, will be documented in an Environmental Project Report (EPR) for each of the three projects.

Prior to the start of TPAP, the Transportation Committee and Council's approval is required. City of Ottawa staff has presented the functional designs for Stage 2, an assessment of all environmental impacts has been conducted, and public consultation has been undertaken. The TPAP process is expected to be concluded by early 2016.

The EAs also included a review of corridors that were deemed for the purposes of the TMP outside the affordable network. This includes the Airport Link, an extension to the Confederation Line East extension from Place D'Orleans to Trim Road and the Highway 174 widening. The recommended approach for both the Airport Link and the Trim Road extension are included in the body of this report. The work on the East LRT extension was carried out in conjunction with the Highway 174 widening study as both are in the same corridor. This ensures that the planning will result in the most efficient and cost-effective design for both facilities. The Highway 174 study is being conducted in accordance with the Municipal Class Environmental Assessment (Schedule C), and will have separate documentation (the Environmental Study Report, ESR).

9. P3 REQUIREMENTS

Given the project's total eligible costs well above the $100 million threshold, the project will require a P3 screen. Should Stage 2 be determined to be potentially suitable for delivery under a P3 model, a Procurement Options Analysis (POA) will be required to be submitted, along with this Business Case, to Infrastructure Canada and P3 Canada.

10. PROJECT RISKS AND MITIGATION MEASURES

Transit infrastructure development presents exposure to a number of risks, which can be mitigated through a comprehensive risk management strategy to minimize potential negative impacts and to ensure the project is successful throughout its life cycle. A comprehensive risk management strategy includes identifying all foreseeable risk that could impact the project, assessing the severity of risk, and implementing measures to mitigate risk. The aim is to minimize the potential for negative effects on businesses, communities, environment, transportation systems, and other infrastructure across all phases of the project, from planning to operation. As part of the Procurement Options Analysis (POA) and value for money exercise required for federal funding, a comprehensive risk analysis and management strategy will be developed.

At this stage, a number of high-level risks throughout the planning, implementation and operations phase of the project were considered, and are outlined below. Some of the risks and mitigation measures mentioned below represent lessons learned in the planning and implementation phases of the Confederation Line, currently in construction.

10.1. PLANNING PHASE

During the planning phase the most significant risks are those that could potentially prevent the project from proceeding to the next phase of implementation. These could include insurmountable design, environmental, or planning problems. At this stage, the project team has not identified any such risks.

Given that the environmental assessments for each of the proposed Stage 2 transit segments have been approved, it is unlikely that there will be any material changes in scope. Other agency approvals will also be required, and thus also pose a risk. There are some risks associated with the Federal Airport Zoning Regulation (AZR), which regulates uses on surrounding off-airport lands. The City is jointly developing a scope of work to explore the best technical long term solution to address the Federal Airport Zoning Regulation (AZR), including timing.

Given the scale of the project and resulting necessary capital investment, Federal and/or Provincial government funding is one significant risk that has the potential to stall the planning and implementation of Stage 2. Nevertheless, measures are being incorporated in order to address the requirements of such funding authorities with a view to ensuring that Federal and Provincial funding and support is forthcoming.

10.2. IMPLEMENTATION PHASE

This phase includes the design, construction and testing of the guideway, stations, vehicles, and maintenance and storage facilities. Sufficient funding at this stage is critical to keep the project on track and to avoid indefinite delays or project termination. The risks that result in budget and/or schedule overruns are manageable with mitigation measures in place to prevent them from happening or lessen their negative impacts to the project.

The major physical components that require attention to minimize risk exposure involve the alignment, stations, and maintenance and storage facilities. The following table outlines potential risks and mitigation measures at this phase. These components are relevant in the Operations Phase as well, with impacts to lifecycle costs and operating expenses.

