HALIFAX

P.O. Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

Item No. 11.3.2
Halifax Regional Council
October 20, 2015

TO:	Mayor Savage and Members of Halifax Regional Council
SUBMITTED BY:	Original Signed Councillor Reg Rankin, Chair, Transportation Standing Committee
DATE:	October 6, 2015
SUBJECT:	Commuter Rail Feasibility Study

ORIGIN

Item 9.1.3, September 24, 2015 Transportation Standing Committee meeting

LEGISLATIVE AUTHORITY

Section 6(a) of the Transportation Standing Committee's Terms of Reference states that the Committee shall review and oversee policy direction and long term funding approach to promote and encourage Transit alternatives as outlined in the Regional Plan.

RECOMMENDATION

Transportation Standing Committee recommends that Halifax Regional Council:

(a) Accept the findings of the Commuter Rail Feasibility Study; and

(b) Direct staff to undertake a process to integrate land use planning and transportation planning to develop a strategic plan specifically aimed at increasing the modal split of sustainable forms of transportation as per the Regional Plan;

(c) And furthermore direct staff to continue consultation with CN in terms of receiving information on cost implications.

BACKGROUND

A staff recommendation report dated September 11, 2015 was before the Transportation Standing Committee at their September 24, 2015 meeting. The Committee passed a motion to approve the staff recommendation with the following amendment:

"And furthermore direct staff to continue consultation with CN in terms of receiving information on cost implications."

DISCUSSION

Halifax Transit staff introduced the report to the Committee. Mr. Eddie Robar, Director Halifax Transit stated that the recommendation would allow staff to investigate how best to achieve the modal split goals as outlined in the Regional Plan.

Members of the Committee stated concern for assumptions in the report regarding the future road network noting that the data was based on certain road improvements not yet confirmed or approved by the Municipality or Province.

Committee members restated the benefits of rail to improve the transportation network in terms of frequency and reliability and were not yet convinced of the cost implications provided in the report. As a result, the Committee agreed to amend the recommendation to direct staff to continue to consult with CN in regard to cost implications as provided for in recommendation c) of this report.

The Committee also requested that staff and the consultant present the findings to Regional Council along with the Committee recommendations.

FINANCIAL IMPLICATIONS

Implications are described in the September 11, 2015 staff report.

COMMUNITY ENGAGEMENT

The Transportation Standing Committee is comprised of six elected members of Regional Council. Meetings are held on a monthly basis and are open to the public (unless otherwise indicated). Agendas, reports and minutes are available on the Halifax website.

Community Engagement is further detailed in the September 11, 2015 staff report.

ENVIRONMENTAL IMPLICATIONS

There were no implications identified.

ALTERNATIVES

There were no alternatives identified.

ATTACHMENTS

Attachment 1: Staff recommendation report dated September 11, 2015

A copy of this report can be obtained online at http://www.halifax.ca/council/agendasc/cagenda.php then choose the appropriate meeting date, or by contacting the Office of the Municipal Clerk at 902.490.4210, or Fax 902.490.4208.

Report Prepared by: Andrew Reid, Legislative Assistant, 902-490-5934

Attachment 1

HALIFAX

P.O. Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

Item No. 9.1.3
Transportation Standing Committee
September 24, 2015

TO: Chair and Members of Transportation Standing Committee

Original Signed

SUBMITTED BY: ______________________________

Eddie Robar, Director, Halifax Transit

Original Signed

SUBMITTED BY: ______________________________

Bob Bjerke, Chief Planner & Director, Planning and Development

DATE: September 11, 2015

SUBJECT: **Commuter Rail Feasibility Study**

ORIGIN

January 10, 2012 motion of Regional Council:

Moved by Councillor Rankin, seconded by Councillor Outhit that Halifax Regional Council:

1. Consider directing staff to engage a consultant through a Request for Proposals for a full feasibility analysis of Commuter Rail in the Halifax to Windsor Junction and Enfield Corridor as part of the 2012/13 budget process.
2. To appropriately engage CN / VIA Rail in participation in the study.

Approval of the 2013/2014 Capital Budget, Supplemental Report page F7, which included funding for the preparation of a commuter rail feasibility study.

LEGISLATIVE AUTHORITY

Section 69(1) of the Halifax Regional Municipality Charter provides the legislative authority for the municipality to provide a public transportation service. The following report conforms to the Charter.

RECOMMENDATION

It is recommended that the Transportation Standing Committee of Council recommend that Regional Council:

(a) accept the findings of the Commuter Rail Feasibility Study; and

(b) direct staff to undertake a process to integrate land use planning and transportation planning to develop a strategic plan specifically aimed at increasing the modal split of sustainable forms of transportation as per the Regional Plan.

BACKGROUND

On January 10, 2012, Regional Council directed staff to undertake a feasibility study for commuter rail in the Halifax to Windsor Junction to Enfield corridor. Halifax Transit engaged a consultant to complete this work. The consultant, CPCS, is an international management consulting firm specializing in transportation sector strategy, planning and policy. CPCS began the Commuter Rail Feasibility Study in September 2014, and it is now complete. The full study is provided as Attachment A to this report.

One of the key transportation objectives in the Regional Plan is to "Implement a sustainable transportation strategy by providing a choice of integrated and connected travel modes emphasizing public and community based transit, active transportation, carpooling and other viable alternatives to the single occupant vehicle." The Regional Plan acknowledges that new investments in transit will be required to address emerging transportation issues, and calls for the investigation of the feasibility of new services such as rail, bus rapid transit, and expanded ferry service. The Regional Plan also sets out modal split targets. The existing transit modal split, or percentage of work trips made on public transit in Halifax, is currently 12%. The goal is to increase this modal split to 16% or more by 2031.

DISCUSSION

Scope

The objective was to produce a comprehensive study that would accurately identify the costs of implementing and operating commuter rail in Halifax. The work plan included:

a) A review of previous commuter rail feasibility studies and other background information;
b) An analysis of performance, physical characteristics, and usage of the existing rail corridor;
c) An assessment of potential infrastructure and operational characteristics of a commuter rail service; and
d) Sufficient information, including ridership projections, to determine both the operational and economic feasibility of commuter rail on the Halifax to Windsor Junction and Enfield corridor.

The study scope did include consulting with external stakeholders, including VIA Rail, CN, and WHRC (Windsor & Hantsport Rail Company). For the purposes of this study, these consultations were preliminary discussions only. CN has indicated that before proceeding with commuter rail, assumptions relating to infrastructure upgrades and track access fees would need to be verified by CN, which requires a separate analysis led by CN.

The study is not intended to be an implementation plan. A significant amount of further investigation and planning would be required prior to implementing a commuter rail service. To estimate costs, assumptions had to be made about the potential operation of commuter rail service, including factors such as fares, station locations, and fleet choices. Although the service details described in the study are intended to demonstrate a potential commuter rail service, if a service were to be initiated in Halifax, the resultant operating and infrastructure choices could vary from those described in the study.

The study is not intended to make value based judgements on whether rail is the right choice for Halifax. Although the study does briefly refer to how rail could influence municipal settlement patterns and Transit Oriented Development (TOD) it does not take into account the long term vision or growth objectives of the Municipality, nor development patterns that could occur if rail was implemented.

Approach

To be comprehensive, and to determine if there exists any alternative service model that would make commuter rail feasible, the study evaluated nine different scenarios. The scenarios included three conceptual corridors, each analysed under three different levels of investment (low, medium, and high).

In the resulting scenarios, low investment refers to minimal capital infrastructure to support rail, medium investment is considered moderate but realistic investment, and high investment refers to maximum investment in rail despite high costs. High investment would mean that the municipality encourage rail ridership at a high infrastructure cost, even at the detriment of the existing bus ridership. Although not advisable, the high investment scenario is important to show the upper threshold for ridership.

The analysis focused on three potential commuter rail operating corridors:

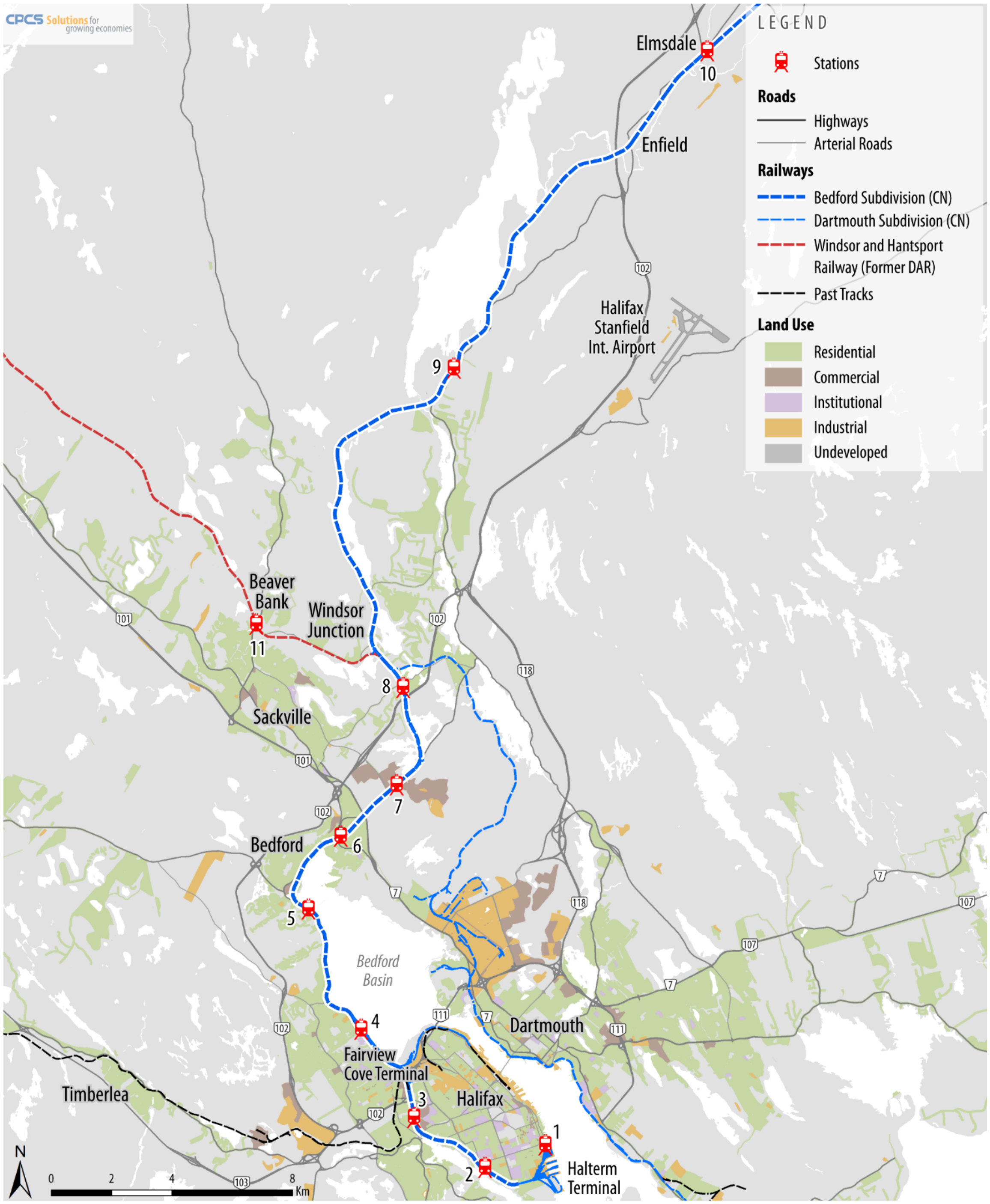
Halifax to Elmsdale: It was determined early in the study that it would not be viable to operate full peak-period service beyond Windsor Junction to Elmsdale under current conditions. There are existing freight trains originating in Dartmouth during the morning that impact the capacity of the track from Windsor Junction to Elmsdale. Operating commuter rail on this portion of track would very likely require the addition of a second main track. Construction of a second main track would be expensive and have significant environmental implications. As such, the Halifax to Elmsdale corridor is absent from a large portion of the discussion and analysis in the study because it was considered extremely cost prohibitive.

Halifax to Cobequid (Windsor Junction): Commuter rail service could physically be introduced between Halifax and Cobequid (Windsor Junction) with the addition of passing sidings and centralized traffic control in key areas. Although this would still require a large capital investment, it would not be the magnitude required for the Windsor to Elmsdale corridor because there is more capacity available on this portion of the track.

Halifax to Beaver Bank: The scope of the study was originally limited to the Halifax to Windsor Junction and Elmsdale corridor, however, during the study it was determined that there was also merit to analyzing the corridor to Beaver Bank. Commuter rail service could physically be introduced between Halifax and Beaver Bank with upgrades similar to the Halifax to Cobequid concept between Halifax and Windsor Junction. Additionally, 4.7 kilometres of mainline track to Beaver Bank would require extensive rehabilitation. However, because of the presence of existing infrastructure, these upgrades are not as costly as building entirely new track.

The analysis resulted in a list of 11 potential station locations, serving the following communities:

1. VIA Rail Station (Halifax)
2. South End
3. West End
4. Rockingham
5. Mill Cove
6. Sunnyside
7. Bedford Common
8. Cobequid
9. Wellington
10. Elmsdale
11. Beaver Bank



Six conceptual rolling stock alternatives were evaluated. Budd RDCs (Rail Diesel Cars) were selected for further analysis. It is anticipated that these vehicles will be the least expensive alternative and would be capable of meeting the anticipated ridership, and would therefore be the most likely to be financially and economically feasible.

The study assumes a basic level of service; specifically, a peak oriented service with trains running every 30 minutes during rush hours. There would also be one trip during the midday. The following table illustrates the travel time for a one way trip. The cumulative travel time presented includes a dwell time of one and half minutes at each station.

		Scenario		
		Halifax - Cobequid	Halifax - Beaver Bank	Halifax - Elmsdale
Cumulative Travel Time (in minutes)	VIA Rail Station	0	0	0
	South End	4	4	4
	West End	7	7	7
	Rockingham	12	12	12
	Mill Cove	18	18	18
	Sunnyside	22	22	22
	Bedford Common	27	27	27
	Cobequid	32	32	32
	Beaver Bank	-	41	-
	Wellington	-	-	45
	Elmsdale	-	-	58

Operational Feasibility

The technical analysis reveals that commuter rail is operationally possible along the proposed corridors. There are no apparent physical or legislative constraints that would preclude the implementation of commuter rail service in Halifax. However, capacity on the rail track significantly limits the potential for commuter rail service between Windsor Junction and Elmsdale. On the remainder of the track, infrastructure improvements, including passing sidings, crossing upgrades, signal upgrades, and new switch infrastructure would be required to minimize disruptions to freight rail service and maintain safe and efficient operations. A new maintenance depot would also be required.