Alignment	
Risk	Mitigation
• Property acquisition costs are higher than planned or unforeseen legal entanglement increase financial stress.	• Financial contingencies
• Design-related risks for the guideway and structures.	• Due diligence and refinements of the design, signal systems based on reliable and tested technology that comply with Canadian standards and legislation
Stations	
Risk	Mitigation
• Design and construction risks	• Transfer of risk to private sector, address in design and construction contract through use of design build / lump sum contract models
Maintenance & Storage Facility	
Risk	Mitigation
• Safety risks	• Ensuring appropriate protocols, designs and structures are in place.
Funding and Financing	
Risk	Mitigation
• Difficulty obtaining Federal and Provincial funding agreements	• Present detailed and comprehensive Business Case documents to justify investment
• Inflationary cost increases due to general economy or specific cost increases in construction materials that exceed current escalation assumptions.	• Not controllable
• Actual ridership does not meet/exceeds projections	• Ensure procurement is structured to scale service in response to demands
• Affordability - that assumptions underpinning the City's long range financial plan for transit do not hold	• Undertake a more detailed assessment of the sensitivity and potential alternative funding sources to continue to meet council's long term vision.

Table 7: High-Level Implementation Phase Risks and Mitigation Measures

10.3. OPERATIONS PHASE

During the operations phase, safety will be a central concern. The planning for this phase of the initiative will ensure that appropriate performance specifications are in place such that the safety and security requirements of the system are met. The safety standards will be established by the performance specifications and will conform to Canadian safety and security protocols and legislation.

Operation-phase risks involve both performance-related (e.g. reliability, punctuality, comfort, customer service), and finance-related risks (e.g. revenue, ridership, operating costs, maintenance costs). Much of the value expected by the stakeholders is related to performance. Therefore, the City needs to ensure that performance standards are strictly adhered to with an appropriate reward/penalty system for enforcement.

The financial risks during the operations phase could potentially seriously impede the delivery of the project to the stakeholders. Since operating revenue is tied to ridership forecasts, there is a financial risk that reductions in ridership or projected ridership not being attained will have financial implications for the project.

10.4. RISK MITIGATION

To achieve desirable economic, social and environmental results, the following key risk mitigation measures should be considered across all components of the project's life cycle:

- Capital Cost: Manage construction costs by reducing the amount and complexity of infrastructure components and by employing value engineering principles.
- Maintenance and Operating Cost: As in the case of the Confederation Line, use of NPV tools to ensure that City costs during the maintenance period are minimized. Ensure that the procurement provides an opportunity to scale the service up or down as needed in response to demand.
- Replacement Cost: As in the case of the Confederation Line, requirements for turn back to ensure that maintenance and renewal investments are carried out to maximize the lifecycle of the assets.
- Total Life Cycle Cost: Evaluate project value by determining the total cost of constructing, maintaining, operating, and replacing the infrastructure components over their intended life spans.
- Social and Environmental Benefits: Consider the economic benefits to the City in regards to social and environmental matters such as improved air quality, health, reduced cost of congestion, reduced travel times, improved goods movement, and increased worker productivity.
- Public Fiscal Benefits: Evaluate the economic spin-off effects associated with potential increased revenue from municipal property taxes, development charges, and other taxes and fees.

- Private Landowner Benefits: Evaluate benefits to property values and explore mechanisms to capture associated “uplift” from the public sector investment in rapid transit.
- Managing Public Perception: Creating an effective communications protocol and strategy to assist with managing the public perception of risks (e.g. traffic management, noise).
- Land Acquisition: Develop a framework to deal with land acquisition from existing landowners

11. RECOMMENDATION

This report recommends that the City of Ottawa commits to providing funds for the Stage 2 extension of the Ottawa LRT. The business case has presented the key benefits of extending transit service across the Ottawa region. At an estimated capital cost of approximately $2.5 billion (in 2013$), the benefits, from both the quantitative and qualitative perspectives, greatly outweigh the investment outlay. From a benefits-cost perspective, this project is highly viable with a ratio of **3.56**. The extension will have a transformative effect on the development of the region and will contribute to the wider economic and growth objectives of the Ottawa region. Strategically, the proposed extension aligns with the City of Ottawa’s policies/plans, such as the City’s Official Plan and the 2013 Transportation Master Plan.