Potential Ridership

Ridership projections vary relative to the level of investment in the rail system. According to the projections, by 2031, the total ridership forecast would range from a low of 1,588 daily weekday boardings to a high of 4,287 daily weekday boardings, depending on the scenario. Weekday boardings refer to the number of passengers that board the train in any direction of the course of one day. For clarification, this is equivalent to between 794 and 2144 people using commuter rail to travel both to and from their destination.

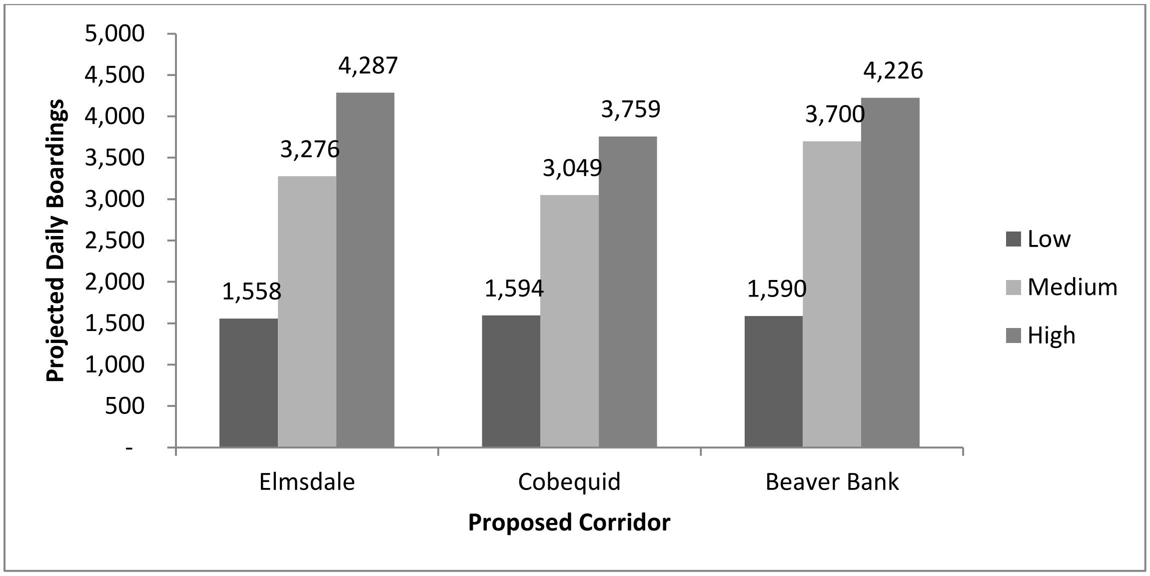
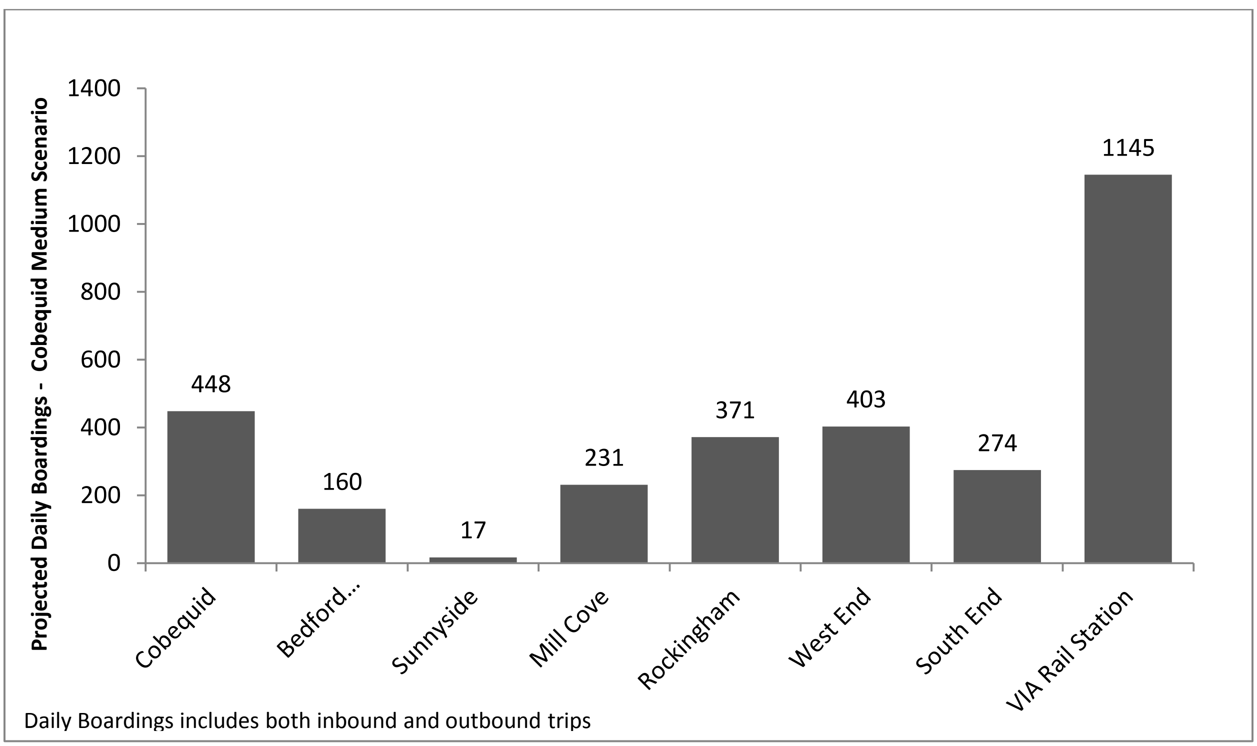


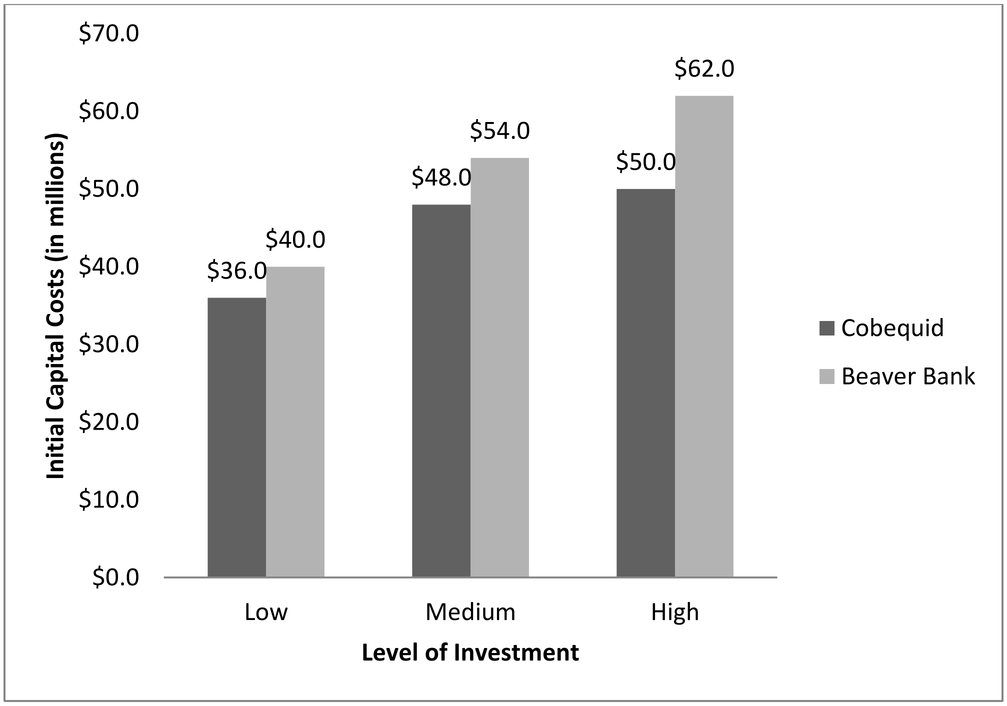
*chart shows the projected ridership for each of the nine scenarios, and is not cumulative.

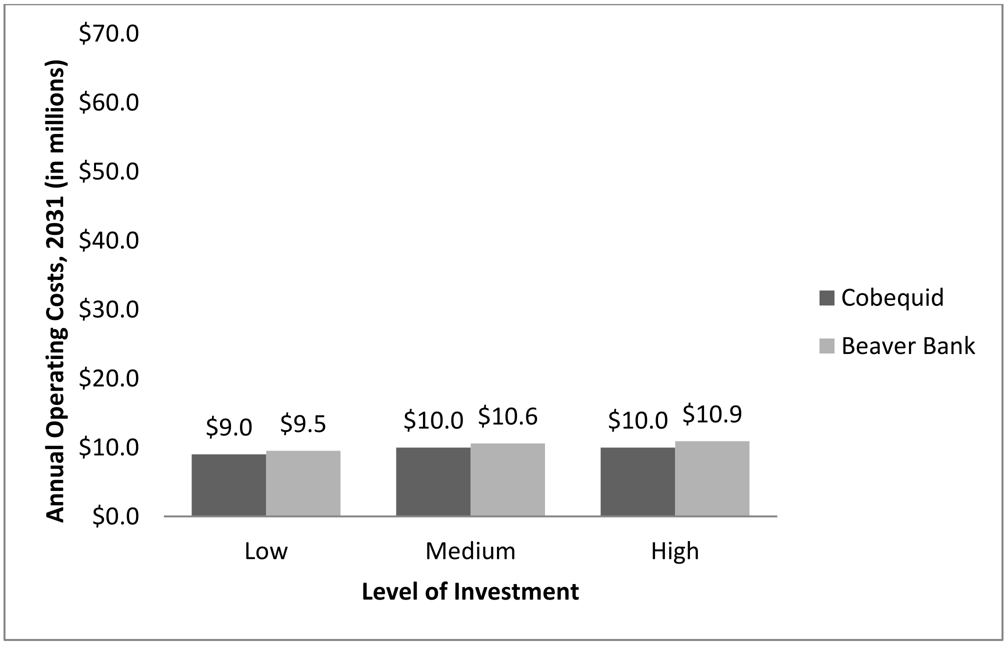
The daily ridership is distributed among the eleven proposed stations. The following chart illustrates this ridership distribution for the Cobequid medium scenario. The highest number of boardings are anticipated from the VIA Rail Station (downtown Halifax); these primarily represent return trips in the pm peak. The Cobequid (Windsor Junction) station would have the highest number of passengers travelling in the inbound direction. The Bedford Common and Sunnyside stations would have the lowest number of boardings per day.



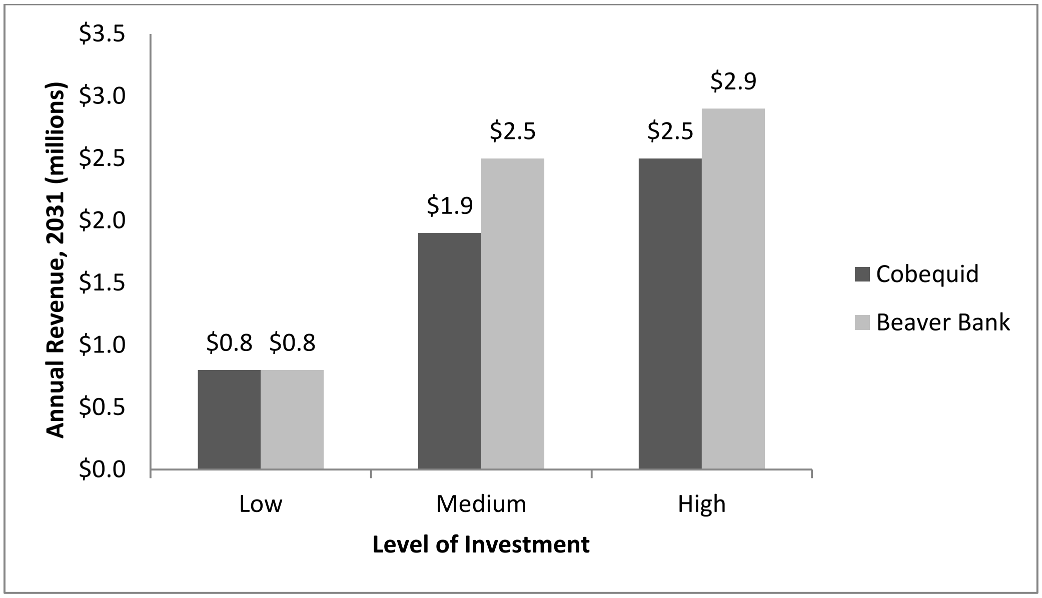
Economic and Financial Feasibility

The capital costs required to establish the commuter rail system varies based on the scenario chosen, and would range from $36 million dollars to $62 million dollars. The annual operating costs of the system would also vary based on the scenario chosen, from $9 million dollars to $10.9 million dollars.

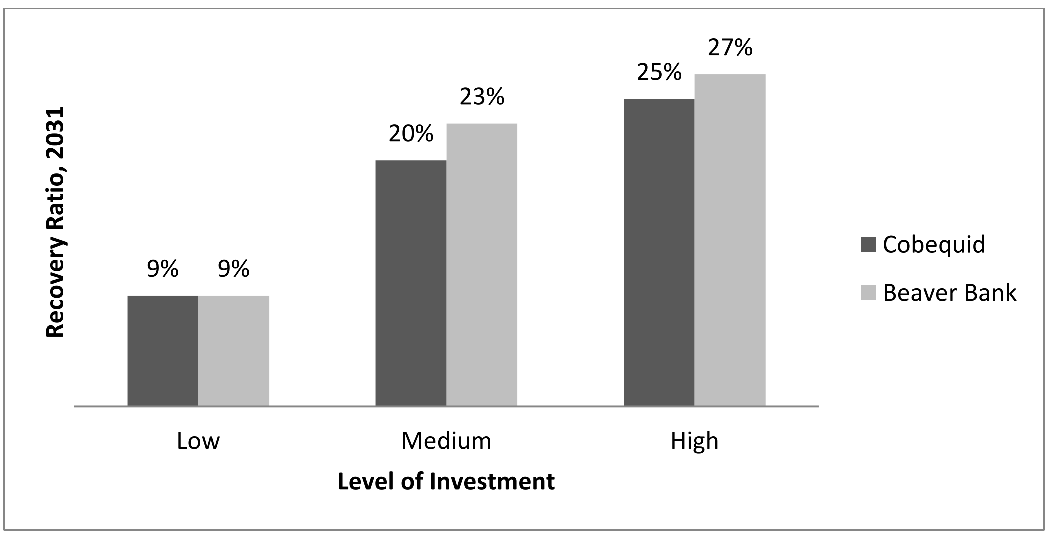




The revenue forecasts for the commuter rail system vary by scenario, and in 2031 are projected to range from $0.8 million dollars per year to $2.9 million dollars per year.



As a result, should a commuter rail system be operating in 2031, CPCS anticipates that it would have a cost-recovery ratio between 9% (Cobequid low scenario) and 27% (Beaver Bank high scenario).



The study concludes that from a net benefits standpoint, implementing a commuter rail system in Halifax is not economically viable. Due to the high initial capital costs, high annual operating costs, and relatively low fare revenue, all scenarios evaluated have a negative financial net present value (FNPV) and negative economic net present value (ENPV).

However the study also acknowledges the analysis is at a very early stage and that there are both upside and downside risks. The study identifies several strategies to mitigate the downside risks and acknowledges that the project may be more economically viable if some or all of the strategies are successful. Strategies to mitigate risk that were identified by CPCS include the following:

- Several growth centres identified in the Regional Plan align with proposed station locations (West End, Mill Cove, Birch Cove, Sunnyside) and there is an opportunity to encourage transit-oriented development;
- federal capital assistance programs; and
- land uplift capture and densification.

Two significant downside risks identified in the study were track access fees and higher than expected capital costs. Track access fees represent a significant portion of commuter rail operating costs (36%). For the purposes of this study, they have been estimated based on fees paid in other areas and the professional judgment of CPCS. However, these fees would ultimately need to be negotiated with CN, and could vary substantially from those proposed in the study. CN has indicated that a CN-directed independent assessment would be required to confirm the infrastructure requirements needed to establish commuter rail. The track access fees would also depend on findings of this assessment.

The study explores a number of potential opportunities to reduce costs, but even a reduction in the estimation of track access fees by 50% would not result in net positive economic benefits. The study also cautions that although there may be some opportunities to reduce costs (i.e., negotiation of lower track access fees); it is also possible that capital and/or operating costs will be higher than expected.

Comparison to Existing Transit

The Cobequid medium scenario would cost approximately $10 million dollars in annual operating costs, and would carry approximately 3,049 passengers daily. For comparison, in the existing Halifax Transit system (including all existing routes and services), for every $10 million dollars spent on operating costs, the service carries approximately 13,500 passengers. As such, the existing service is almost four and a half times more cost efficient than commuter rail would be. However a direct comparison between commuter rail and existing transit services is difficult. The existing passenger count includes transfers made between routes, while the commuter rail ridership assumes one complete journey to work trip.

A better comparison is today's urban express transit routes that travel to downtown Halifax (Route 31, 32, 33, 34, 35, 84, 85, and 86) which carry 3,608 passengers daily, and cost approximately $2.3 million dollars to operate.

Comparing the cost of commuter rail to other modes of transit is best achieved by comparing the total capital and operating costs (with and without commuter rail) needed to achieve the modal split target established in the Regional Plan. The Regional Plan anticipates that the modal split will increase from 12% of home based work trips to 16% of trips by 2031. This represents an increase of 2% per year in transit ridership, compared to an increase in transit ridership of 0.6% per year needed to maintain the current modal split. This cannot be achieved by implementing commuter rail alone, and there currently is no strategy on how the modal split target will be met.

Conclusion

The Commuter Rail Feasibility Study completed by CPCS is comprehensive and meets the objectives set out for the study. The study concludes that although commuter rail in Halifax is operationally feasible, it is not economically viable at this time.

Transportation is a key issue to some of the communities around the rail corridor, including areas such as Bedford West that are experiencing development and population growth, however, the rail corridor is in a fixed location which limits the functionality of the service, both in terms of the neighbourhoods it can reasonably attract ridership from, and in terms of the downtown station, which is unfavourably located in terms of the major employment centres in the downtown.

In addition, it is clear from the ridership projections provided that implementing a commuter rail system by itself will not allow Halifax to meet the modal split target set out by the Regional Plan. Working towards achieving the modal split target will require fully integrating land use planning with transportation to create a strategic long term plan that looks at the entire region. Other ongoing initiatives, such as the Moving Forward Together Plan, which places emphasis on increased transit ridership, and the Centre Plan, which focuses on high quality, connected, and sustainable land uses, will contribute to meeting the goals of the Regional Plan. The Commuter Rail Feasibility Study, the Moving Forward Together Plan, and the Road Network Priority Plan, are all integral components required to understand how transit can be integrated with land use to create this strategic vision.

As such, the recommendation is that following the completion of the Moving Forward Together Plan and Road Network Priority Plan, staff undertakes a process to integrate land use and transportation to develop a strategic plan for achieving the modal split target set out in the Regional Plan.

FINANCIAL IMPLICATIONS

Should Regional Council decide to pursue the implementation of commuter rail system, resources would need to be identified.

As an example, to proceed with the Cobequid medium scenario without reducing other expenditures, it would require an average increase of 24.7% for the first five years of operational service, falling gradually over time with growth in the assessment base. The impact on the average home for operating costs would be $27 in additional tax payable, falling gradually over time with growth in the assessment base.

Assuming HRM issues bonds (for intergenerational equity purposes) and with some cost-sharing between higher levels of government; the burden of funding $48 million of capital requirements would be reduced, but would nonetheless require a tax rate rise to fund a portion of this, in addition to the principle and interest stemming from bond issuance, holding all else equal in the long run.

There would be financial implications associated with developing a strategic plan, which can be determined should Regional Council provide direction to do so.

COMMUNITY ENGAGEMENT

A public open house was held on February 26, 2015 at the Sunnyside Mall with a panel display and slideshow of commuter rail feasibility analysis technical information. Coordinated and facilitated by CPCS, the event attracted over 300 people. Follow-up questions and answers were made available on the Halifax Transit website. If Council chooses to pursue commuter rail, a more comprehensive public consultation program may be warranted.

ENVIRONMENTAL IMPLICATIONS

There were no environmental implications identified associated with this report.

ATTACHMENTS

Attachment A – Commuter Rail Feasibility Study

A copy of this report can be obtained online at http://www.halifax.ca/commcoun/index.php then choose the appropriate Community Council and meeting date, or by contacting the Office of the Municipal Clerk at 902.490.4210, or Fax 902.490.4208.

Report Prepared by: Patricia Hughes, MCIP, LPP, Supervisor Service Design & Projects, Halifax Transit
902.490.6287

Robert Jahncke, MCIP, LPP, CSLA, Coordinator, Project Planning, Halifax Transit 902.490.6683

Peter Duncan, P.Eng, Planning and Development Services, 902.490.5449

Original Signed

Report Approved by: ____
Dave Reage, MCIP, LPP, Manager, Planning & Scheduling, Halifax Transit 902.490.5138

Original Signed

Financial Approval by: ____
Amanda Whitewood, Director of Finance and Information Technology/CFO, 902.490.6308

FINAL REPORT

Commuter Rail Feasibility Study

(Halifax Ref: RFP #P14-047)

Final Report

Prepared for:

Halifax

Prepared by:

CPCS

In association with sub-contractors:

Dillon Consulting Limited
Ekistics Planning & Design
First Class Partnerships

Solutions for growing economies

CPCS Ref: 14169
August 31, 2015

www.cpcs.ca

Acknowledgements

The CPCS team would like to thank all of those who provided information for the preparation of this report. We would also like to thank Halifax Transit and Halifax Regional Municipality for their support in the development of this report.

Contact

George Kaulbeck
Project Manager
CPCS
gkaulbeck@cpcs.ca
Tel: (506) 386-1352

72 Chamberlain Ave.
Ottawa, Ontario
Canada K1S 1V9
ottawa@cpcs.ca
www.cpcs.ca

August 31, 2015 CPCS Ref: 14169

Halifax Regional Municipality

Re: Commuter Rail Feasibility Study

To whom this may concern:

CPCS Transcom Limited (CPCS)[1] was retained last summer, pursuant to the above referenced Request for Proposal (RFP) process, to:

> *Produce a comprehensive feasibility study that accurately reflects the costs of implementing and operating commuter rail in Halifax.*

Our analysis focused on three potential commuter rail operating concepts (Halifax-Elmsdale, Halifax-Cobequid and Halifax-Beaver Bank), each with a different terminus (i.e. end-of-line station). All concepts would primarily use the existing CN Bedford Subdivision rail corridor.

Depending on the operating concept and related traffic scenarios, the estimated up front capital costs of the project ranges from $36 to $62 million; the annual net operating cost (i.e. operating cost minus incremental revenues) thereafter is estimated to be in the order of $8 million per year. The resulting financial net present value is between -$164 million and -$187 million over the 25-year analysis period. We determined that service to Elmsdale as a standalone concept is not viable; as such, the above estimates only include the results from the Halifax-Cobequid and Halifax-Beaver Bank concepts.

The analysis revealed that though commuter rail is technically feasible (subject to suitable track access and operating arrangements with CN), based on the assumptions used in the study, none of the operating concepts assessed would result in economic benefits that exceed the cost of implementing the service. The highest benefit-cost ratio calculated was approximately 0.7, which indicates that the estimated project benefits equal about 70% of the project's costs.

In short, our analysis revealed that, on balance, commuter rail in Halifax – as currently conceived – is not economically viable. There may be opportunities to increase the viability of the project, by leveraging Transit Oriented Development (TOD) or through downtown revitalization, though these scenarios would require further study.

There is nevertheless notable public enthusiasm for commuter rail in Halifax, as evidenced during the public open house meeting held in February 2015. The development of commuter rail service in Halifax could be considered in the context of a broader, long-term corridor development vision, supported by plans and policies to enable densification and development around commuter rail stations and reduce road traffic. However, there are also risks that could make the project less economically viable, such as higher than estimated track access fees, which would have to be negotiated with CN.

---

[1] CPCS is a global management consulting firm specializing in transportation sector strategy, economic analysis and policy; we have an established track record and reputation in undertaking rail-sector feasibility studies and drew on over 30 years of Canadian and global experience in assessing the feasibility of the commuter rail project in Halifax.

We thank you for the opportunity to have worked with Halifax in undertaking this study.

Finest regards,

CPCS Transcom Limited

Original Signed

Marc-André Roy
Project Director

Table of Contents

Acronyms / Abbreviations

AAR	American Association of Railroads
ALOP	Advanced Loss of Profit
AMT	Agence métropolitaine de transport
APTA	American Public Transportation Association
AREMA	American Railway Engineering and Maintenance of Way Association
ATA	Above top of rail
C & S	Communications & signalling
CEM	Crash-energy management
CN	Canadian National Railway Company
CP	Canadian Pacific
CAPEX	Capital expenditure (or cost)
CPTED	Crime Prevention Through Environmental Design
CROR	Canadian Rail Operating Rules
CTA	Canadian Transportation Agency
CTC	Centralized Traffic Control
CWR	Continuously welded rail
DMU	Diesel-multiple unit
EMD	Electromotive Diesel
EMU	Electric multiple unit
ENPV	Economic net present value
FNPV	Financial net present value
FRA	United States Federal Railroad Administration
GCP	Grade Crossing Predictor
GM	General Motors
HIT	Halifax Intermodal Terminal
HOT	Halifax Ocean Terminal
Halifax	Halifax Regional Municipality
Km	Kilometre
MPH	Miles per Hour
MX	Metrolinx
NS	Nova Scotia
NSCAD	Nova Scotia College of Art and Design
OCS	Occupancy Control System
OPEX	Operating expenditure (or cost)
PR	Park and ride
PTC	Positive-Train Control
RBM	Rail bound manganese

RDC	Rail diesel car
RFP	Request for Proposals
RTC	Rail Traffic Controller
RVM	Remote video monitoring
SDR	Social discount rate
SGM	Self Guarded Manganese (railway frog)
SMART	Sonoma-Marin Area Rail Transit
SMU	Saint Mary's University
TAZ	Traffic analysis zone
TC	Transport Canada
TOD	Transit Oriented Development
TSB	Transportation Safety Board
TVM	Ticket vending machine
UIC	International Union of Railroads
VHF	Very high frequency
WDC	Waterfront Development Corporation
WHRC	Windsor & Hantsport Railway Company
YTC	Yard Traffic Control

Executive Summary

Commuter rail service in Halifax is not a new idea, and was most recently studied in 2003. A City staff report to Council updated this analysis in 2011. The present report provides a comprehensive assessment of the feasibility of commuter rail service in Halifax and associated issues and considerations. As stated in the Request for Proposals (RFP) (p. 25), the goal for the present project can be summarized as follows:

> *To produce a comprehensive feasibility study that accurately reflects the costs of implementing and operating commuter rail in Halifax.*

The study includes an analysis of any financial, regulatory and organizational issues and costs associated with building, implementing, operating and maintaining the project. In effect, the study seeks to present the optimal set-up for a commuter rail service in Halifax.

The feasibility of a commuter rail operation in Halifax is a function of several factors, including:

- **Ridership:** Whether there is sufficient potential market demand along the corridor(s) to warrant a commuter rail service vis-à-vis the status quo;
- **Technical Feasibility:** Whether the existing rail corridor can accommodate a commuter rail operation and associated infrastructure (and without disrupting existing operations along the existing Canadian National Railway (CN) line);
- **Track Access:** CN's support of the initiative especially as it relates to permitting the use of its rail line for commuter service, and the associated terms and conditions in the event permission is granted;
- **Financial Affordability:** The feasibility of the project would depend on its financial affordability – for Halifax and funding partners; and
- **Economic Benefits:** Whether the project's expected benefits are likely to exceed the project's costs (i.e. generate net benefits).

This executive summary, after reviewing the study area, presents the findings and conclusions associated with each one of these factors.

Existing Rail Infrastructure and Potential Station Locations

Figure ES-1 shows the study area and potential station locations.

Existing Rail Infrastructure

Rail infrastructure in Halifax consists of the following subdivisions:

- CN Bedford Subdivision
- CN Dartmouth Subdivision
- Windsor & Hantsport Railway Company (WHRC) Halifax Subdivision (not operational)

The focus of the study is potential commuter service from Halifax to Cobequid Road or Elmsdale along the CN Bedford Subdivision, with possible extension to Beaver Bank Road along the WHRC.