APPENDIX A – SUMMARY OF ASSUMPTIONS

Factor	Value	Assumptions	Source
Discount Rate	5%	Consistent with discount rate used for DOTT business case.	Province of Ontario
Inflation • Consumer Price Index • Construction Price Index	1.8% 3.25%	Based on average of past 5 years. Rate for rail industry.	Consumer Price Index, by city. Statistics Canada http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/econ45a-eng.htm
Value of Time	$12.73/hr (2008$) $22.65 /hr (2023$)	Consistent with rate used for DOTT business case. Alternate value calculated from median total income, Ontario.	Transport Canada, *Value of Time and Reliability for Local Trips in Canada (2008)*. BC Ministry of Transportation, *Default Values for Benefit Cost Analysis in British Columbia.* https://www.th.gov.bc.ca/publications/planning/Guidelines/Business%20Case%20Guidelines/DefaultValues-BenefitCostAnalysis.pdf
Value of Time Growth	1.8%	Based on inflation.	
Vehicle Operating Cost Savings	$0.19 /km	• 2011 Honda Civic, 1.8L 4 auto • Total annual driving: 20,000 km • Average Consumption 6.83L/100 km • City vs. Highway Mileage (45% vs. 55%) • Current Fuel Price/L ($1.25) • Finance and purchase price, these were not included Assumed that transit users will not forego car ownership. Assumed that savings can only be incurred on variable costs per work km, including fuel, 20% of insurance (as a result of switching use from commuter to occasional driver), 50% of $1000 annual maintenance costs, and 25% of depreciation (mileage-related).	CAA Driving Costs Calculator. http://caa.ca/car_costs/
Accident Costs • Fatal • Injury Only • Property	$180,000/acc (2010$) $40,000/acc. (2010$) $11,000/acc (2010$)		Based on Capital Region Intersection Safety Partnership, *Collision Cost Study (2010)* http://drivetolive.ca/wp-content/uploads/2014/02/Collision_Cost_Study_Final_Report_Feb_2010.pdf
Incident Rate • Fatal • Injury Only • Property	3.7 /billion VKT 465.6 /billion VKT 3670 /billion VKT		Based on Transport Canada, *Canadian Motor Vehicle Traffic Collision Statistics (2013)* http://www.tc.gc.ca/media/documents/roadsafety/cmvtcs2013_eng.pdf
GHG Emissions Cost	$37.38 /tonne CO_2 equivalent (2000$)		Based on Transport Canada, *Estimating the Costs of Greenhouse Gas Emissions from Transportation (2007)*
CAC Emissions Cost VOC NOx SOx TMP	$877 /tonne of emission (2000$) $5,490 /tonne of emission (2000$) $6,520 /tonne of emission (2000$) $29,100 /tonne of emission (2000$)		Based on Transport Canada, *Estimating the Costs of Greenhouse Gas Emissions from Transportation (2007)*
Emissions Efficiency Rate	0.50%	Annual improvement rate of fuel efficiencies.	Based on Transport Canada, *User Guide for Urban Transportation Emissions Calculator (UTEC)* http://www.gtkp.com/assets/uploads/20091124-131438-4013-UTEC-CETU-E.pdf
GHG Emissions	0.187 kg/km	Based on carbon footprint calculator for mid-sized vehicle.	Based on US Environmental Protection Agency, *Carbon Footprint Calculator* http://www3.epa.gov/carbon-footprint-calculator/
CAC Emissions VOC NOx SOx TMP	0.000453 kg/km 0.00471 kg/km 0.000122 kg/km 0.000319 kg/km		Based on City of Toronto, *Greenhouse Gases and Air Pollutants in the City of Toronto* http://www1.toronto.ca/city_of_toronto/environment_and_energy/key_priorities/files/pdf/ghg-aq-inventory-june2007.pdf
Sensitivity	100% 50% Alternate VOC rate	Best case scenario Half of benefits scenario Utilizing full VOC rate, as in DOTT	

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