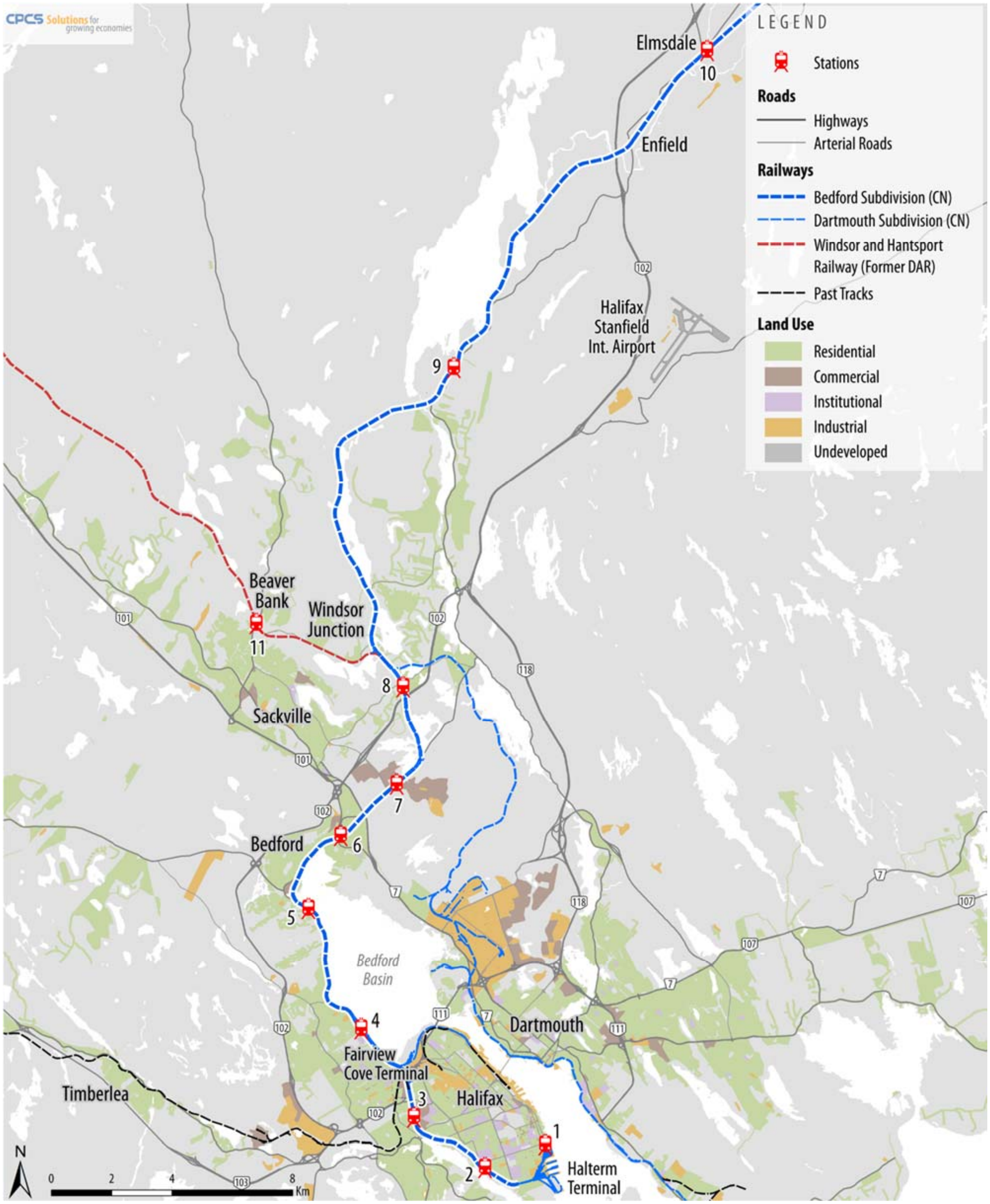
Potential Station Locations

Because the purpose of this study is to assess the feasibility of a commuter rail system – not make specific planning decisions – we have used several considerations to develop a list of 11 potential station locations. These stations would serve the following areas and communities (numbers correspond to the station location on Figure ES-1):

1. VIA Rail Station (Halifax)
2. South End
3. West End
4. Rockingham
5. Mill Cove
6. Sunnyside
7. Bedford Common
8. Cobequid
9. Wellington
10. Elmsdale
11. Beaver Bank

The potential station in Beaver Bank would be the terminus should commuter rail service continue along the WHRC. We also developed a concept terminating at Cobequid Road, which would not serve stations 9, 10 and 11.

Figure ES-1: Study Area and Potential Station Locations



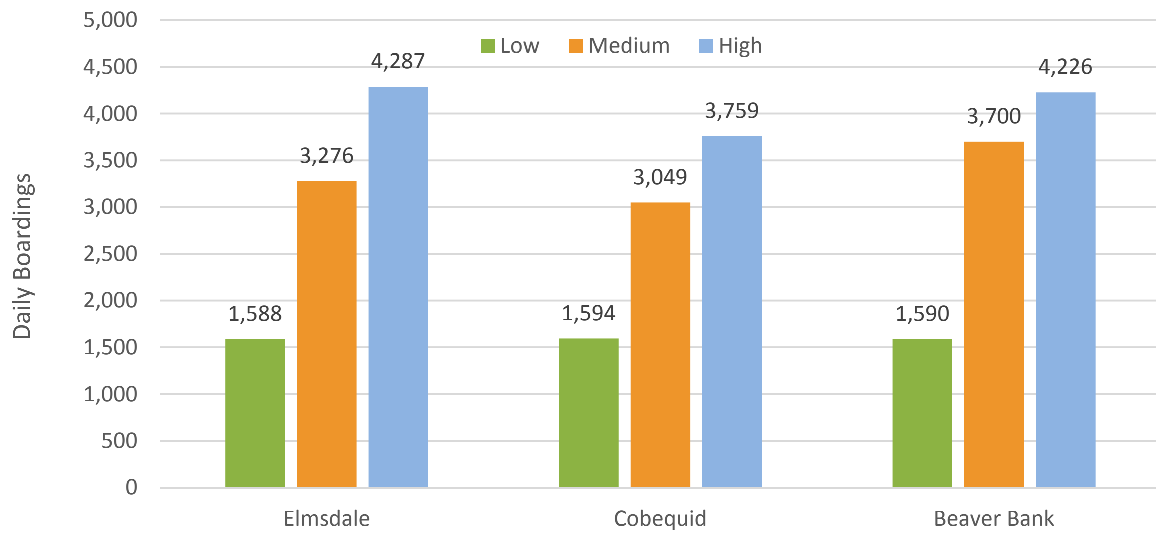
Ridership

The Halifax Regional Travel Demand Model was the primary tool used to generate commuter rail ridership projections. Because of the unique characteristics of the commuter rail system relative to existing transit in Halifax, we made several changes to the model inputs and adjusted the raw model outputs, in line with local knowledge and reference sources. As a result, the Halifax Travel Demand Model was only one tool used, albeit an important one, in forecasting potential demand for commuter rail service.

We studied nine traffic scenarios: three travel demand forecasts (low, medium and high) were developed for three operating concepts (Halifax-Elmsdale, Halifax-Cobequid and Halifax-Beaver Bank), each with a different terminus (i.e. end-of-line station). In all cases in this report, we only considered peak-period service with one mid-day trip. We assessed that such a service plan would be (1) the most cost-effective to implement given the existing train schedule on the Bedford Subdivision and (2) capture the majority of commuter demand to/from Halifax.

In 2031, we forecast total ridership would range from a low of 1,588 daily weekday boardings to a high of 4,287 daily weekday boardings, depending on the scenario (Figure ES-2). Traffic is forecast to grow at an annual rate of 1.06% from the entry into service of the rail line in 2018 through the forecast period, based on the forecasted growth in the total number of trips in Halifax from 2013 to 2031. The travel demand modelling suggests that the majority of commuter rail users would be comprised of travellers who would otherwise use personal vehicles – that is, demand is largely a function of commuters shifting from auto use to commuter rail use, where there is an advantage in doing so. After rail service is introduced, bus ridership remains approximately constant at an average of 8.5% (depending on the scenario) based on all trips modelled within the Halifax Travel Demand Model, whereas auto share slightly declines.

Figure ES-2: Weekday Daily Boardings by Scenario, 2031



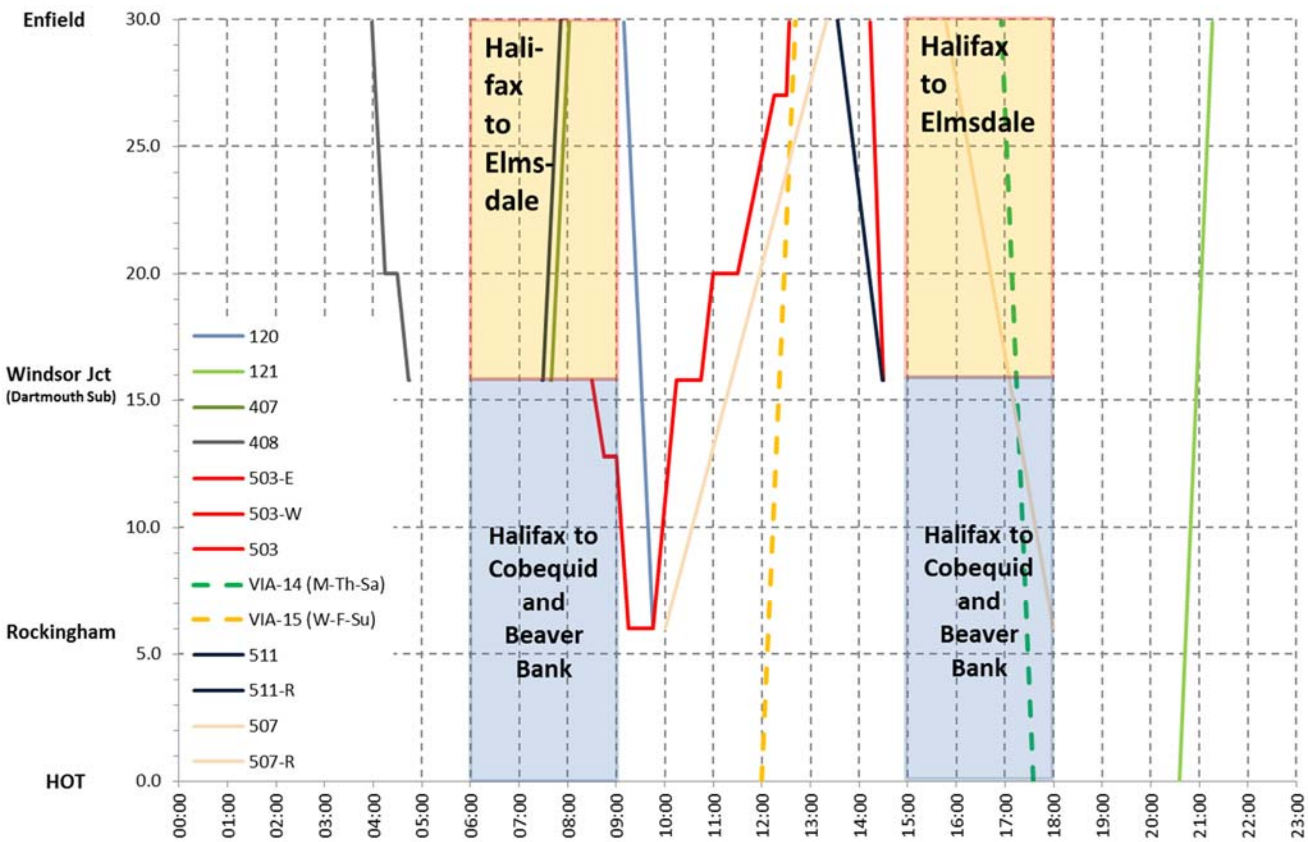
Source: CPCS analysis. Note: These figures have already been adjusted to account for the zonal fare structure proposed in Chapter 11.

Technical Feasibility

There are no technological constraints that would preclude the implementation of commuter rail service in Halifax. However, available capacity on the existing CN Bedford Subdivision would dictate the necessary infrastructure improvements, and hence costs, to implement commuter rail service.

Figure ES-3 shows existing freight and passenger rail (VIA Rail) traffic along the CN Bedford Subdivision. The Bedford Subdivision's available capacity for commuter rail service decreases west of Windsor Junction, because of additional trains using the line west of the junction with the Dartmouth Subdivision (at Windsor Junction). Rail freight traffic levels to and from Halifax on the CN Bedford Subdivision have been essentially flat (at best) in recent years. It is our expectation that trend will not change. There is currently no traffic over the WHRC.

Figure ES-3: Existing Freight and Passenger Services (Bedford Subdivision)



Source: CPCS analysis of train operating schedules

On the basis of this capacity analysis, we have made the following assessment of the three potential operating concepts:

Halifax-Cobequid: We anticipate that commuter rail service could be introduced between Halifax and Windsor Junction with the addition of passing sidings and centralized traffic control in key areas at a relatively low cost. The commuter rail service would only conflict with local freight switchers and the VIA passenger train; we anticipate that there would be some flexibility to alter the schedule of these services to accommodate commuter rail service.

Halifax-Elmsdale: It would not be viable to operate full peak-period service beyond Windsor Junction to Elmsdale, because doing so would almost certainly require the addition of a second main track due to the presence of two westbound freight trains originating in Dartmouth during the morning peak. Given that a rail grade does not exist for a second track, construction would be cost prohibitive and have significant environmental implications. However, it may be possible to extend some train services from Cobequid to Elmsdale during times that do not conflict with existing freight traffic with more modest infrastructure upgrades, subject to further discussions with CN.

Halifax-Beaver Bank: We anticipate that commuter rail service could be introduced between Halifax and Beaver Bank with upgrades similar to Halifax-Cobequid concept between Halifax and Windsor Junction. Additionally, 2.9 miles of WHRC mainline track would require extensive rehabilitation. However, because of the presence of existing infrastructure, these upgrades are not as costly as building entirely new track.

We identified no regulatory impediments that would outright preclude commuter rail operations in Halifax, though existing safety regulations would need to be accounted for during the design, construction and operation of the system. Of note, in the immediate term, rolling stock used for the proposed Halifax commuter rail service must meet existing Transport Canada and US Federal Railroad Administration regulations.

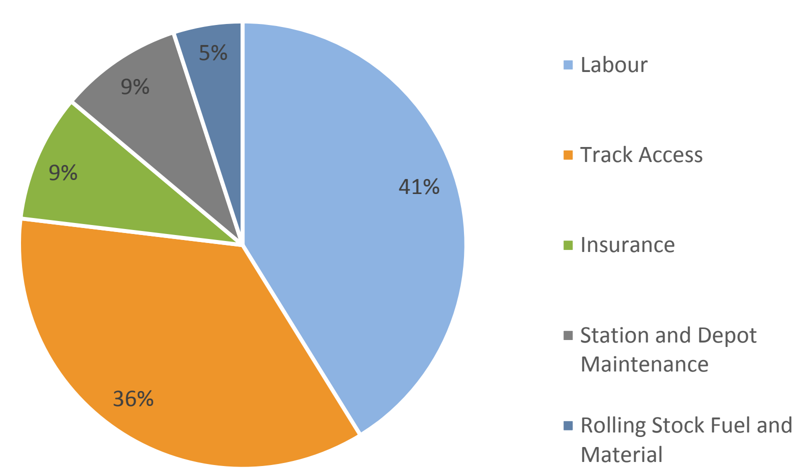
Track Access

In Canada, track access charges are negotiated with the host railway, which in this case is CN, and set in a confidential contract. CN has indicated that a CN-directed independent assessment would be required in order to determine the capital requirements to accommodate commuter rail. CN indicated that track access costs would also depend on findings of this assessment.

Should Halifax Transit proceed with the implementation of commuter rail service and be unable to come to an agreement with CN, Halifax Transit may, "after reasonable efforts to resolve the matter have been made," apply to the Canadian Transportation Agency (CTA) under Section 152.1(1) of the *Canada Transportation Act* for the CTA to rule on the amount that Halifax Transit would pay for the use of the railway company's facilities. Between 2009 and 2013, VIA Rail pursued three cases with the CTA under this section, none of which has involved CN as the other party.[2]

Track access charges represent a significant cost uncertainty. As shown in Figure ES-4, and based on our estimates, track access costs are the largest operating cost component after labour. While labour costs can be estimated with some certainty given the characteristics of the operation, track access charges represent a significant uncertainty as they would be subject to negotiation with CN, as discussed above. Any modest increases or decrease in these charges would noticeably enhance or diminish the financial performance of the system.

Figure ES-4: Operating Cost Breakdown for Cobequid Medium Scenario



Source: CPCS analysis

Financial Affordability

Rolling Stock

In total, we studied six conceptual rolling stock alternatives for potential commuter rail service in Halifax. Because the projected traffic demand in Halifax is modest, we selected Budd RDCs (Rail Diesel Cars) for further analysis. We anticipate that these vehicles would be the least

[2] Refer to CTA Decision No. 195-R-2013, Decision No. 333-R-2009, and Decision No. 118-R-2011, and a discussion of the process available here: https://services.otc-cta.gc.ca/eng/disputes-about-public-passenger-service-providers%E2%80%99-use-railway-lines-and-other-assets.

expensive alternative from a capital cost perspective capable of meeting the projected passenger traffic, and thus the most likely to be financially and economically feasible.

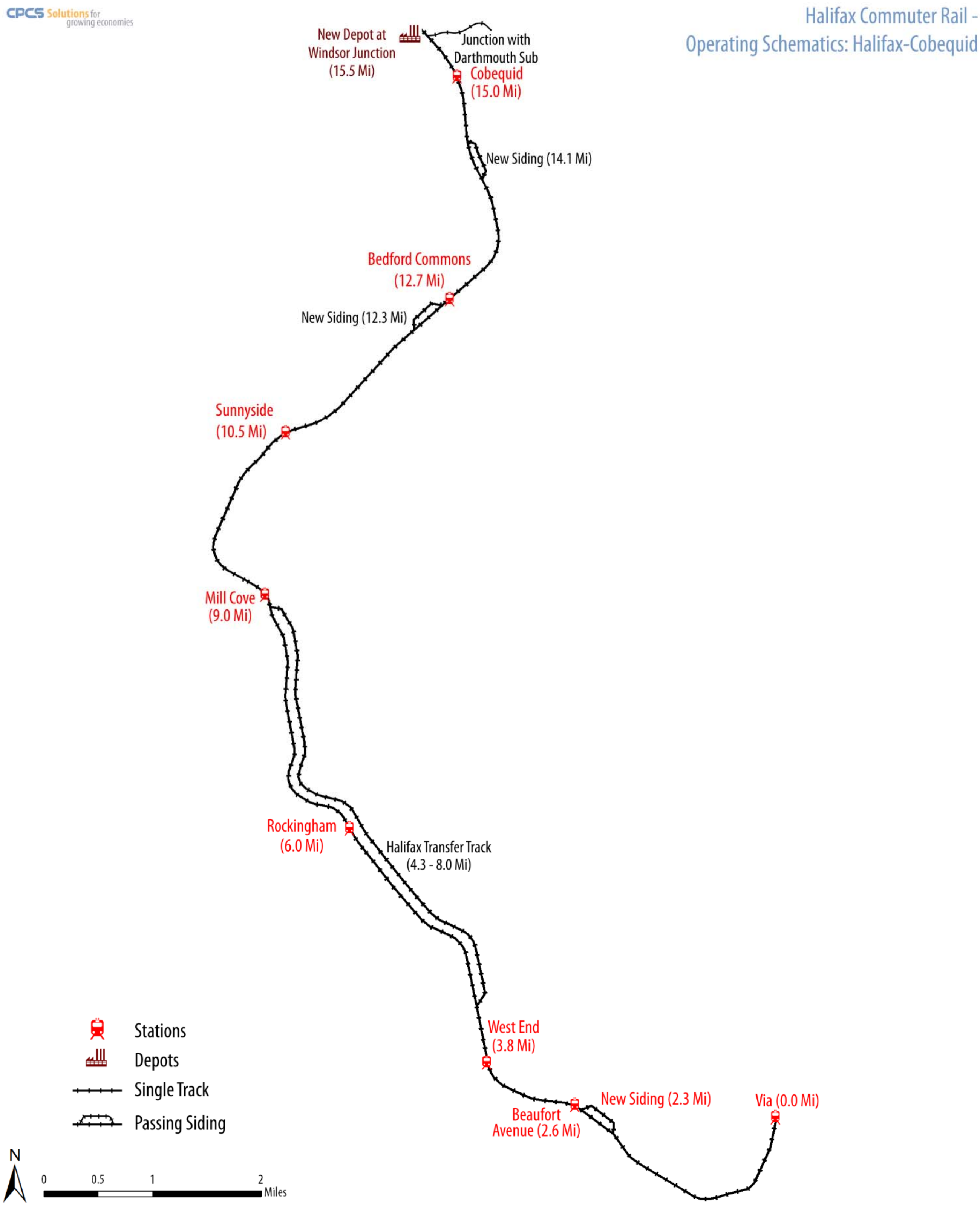
Infrastructure Requirements

CN would require upgrades to infrastructure to largely mitigate any resulting disruptions to its service from Halifax to Windsor Junction, which is the core route for both a Halifax-Cobequid and Halifax-Beaver Bank service. In addition, infrastructure changes would be needed to assure efficient and safe commuter service operations. The changes presented here are our assessments of the requirements, which may be less or more demanding than those ultimately required by CN or Transport Canada.

Figure ES-5 shows the infrastructure requirements for services from Halifax to Cobequid. For service to Cobequid and Beaver Bank, track upgrade requirements would include passing sidings, crossing upgrades, signal upgrades and new switch infrastructure between Halifax and Windsor Junction. A new rolling stock depot would be needed to provide day-to-day maintenance; an ideal location for the rolling stock depot is at Windsor Junction for the Halifax-Cobequid and Halifax-Beaver Bank service.

For continuing service to Beaver Bank, the infrastructure requirements between Halifax and Windsor Junction would be similar to the infrastructure requirements for service ending at Cobequid. In addition to the upgrades between Halifax and Windsor Junction required for service to Cobequid, approximately 2.9 miles of WHRC track would also require rehabilitation, but could be done at much lower cost than providing a second track between Windsor Junction and Elmsdale.

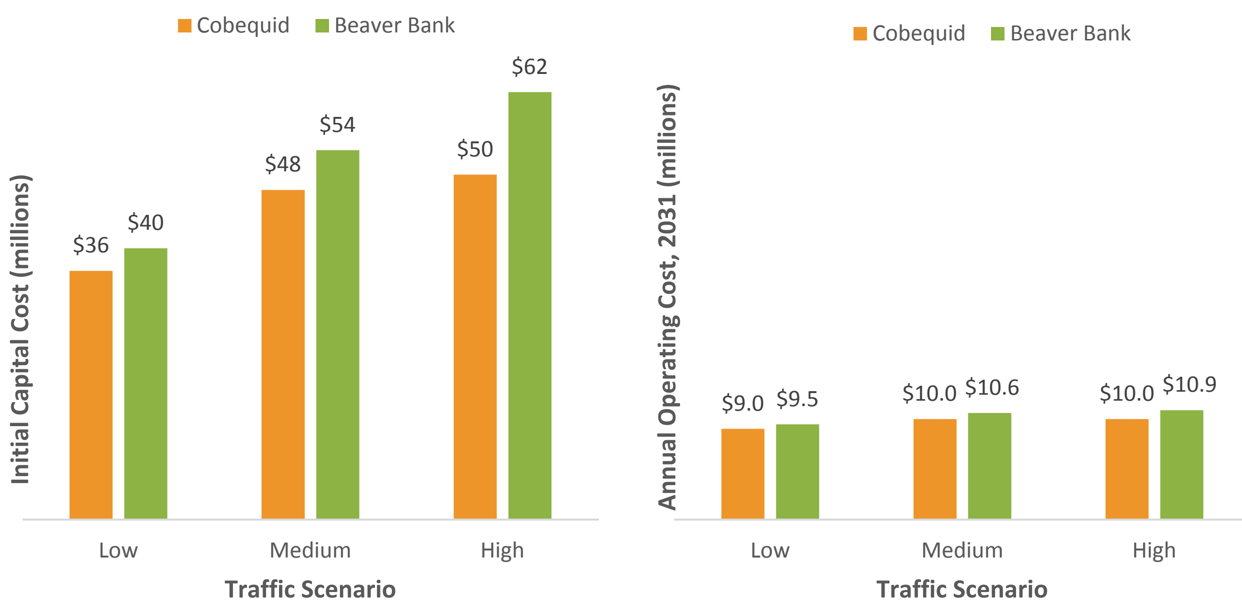
Figure ES-5: Halifax-Cobequid Infrastructure Schematic



Costs

Figure ES-6 contains a summary of the capital and operating costs for the Halifax-Cobequid and Halifax-Beaver Bank concepts. The estimated capital cost ranges from a low of $36 million for the Cobequid Low Scenario to a high of $62 million for the Beaver Bank High Scenario. For comparison, the estimated capital cost of the Elmsdale Scenarios, which were not studied in depth, would range from approximately $110 million (low scenario) to $130 million (high scenario), i.e. over twice the capital cost of the Cobequid or Beaver Bank Scenarios. Capital cost includes track and signal upgrades, station and rolling stock depot infrastructure, and rolling stock. The estimated operating cost ranges from a low of $9.0 million per year in the Cobequid Low Scenario to a high of $10.9 million per year in the Beaver Bank High Scenario.

Figure ES-6: Capital and Operating Cost Summary by Scenario

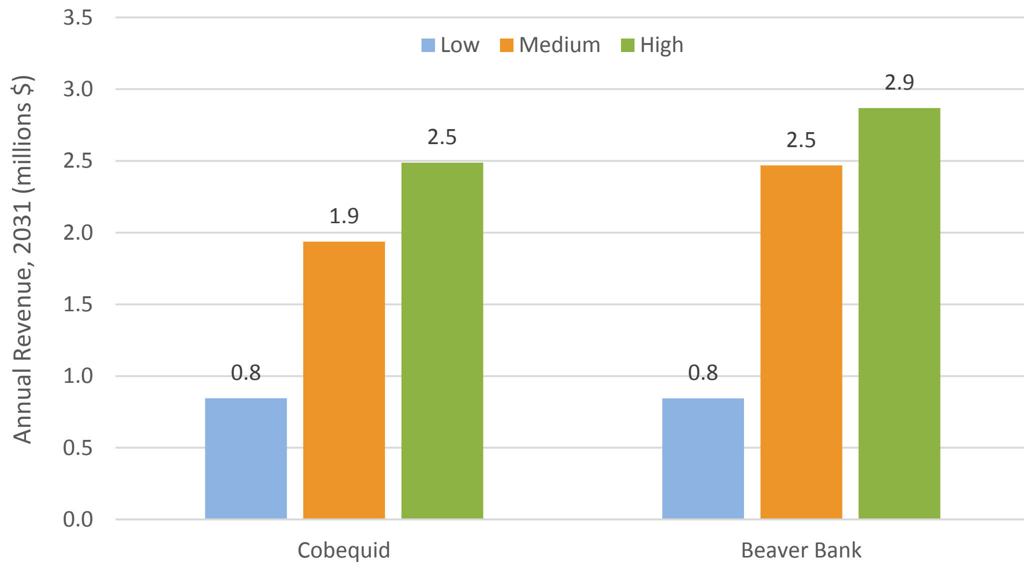


Source: CPCS analysis

Revenues

As shown in Figure ES-7, revenue forecasts vary between $0.8 million per year (both low-demand scenarios) to $2.9 million per year (Beaver Bank High Scenario). In the medium and high scenario, the addition of a station at Beaver Bank would provide an additional $0.4 to $0.5 million in annual revenue beyond the Cobequid service.

Figure ES-7: Revenue Forecast

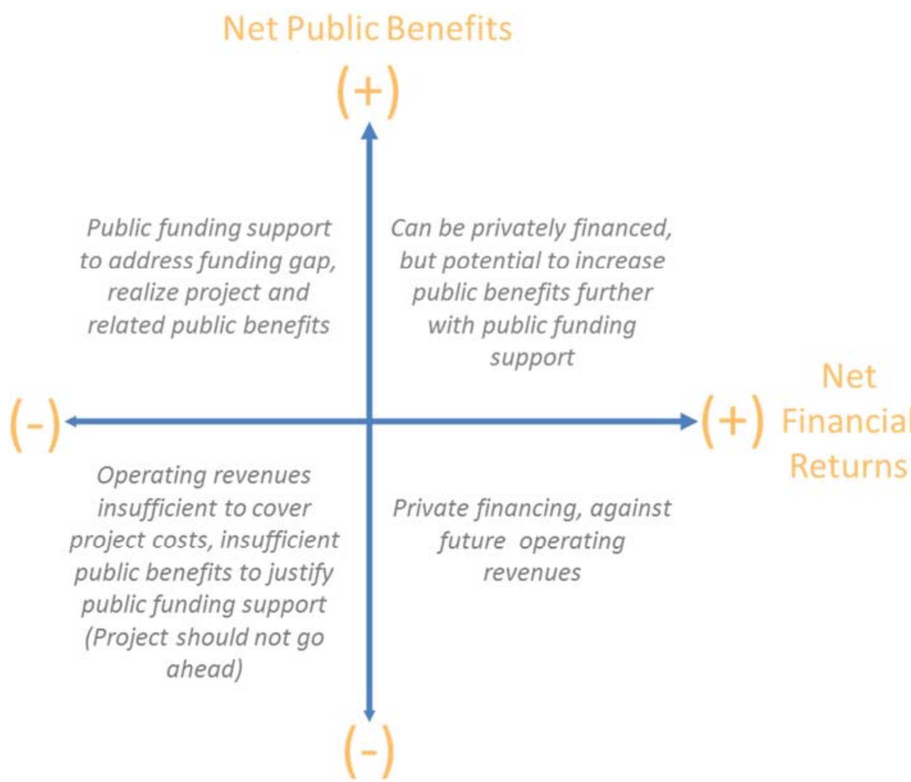


Source: CPCS analysis

Financial Analysis

The implications of a transportation infrastructure project can be thought of along two key dimensions, as shown in Figure ES-8. In this matrix, the vertical axis represents the social benefits of a project; projects in the upper two quadrants have social benefits (e.g. travel time savings, automobile cost savings and environmental benefits, among others) that exceed the cost of the project. The horizontal axis represents the financial returns of the project; that is, the benefits that accrue solely to the entity that implements the project (i.e. the commuter rail agency). Projects in the two right quadrants have financial returns that exceed the cost of the project. Projects in the left quadrants have negative financial returns.

Figure ES-8: Matrix of Public and Financial Benefits



Source: CPCS

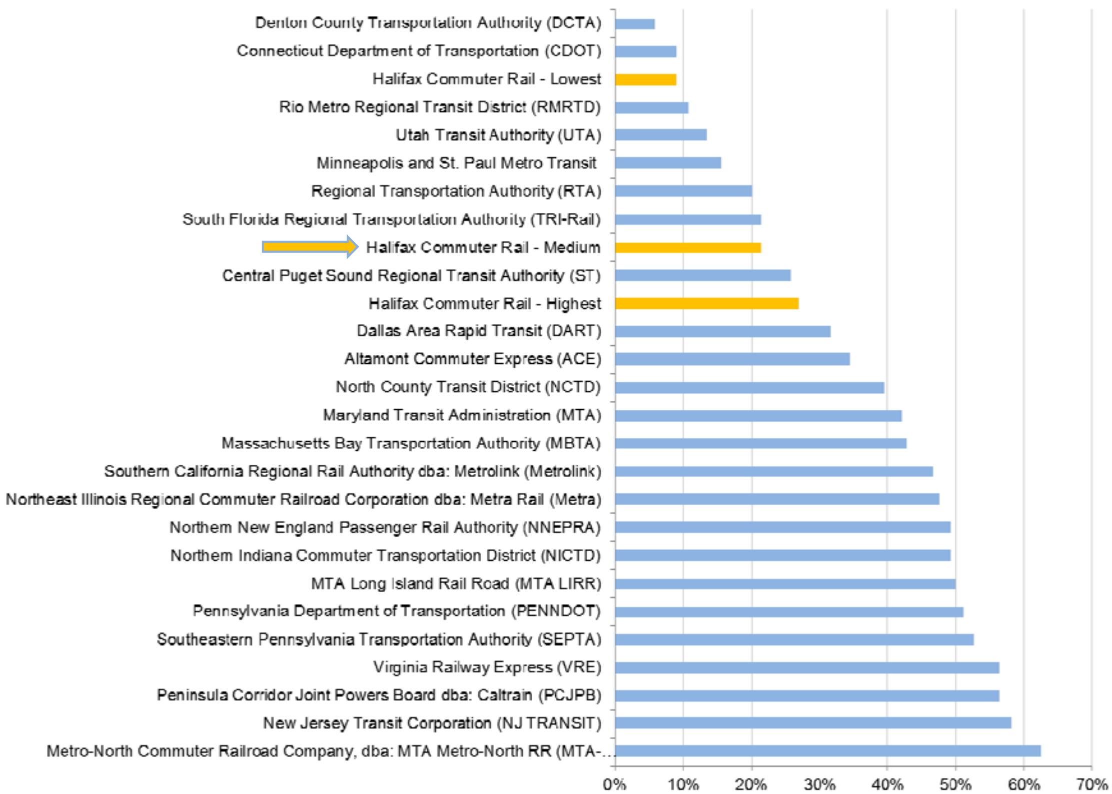
The quadrant that a project is in determines what type of support or action would be needed to make the project viable. Commuter rail projects are generally located in one of the left two quadrants; that is, the commuter rail agency does not recover its capital and operating costs through farebox and ancillary revenues alone, so its financial returns are negative. However, should a project create net social benefits and fall in the upper-left quadrant, government capital and operating funding could be justified on the basis that it supports positive social benefits. By contrast, projects in the lower left quadrant should not proceed because neither the net social benefits nor financial returns of the project are positive.

As expected, a commuter rail system in Halifax would result in negative financial returns for Halifax Transit, and would fall in one of the left two quadrants. Specifically,

- Should a commuter rail system be operating in 2031, we anticipate that it would have a financial cost-recovery ratio between 9% (Cobequid Low Scenario) and 27% (Beaver Bank high Scenario). The Beaver Bank Scenarios have a slightly higher recovery ratio than the Cobequid Scenarios.

To put these values in context, the recovery ratio of the Cobequid and Beaver Bank Medium Scenarios (in 2031) would result in a higher recovery ratio than seven of the 24 existing commuter rail operations (29%) in the US. (Figure ES-9).

Figure ES-9: Halifax Commuter Rail Cost Recovery Expectations in the Context of US Commuter Rail System Cost Recovery



Source: CPCS analysis of Federal Transit Administrations' 2012, National Transit Database (NTD), 2012 NTD Data Tables

In all six scenarios the financial net present value (FNPV) is negative, and varies only modestly between -$164 million (Cobequid Low) and -$187 million (Beaver Bank High). This result reflects relatively high upfront capital costs, high operating costs, and relatively modest revenues during the operating phase of the project. At each demand level, the Cobequid Scenario has a slightly less negative FNPV than the Beaver Bank Scenario.

Economic Benefits

The purpose of the economic analysis is to allow decision makers to evaluate the scenarios in terms of their economic benefits, i.e. from the societal perspective of Halifax. It is therefore different than financial impacts, which consider a project's financial profile from the perspective of the owner (Halifax Transit), and can be affected by the financial structure of the project (e.g. debt versus equity, PPP versus entirely private, etc.). Key economic benefits estimated are travel time savings, automobile operating cost savings and CO2 emissions reductions.

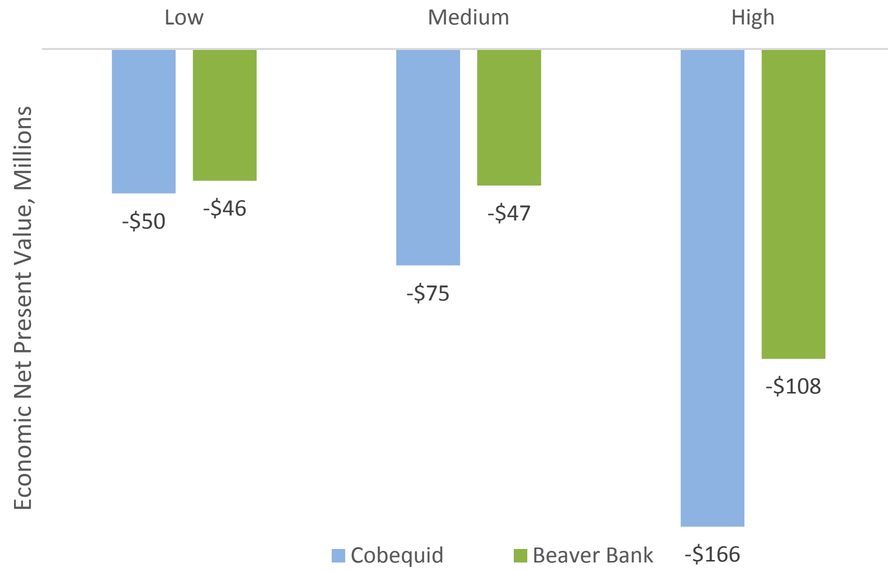
Two metrics are used to assess each scenario: economic net present value (ENPV) and the benefit-cost ratio (BCR). The ENPV is the discounted sum of all benefits less the discounted sum of all costs for each scenario. The BCR is the ratio of the present value of the benefits of each scenario to the present value of its costs. Any potential wider benefits associated with transit-oriented development (TOD)[3] and downtown revitalization were not included in this analysis, as they were beyond the scope of the terms of reference, though they could increase the economic viability of the project.

The ENPV for all six scenarios is negative, indicating that undertaking any of the six scenarios would result in net economic costs (Figure ES-10). The Beaver Bank Low Demand Scenario would have the least negative ENPV (-$46 million) and the Cobequid High Scenario would have the most negative (-$166 million). For all three demand scenarios the Beaver Bank concept would outperform the Cobequid concept, which indicates that additional economic benefits would possibly come from continuing service to Beaver Bank.

Overall, these findings suggest that *none* of the scenarios would generate net positive economic benefits given the assumptions made in the analysis. Combined with the results of the financial analysis, the results suggest the project would fall in the lower-left hand quadrant of Figure ES-8.

[3] Forecast population and employment growth in the 2031 horizon year in the Halifax Travel Demand Model were based on the 2014 Halifax Regional Plan (RP+5) figures and applied by Halifax in their model. While these official population and figures were used in the development of the rail corridor ridership forecasts, and, by extension, the economic and financial analyses, they do not explicitly consider potential intensification and/or growth over and above the RP+5 figures. For example, the area around the proposed Mill Cove Station has the potential for higher density, transit-oriented developments (TODs). However, this additional growth is not currently represented in the model, as the developments are currently not approved. Therefore, for example, forecasted commuter rail transit ridership in the Mill Cove area is likely underestimated. By extension, the forecasted benefits accruing from a commuter rail system do not account for this potential growth.

Figure ES-10: Economic Net Present Value



Source: CPCS analysis

We attempted to further optimize the system to improve the ENPV of the project. We reduced the number of trainsets required in the Halifax-Cobequid Scenarios from three to two by operating only as far as Bedford Common (instead of Cobequid) and removing stops in the off-peak direction, which would reduce cycle times. This alternative would reduce the present value of the cost by approximately $23 million. We anticipate that with careful service planning it would suggest that ridership would only modestly reduce, as headways could be maintained at around 30 minutes, so the potential economic benefit of the system would only slightly decrease. However, given that the ENPV of the Cobequid Medium Scenario is -$75 million, the cost savings that could be achieved by terminating service at Bedford Common would not result in a positive ENPV.

We also assessed the impact of a reduction in track access charges by 50% given the uncertainty that surrounds their estimation. In the case of the Beaver Bank Low Scenario, which has the least negative ENPV, the savings would be approximately $1.8 million per year, or approximately $25 million in present value terms. Since a reduction in track access charges would not influence the benefits resulting from the project, the ENPV would increase to approximately -$21 million per year, but still remain negative. A similar conclusion would be reached using the Cobequid Medium Scenario and considering the further optimization discussed.

Even after the optimization considered, from a net benefits standpoint, *none* of the scenarios generates net positive economic benefits given the assumptions made in the analysis. However, while the analysis is based on the best available information and reasonable assumptions, there are several uncertainties and limitations in the analysis that could result in the project being less or more economically viable than our findings indicate. If strategies are employed to encourage transit-oriented development and discourage auto use, there is the potential for a more economically viable project, subject to further analysis. However, particularly at this early feasibility stage of analysis, there is also the potential for downside risks, such as lower than expected ridership and higher than expected costs. The strategies noted have the potential to mitigate some of the downside demand risk, and careful discussions with CN have the potential to mitigate some of the cost risks pertaining to infrastructure requirements and track access charges; however, both risks remain present.

1 Introduction

1.1 Background

Commuter rail service in Halifax is not a new idea, and was most recently studied in 2003. A City staff report to Council updated this analysis in 2011.

The feasibility of a commuter rail operation in Halifax is a function of several factors, including:

- Whether there is sufficient potential market demand along the corridor(s) to warrant a commuter rail service vis-à-vis the status quo;
- Whether the existing rail corridor can accommodate a commuter rail operation and associated infrastructure (and without disrupting existing operations along the line);
- CN's support of the initiative especially as it relates to permitting the use of its rail line for commuter service, and the associated terms and conditions in the event permission is granted;
- Whether the project's expected benefits are likely to exceed the project's costs (i.e. generate net benefits);

The Halifax Regional Municipality retained a team led by CPCS Transcom Limited (CPCS) to address these questions in the context of a comprehensive feasibility study of commuter rail service in Halifax.

1.2 Study Objective

As stated in the Request For Proposals (RFP) (p. 25), the goal for the project can be summarized as follows:

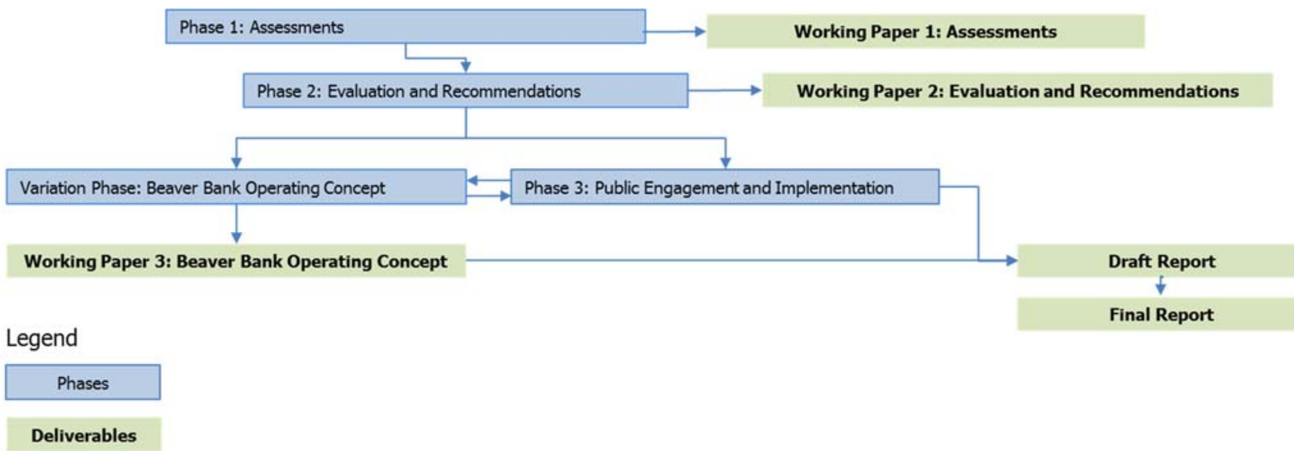
> *To produce a comprehensive feasibility study that accurately reflects the costs of implementing and operating commuter rail in Halifax.*

The study includes an analysis of any financial, regulatory or organizational issues and costs associated with building, implementing, operating and maintaining the project. In effect, the study is aiming to present the optimal set-up for a commuter rail service in Halifax.

1.3 Project Structure

The project was originally to be developed in three broad phases. Subsequently, at the request of Halifax Transit, we undertook additional analysis of a third operating concept along the former Windsor & Hantsport Railway (WHRC). As shown in Figure 1-1, this phase was undertaken in parallel to the preparations and execution of a public open house held at Sunnyside Mall on February 26, and preliminary material was included in the presentations. This final report is the output of all four phases.

Figure 1-1: Phased Approach to the Study



1.4 Purpose of this Report

The primary purpose of this report is to assess the feasibility of providing commuter rail service in Halifax. This report also addresses comments received from Halifax Transit following the submission of Working Papers 1, 2 and 3.

1.5 Methodology

This report was prepared in consultation with Halifax Transit and other government stakeholders including Halifax and Waterfront Development Corporation. The team also solicited information from CN, VIA Rail, the Windsor & Hantsport Railway (WHCR), Heritage Management[4] and Transport Canada.

Infrastructure requirements were developed based on what we deemed as necessary for safe and efficient commuter service, legal and regulatory requirements, and our assessment of what CN would require given the existing freight and passenger services on the CN Bedford Subdivision. We performed a walking inspection of the Bedford Subdivision, but not of the WHRC.[5] Instead, we relied on information from the WHCR, Transport Canada and from inspections using Google Earth imagery.

Though discussions were held with CN, it did not provide any assessment as to its required infrastructure requirements. Capital costs were developed based on rates, as we know them, for CN (for track and signals) and for local contractors for all other infrastructure development (stations and maintenance depot).

---

[4] The owners of Budd RDCs in Moncton, New Brunswick.

[5] The analysis of the extension to Beaver Bank along the WHRC occurred during the winter months, and as such, a walking inspection was not possible.

We studied nine traffic scenarios: three travel demand forecasts (low, medium and high) were developed for three operating concepts (Halifax-Elmsdale, Halifax-Cobequid and Halifax-Beaver Bank), each with a different terminus. In all cases in this report, we considered peak-period service with one mid-day trip. We assessed that such a service plan would be (1) the most cost-effective to implement given the existing train schedule on the Bedford Subdivision and (2) capture the majority of commuter demand to/from Halifax. For modelling purposes only, we assumed that construction would begin in 2016 and operations would begin in 2018. (Provided the construction period remains approximately two years long, a change in the construction start date within one or two years would likely not significantly change the results.)

All realistic rolling stock options were considered, but for the sake of detailed analysis, we used only the one that we thought to be the most cost-effective. For the purposes of assessing the feasibility of in-street running into downtown Halifax, we consulted with Transport Canada regarding alternative-compliance of potential rolling stock options. These discussions were preliminary and intended to understand, at a high level, how Transport Canada's existing regulations and processes compare with those in the United States.

Our projection of operating requirements, structures and costs were largely based on successes elsewhere and the unique travel and operating demands of Halifax. We also considered the cost and revenue impacts on Halifax Transit's bus service in the event the commuter rail service was implemented as planned. All of these data were used to provide an economic and financial feasibility of the commuter rail service.

1.6 Limitations

While the study covers significant breadth, more detailed study would be required in key areas in the event of a decision to move forward, especially related to infrastructure requirements and track access charges. Notably, these items require further CN participation.

1.7 Report Organization

This report is organized into 14 chapters, proceeding from an initial assessment of existing infrastructure and ending with a discussion of further optimization opportunities.

Chapter 2: Existing Rail Infrastructure

Chapter 3: Existing Rail Operations and Available Capacity

Chapter 4: Conceptual Alignment and Station Location

Chapter 5: Regulatory, Commercial and Legal Considerations

Chapter 6: Traffic Analysis

Chapter 7: Rolling Stock Alternatives

Chapter 8: Service Design, Operating and Maintenance Requirements

Chapter 9: Fixed Infrastructure Requirements

Chapter 10: Operating and Capital Cost Projects

Chapter 11: Fare Analysis

Chapter 12: Financial Analysis

Chapter 13: Economic Analysis

Chapter 14: Further Optimization Potential

2 Existing Rail Infrastructure

Key Messages

Rail infrastructure in Halifax consists of the following subdivisions:

- CN Bedford Subdivision
- CN Dartmouth Subdivision
- Windsor & Hantsport Railway Company (WHRC) Halifax Subdivision

The focus of the study is potential commuter service from Halifax to Cobequid Road and Elmsdale along the CN Bedford Subdivision, with possible extension to Beaver Bank Road along the WHRC.

Most infrastructure along the CN Bedford Subdivision is in good condition and there are several locations where double track existed less than 20 years ago between mile 0 to 15.6 (Windsor Junction), which would facilitate the installation of any parallel tracks required.

The condition of the WHRC track is poor and significant rehabilitation would be required prior to any operations commencing.

2.1 Mainline Tracks

A map of the study area is shown in Figure 2-1, on the next page. Rail infrastructure in Halifax consists of the following subdivisions[6]:

- CN Bedford Subdivision
- CN Dartmouth Subdivision
- Windsor & Hantsport Railway Company (WHRC) Halifax Subdivision (not operating)

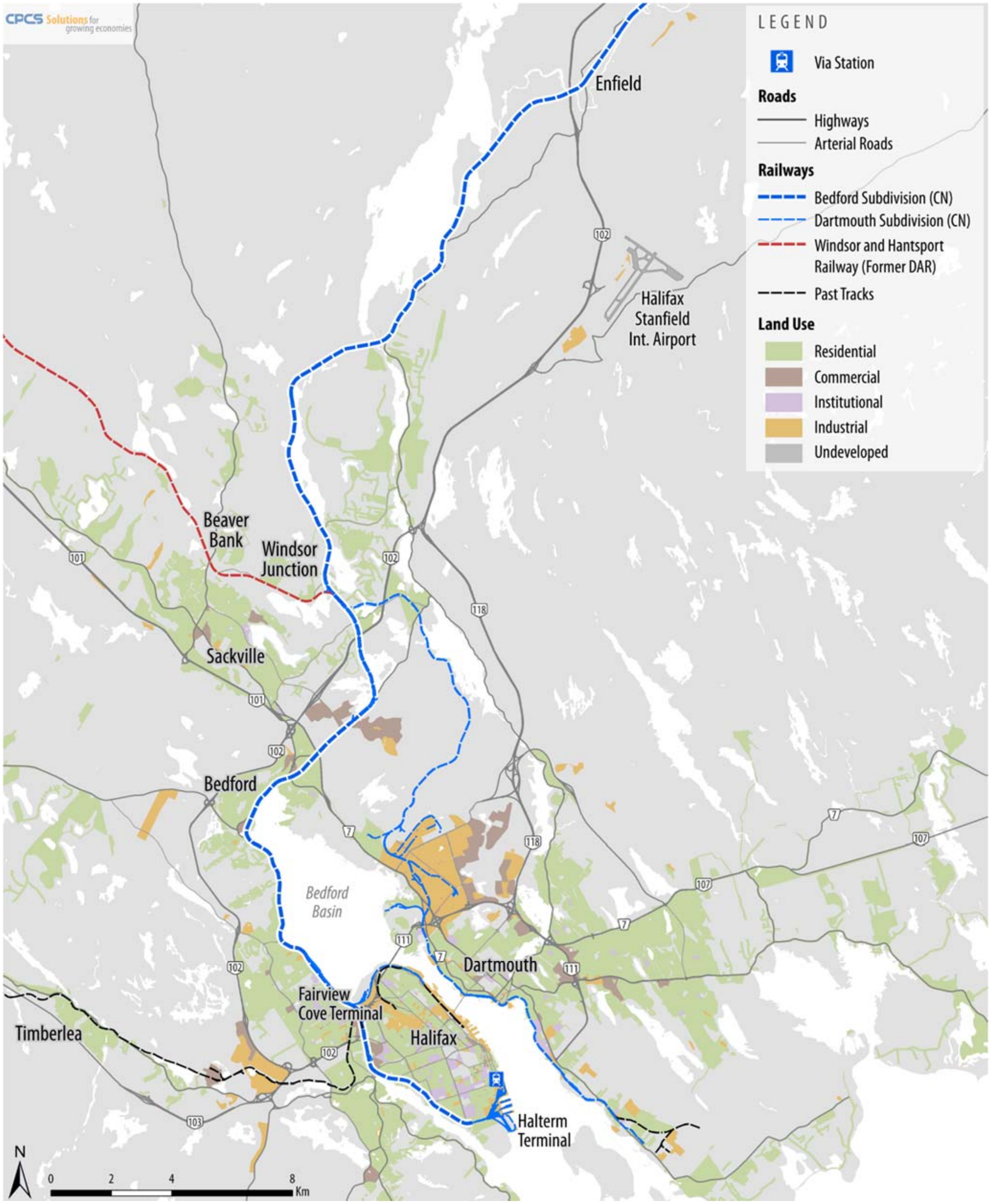
The Bedford Subdivision starts at the Halifax VIA Rail station (mile 0.0) and continues west to Truro (mile 64.0). At Windsor Junction (mile 15.6), the CN Dartmouth Subdivision starts and heads east. This subdivision is still used by several trains per day that enter and exit onto the Bedford Subdivision. The WHRC Halifax Subdivision once originated on the south side of Windsor Junction (mile 15.7), but the switch has been removed.

The road crossing located within the center of Enfield is located at mile 29.7 (near the municipal boundary of Halifax). The next major crossing is in Elmsdale at mile 32.1 (outside of Halifax). Our traffic and operations analysis is based on service up to and including Elmsdale because Elmsdale is a better location for a terminus than Enfield. (Possible station locations are discussed in Chapter 4.)

The focus of the study is potential commuter service from Halifax to Cobequid Road or Elmsdale along the CN Bedford Subdivision, with possible extension to Beaver Bank Road along the WHRC.

[6] As defined by Transport Canada (in Canadian Rail Operating Rules), a subdivision is railway trackage designated by timetable.

Figure 2-1: Study Area



2.2 CN Bedford Subdivision

The Bedford Subdivision is single track from Halifax through to Truro. Double track existed less than 20 years ago between mile 0 to 15.6 (Windsor Junction) but was removed or designated as non-mainline track in 2003 or earlier.

Several systems of traffic control are used by CN on the Bedford Subdivision:

- Centralized Traffic Control (CTC) – trains operate under signal indication as directed by rail central control at Rail Traffic Control (RTC) Montreal;
- Occupancy Control System (OCS) – trains are authorized verbally by a dispatcher at RTC Montreal.
- Rule 105 – trains must operate at a speed that permits stopping within half the range of vision of equipment and track units and short of red and blue flags (used to protect workers and equipment). Yard Traffic Control (YTC) is a verification of Rule 105.

As per Canadian Rail Operating Rules (CROR), track where CTC and OCS are used is "main track", whereas rule 105 applies on "non-main track". Non-main track is of the least suitable for commuter rail due to lower speeds and lower capacity. CTC offers the potential for highest speeds and capacity.

The limits of each system of train control on the Bedford Subdivision main track is shown in Figure 2-2.

Figure 2-2: Bedford Subdivision Train Control on Main Track

Mileage / Location	Type of Control	Number of Main Tracks	Previous Double Track
0-1.8	Rule 105	Single	Yes
1.8-7.93	OCS	Single	Yes
7.93-64.0	CTC	Single	Yes (0.00 – 15.6)

2.2.1 Major Rail Yards and Facilities

There are several rail yards on the Bedford and Dartmouth Subdivisions. Train services to these facilities would not directly interfere with the proposed commuter rail service, but feed traffic onto the Bedford Subdivision. Major rail yards and facilities in Halifax on the Bedford Subdivision include:

- South End Container Terminal – Piers 36-42 (Halifax Port Authority operated by Halterm Limited)
- Fairview Cove Container Terminal (Halifax Port Authority operated by Cerescorp)
- Halifax Ocean Terminal (CN Rail marshalling yard)
- Rockingham Yard (CN Rail marshalling yard, Figure 2-3)

- Halifax Intermodal Terminal (intermodal facility owned and operated by CN Rail)
- Fairview Maintenance Facility (CN's facility for rolling stock maintenance and service)

Other major facilities in the Halifax on the Dartmouth Subdivision include:

- Dartmouth Yard (CN Rail marshalling yard)
- Wrights Cove Gypsum Terminal (owned and operated by National Gypsum Company)
- Autoport (owned by CN Rail and operated by Autoport Limited)
- Burnside Industrial Park includes a network of non-mainline tracks servicing local industries, a common use yard and a small marshalling yard.

Figure 2-3: CN Rockingham Yard

Source: Rob Leblanc

2.2.2 Track and Bridges

Mainline track is constructed of a subgrade mainly of rock along with an excellent ballast section with good drainage (e.g. Figure 2-5). Rail weight is a mix of 100, 115 and 136 lb/yard on wood ties (e.g. Figure 2-6). Vegetation is a present issue between Windsor Junction and Fairview.

Figure 2-4: Track Section in Rail Cut in the South End of Halifax

Source: Rob Leblanc

Figure 2-5: Typical Track Section Near Bedford

Source: Rob Leblanc

Figure 2-6: Halifax-Elmsdale Corridor Track and Bridges

Mile From	Mile to	CWR / Jointed (J)	Rail Weight (lb/yard)	General condition (Good / Poor)
Mainline Track				
4.3	15.6	CWR, Mainline Track	100/115/136	Good
15.6	32.0	CWR	136	Good
Halifax Transfer Track				
4.3	8.0	CWR, Halifax Transfer Track	100/115	Good

Track Clearances

CN has detailed standards for horizontal and vertical clearances that would need to be accounted for in the track and station platform design and rolling stock selection, as follows:[7]

- Overhead from top of rail (23 feet)
- Side clearance from centre of track section (8 feet to fixed point)
- Track centres for all tracks (14 feet)

Locations of limited clearance are located in Rockingham, HOT, Fairview and Dartmouth Yards.

Bridges and Structures

Between Halifax (mile 0) and Elmsdale (mile 32), there are:

- 25 road over rail structures (e.g. Figure 2-7)
- 10 rail over road structures (two of which are out of service)
- One overhead pipe
- One pedestrian tunnel under rail

Figure 2-7: Young Avenue Bridge over the CN Bedford Subdivision

Source: Rob Leblanc

Details are included in Appendix A.

[7] Transport Canada also has "Standards Respecting Railway Clearances", though CN's requirements are more stringent.

As fixed structures, locations of bridges (both rail and road) pose restrictions on the cost-effective addition of passing sidings or second main tracks. As such, the placement of these tracks would need to consider the location of bridges. It is important to note that many of the bridges were once used for double track; however, in some areas, such as sections between Millview and Windsor Junction, the track has been lined to the centre of the right of way. As such, the re-introduction of a second track is likely cost-prohibitive along much of the alignment.

Passing Sidings and Mainline Turnouts

In addition to the Halifax Transfer Track in the vicinity of Rockingham, which is a non-mainline track that runs parallel to the mainline track between mile 4.3 to 8.0, there are two active passing sidings on the Bedford Subdivision between Halifax and Elmsdale, as shown in Figure 2-8.

Figure 2-8: Halifax-Elmsdale Corridor Passing Sidings

Siding	Location (mile)	Length (feet)
Kinsac	20.0	3,290
Sandy Cove	27.0	3,800

These sidings are very short for current operations and are only long enough to hold a VIA Rail train, or a local switcher train, but they could accommodate a potential commuter train. However, Kinsac is already often used to set off train cars destined to or from Halifax or Dartmouth. Locomotives also use Kinsac to “run around” trains travelling between Halifax and Dartmouth; that is, move from one end to the other.

Dual control power switches, which permit either the RTC or a conductor to throw the switch, are located at the end of both sidings. Figure 2-10 presents all of the mainline switches between Halifax and Elmsdale.

Trains could occupy the non-mainline Halifax Transfer Track between mile 4.3 and 8.0 (Figure 2-9). However, operations are currently governed by rule 105 so it is not ideal for mainline train meets.

Figure 2-9: Halifax Transfer Track

Source: Rob Leblanc

Figure 2-10: Halifax-Elmsdale Corridor Mainline Switches

Mile	Designation	Frog	Switch Stand	Size/ No.	Condition
1.6	HOT Yard Switch	SGM	22E	100/10	Good
4.3	TC50	Spring	31B	100/10	Good
6.05	West Xover	RBM	31B	100/12	Good
7.6	Birch Cove	RBM	22E	100/10	Good
8	Millview	RBM	Dual Control	115/12	Good
12.7	Bedford Quarry	RBM	31B	115/10	Good
13.15	Main Line	RBM	31B	115/10	Good
15.6	Dartmouth ML	RBM	Dual Control	115/12	Good
19.2	Kinsac East	RBM	Dual Control	132/12	Good
20.01	Kinsac West	RBM	Dual Control	132/12	Good
26.73	Sandy Cove East	RBM	Dual Control	132/12	Good
27.56	Sandy Cove West	RBM	Dual Control	132/12	Good

Note: RBM stands for rail bound manganese.

2.2.3 Public Road Crossings

There are 11 public road crossings between Halifax and Elmsdale, as shown in Figure 2-11. All have automatic protection by lights and bells, but three lack gates. Any upgrades to crossings that likely would be required to implement commuter rail service are discussed in Chapter 9.

Figure 2-11: Halifax-Elmsdale Corridor Public Road Crossings

Mile	Name	Lanes	Tracks	Protection
10.32	Isleview Lane	2	1	Gates / Lights / Bells
15.09	Cobequid Rd.	2	1	Gates / Lights / Bells
16.02	Mcquines Rd.	2	1	Gates / Lights / Bells
16.31	Access Rd.	2	1	Gates / Lights / Bells
17.24	Fall River Rd.	2	1	Gates / Lights / Bells
22.65	Sunnylea Rd.	2	1	Lights / Bells
27.47	Frenchman's Rd.	2	2	Gates / Lights / Bells
29.18	Hall's Rd.	2	1	Lights / Bells
29.72	Enfield Road #2	2	1	Gates / Lights / Bells
31.98	Private Rd.	2	1	Lights / Bells
32.18	Elmsdale Rd.	2	1	Gates / Lights / Bells

Figure 2-12: Typical Road Crossing with Lights, Bells and Gates

Source: Rob Leblanc

2.2.4 Private Road Crossings

There are 12 private crossings and no farm crossings between Halifax and Elmsdale, as shown in Figure 2-13.

Figure 2-13: Halifax-Elmsdale Corridor Private Road Crossings

Mile	Name	Protection
7.59	Private	Private signs / stop signs
16.46	Private	Private signs / stop signs
16.85	Private	Private signs / stop signs
17.04	Private	Private signs / stop signs
20.02	Private	Private signs / stop signs
22.25	Private	Private signs / stop signs
25.02	Private	Private signs / stop signs

Mile	Name	Protection
27.03	Private	Private signs / stop signs
27.73	Private	Private signs / stop signs
30.38	Private	Private signs / stop signs
30.70	Private	Private signs / stop signs
33.39	Private	Private signs / stop signs

Like bridges, the introduction of passing sidings or second main tracks at crossings would be prohibitively expensive. Where crossings were once for double track, they have now been modified for single-track operation. As such, where second tracks would be required, crossings will need to be avoided. In addition, station locations should not be on or near crossings, as stopping of a train would not be practical and modifications to the crossing would likely be necessary to minimize unnecessary activation.

2.2.5 Signals and Communications

The CTC system that is in use on the Bedford Subdivision was installed in the 1940s. All control and approach signal locations have been rebuilt between 20 and 30 years ago using the same technology and equipment in new housings. The overall condition of the plants is fairly good. However, the pole lines that handle the control wires for the controlled locations and the control wires for the approach signals are in poor condition.

There are two wayside inspection stations (hot box detectors [HBDs]) between Halifax and Elmsdale, as follows:

- Windsor Junction (mile 17) with hot wheel, hot axle and dragging equipment detection
- Enfield (mile 31) has hot axle and dragging detection. Both have new up-to-date equipment

For radio communications, a VHF (very high frequency) system is used between RTC Montreal, trains and engineering personnel. CN has two towers in Halifax: one at Geiser Hill in Halifax and the other at Windsor Junction.

The signal system between mile 5 and 37 permits follow-up movements within a block. This arrangement means that there is one intermediate signal within a block permitting, which allows two trains within a given segment of track (one following another) both operating under signal indication. (Some CTC systems are light traffic control and do not allow this.) This arrangement generally increases train capacity by permitting trains to “fleet,” and is a consideration in developing the operations plan.

All public crossings have automatic protection (but some without gates, as noted in Figure 2-11). Not all crossings have Grade Crossing Predictors (GCPs). GCPs detect the presence, movement and speed of a train. This eliminates excess ringing of the crossing protection by always giving a 25-second warning time and turning protection off if the train stops on crossing circuit.

The cost of upgrading any crossings is considered in the evaluation of commuter rail operating options, and the project's feasibility.

2.3 WHRC

The WHRC has roadbed and/or track roadbed from Windsor Junction to New Minas. Two gypsum quarries at Wentworth Creek and Mantua, NS, have been its business mainstay for most of the past 20 years. The railway has been effectively shut down for five years since there is no longer gypsum traffic.

The WHRC has recently purchased the track along with the east leg of the wye at Windsor Junction from CN. There are three overhead road bridges crossing over the line, all of which are owned by the province. All bridges over water are owned by WHRC. The line is not currently connected to the CN Bedford Subdivision, but the existing grade for a connection remains.

The WHRC owns two locomotives (GM EMD GP 9); a fleet of 60 gypsum cars; six box cars; one passenger coach; and four pieces of track maintenance equipment (tamper, regulator, speed swing and tie inserter).

Should commuter rail service continue to Beaver Bank, it would run over an approximately 2.9 mile stretch of the existing alignment from Windsor Junction to Beaver Bank Road. This section describes the infrastructure condition along this stretch based on our discussions with the WHRC and photos of the area.

2.3.1 Track and Bridges

Overall, the condition of the existing track is poor (Figure 2-14). There is 100 lb. rail from mile 0 (junction with the CN Bedford Subdivision) to mile 1.0, and 85 lb. rail from mile 1.0 to 2.9. The 85 lb. rail is very light-duty and would likely need to be replaced. The condition of the existing ties is also poor. There is significant vegetation around the line that would need to be cleared and brushed before service can be resumed.

Figure 2-14: WHRC Looking East from Beaver Bank Road

Source: Ekistics

There are no bridges over this section of line, though there may be some culverts that need to be inspected and cleared.

2.3.2 Road Crossings

There are several existing road-rail crossings that provide access to property on the south side of Windgate Drive (Figure 2-15). All of these crossings are classified as private, based on information provided by Transport Canada.

Figure 2-15: : WHRC Road Crossings

Mileage from Windsor Junction	Description	Type (Public/Private)
0.05	Kermit Lane	Private
0.50	Windgate Farm	Private
0.93	One house	Private
0.95	No description	Private
1.11	Keough Lane	Private
1.50	East of Terry Road	Private

Source: CPCS summary of Transport Canada data

Before commencing commuter rail service, the condition of each crossing would need to be assessed in accordance with Transport Canada's Grade Crossings Standards.[8] Under these standards, a warning system (e.g. lights and bells) is generally required at private crossings only if the cross-product (the product of the Average Annual Daily Vehicle Traffic and Average

[8] https://www.tc.gc.ca/eng/railsafety/grade-crossings-standards.htm

Annual Daily Rail Traffic) exceeds 2,000 (Section 9.3.1). Based on only road and rail traffic levels, additional warning systems (e.g. lights, bells, gates) would not be required to operate peak-period commuter rail service at the private crossings listed in Figure 2-15. Assuming approximately 26 trains per day would pass each crossing, over 76 daily road crossings would be required to justify the installation of a warning system.

However, these criteria are general standards only; the safety of each crossing would need to be assessed as part of a detailed design process. We anticipate notably that a warning system (lights and bells) may be required at Windgate Farm (mile 0.50) and Kermit Lane (Mile 0.05), due to the proximity of the crossings to rail curves, which diminishes the sightlines. (The remaining crossings are located on straight stretches of rail.) The proximity of the remaining crossings to Windgate Drive also increases the need for an additional warning system. Though Transport Canada standards do not require warning systems for private crossings located near intersections, this design factor would also need to be considered as part of a potential future design phase.

2.3.3 Signals and Communication

There is no signalling system in place along the WHRC section of track approaching the CN Bedford Subdivision. Should commuter rail service use this alignment, the control system would need to be upgraded to an occupancy control system (OCS), which allows trains to be controlled through radio dispatch.

3 Existing Rail Operations and Available Capacity

Key Messages

- There has been no growth in rail freight traffic volumes to and from Halifax in recent years. It is our expectation that trend will not change and that traffic may actually decline in future years. Furthermore, the number of freight trains per day has decreased due to trains becoming longer.
- The Bedford Subdivision's available capacity for commuter rail service decreases west of Windsor Junction, because of additional trains using the line west of the junction with the Dartmouth Subdivision (at Windsor Junction).
- In general, we anticipate that commuter rail service could be introduced between Halifax and Windsor Junction with the addition of passing sidings and centralized traffic control in key areas.
- Overall, we do not anticipate that it will be viable to operate full peak-period service to Elmsdale; however, it may be possible to extend some train services from Cobequid to Elmsdale during times that do not conflict with existing freight traffic.
- Currently, there are no trains operating over the WHRC from Beaver Bank eastward. Should traffic resume, we do not anticipate any capacity constraints.

3.1 Existing Freight Operations

3.1.1 Rail Operations

In recent years, there has been no growth in rail freight traffic volumes on the Bedford and Dartmouth Subdivisions. However, the number of trains has been reduced on account of trains becoming longer. As discussed in Section 3.3, this trend is not likely to be reversed. Figure 3-1 provides the details of the current trip plans within Halifax. As an example, less than 10 years ago, CN departed three intermodal trains daily from Halifax (two with international traffic from Ceres and Halterm and one from the CN Halifax Intermodal Terminal [HIT]). It now departs one train daily (121) composed of both domestic and international container traffic.

Figure 3-1 provides a summary of freight trains on the Bedford and Dartmouth Subdivisions.

Figure 3-1: Freight Trains on Bedford and Dartmouth Subdivisions

Train	Location	Departure	Location	Arrival	Schedule (Days)	Length (ft.)
120	Truro	0820	Rockingham	0945	S M T W T F S	11,000
121	Halifax	2035	Truro	2235	S M T W T F S	7000-8000
407	Dartmouth	0710	Truro	940	S M T W T F S	3000-6000
408	Truro	0305	Dartmouth	0515	S M T W T F S	4000
511	Dartmouth	0700	East Milford	0805	M T W T F	3000-4000
511	East Milford	1300	Dartmouth	1500	M T W T F	3000-4000
507	Rockingham	1000	Milford	1430	S M T W T F S	500
507	Milford	1500	Rockingham	1800	S M T W T F S	500
501	Rockingham	2100	Rockingham	0500	Tuesday	500
509	Dartmouth	1600	Dartmouth	2400	S M T W T F S	3000
503	Dartmouth	0700	Dartmouth	1500	S M T W T F S	500

Major rail customers that drive traffic onto the rail system with Halifax include:

- Halterm Limited at South End Container Terminal
- Cerescorp at Fairview Cove Container Terminal
- National Gypsum at Wrights Cove gypsum terminal
- Autoport Limited
- Halifax Intermodal Terminal (intermodal facility owned and operated by CN Rail)

Smaller customers are located with Burnside Industrial Park, Rocky Lake Quarry and near the former Imperial Oil Refinery.

3.1.2 Transportation Staffing

There are 54 CN transportation (running trade) employees working from Halifax. They cover some road assignments (trains to Moncton and back); but mostly are used for yard work (serving local customers and marshalling trains) (Figure 3-2). Spare board employees are called if extra trains are required and to cover sick employees.

Figure 3-2: CN Transportation Staffing

Assignment	Number of Employees
Road	8
Yard	42
Spare Board	4

There are two transportations supervisors in Halifax (covering all Nova Scotia operations) with one based in Rockingham and the other in Dartmouth.

3.1.3 Rolling Stock Maintenance

The CN Fairview Yard (mile 5 Bedford Sub) includes a rolling stock maintenance facility. Employees are dispatched from Fairview Yard to complete locomotive and car repairs located on tracks elsewhere in Halifax.

Due to operational and traffic changes, the number of rolling stock maintenance employees has been greatly reduced in recent years to approximately 30 employees covering the current shifts (Figure 3-3).

Figure 3-3: Rolling Stock Maintenance Staffing

Classification	Shift	Schedule	Number
Carmen	0800 - 1600	7 day operation	8
Carmen	1600 - 2400	7 day operation	6
Facility Mtce. Electrician	0800 - 1600	Mon – Friday	1
Industrial Electrician Motive Power	1400 - 2200	7 day operation	1
Heavy Duty Mechanic	1400 - 2200	7 day operation	2
Supervisor	0800 - 1700	5 days (Change)	1

Rolling stock maintenance is supervised by a mechanical supervisor, who is based in Fairview.

There are three pad tracks approximately 500 feet each in length of track serviced by air and electricity. Key equipment includes:

- Fork lifts (5)
- Air jacks (100 ton) for heavy lifts
- Hydranor jacks (6) for changing wheels on pier tracks

There is also a working turntable that is able to turn a single locomotive. The employees' headquarters and offices are situated to the west of the pad facility.

Locomotives

All locomotives within the terminal and locomotives arriving and departing on main line trains are serviced on one of the two fuel stand tracks. Each track is approximately 250 feet in length and equipped for small running repairs along with fuel and sand for locomotives.

Cars

The majority of the car repairs and wheel change out happens on the pier tracks along with a small track that is located at RG12 (in Rockingham Yard). Other repairs completed by a mechanical group are air brake work to equipment along with safety apparatus.

3.1.4 Infrastructure Maintenance

Infrastructure maintenance is divided at CN Rail and divided along functional and geographical lines. Functional lines include:

- Track (local and regional employees)
- Bridges and Structures (regional employees)
- Signals and Communications (local and regional employees)

Local track employees inspect and undertake maintenance, whereas regional employees complete capital improvement programs (such as tie and rail replacement). Bridge inspection, maintenance and capital improvements are undertaken by regional bridges and structures employees. With respect to signals and communications maintenance, local employees inspect, test and maintain installations and regional employees execute major programs (such as new installations).

Local track employees within Halifax consist of two track foremen and three track maintainers, located in Rockingham and Dartmouth. Between them, they have two hi-rail trucks equipped with small booms and hydraulic tools. Their track supervisor covers from Halifax/Dartmouth to Colledge Bridge (near Memramcook), New Brunswick. He is assisted by two assistant track supervisors who assist the track supervisor in inspections.

Two signal maintainers based in Fairview perform weekly, monthly and yearly tests on equipment and perform maintenance as needed on signal and communication installations in Halifax. They report to a supervisor out of Moncton, New Brunswick.

It is possible that implementation of commuter rail services may require dedicated track for its own use and purpose, such as stabling tracks. In that event, a regular regimen of light maintenance would be required. As the workload would be very light (requiring few full-time staff), contracting to CN for this maintenance work is a possibility. In addition, a key component of estimating access fees is maintenance costs of shared infrastructure. For this reason, understanding CN's infrastructure maintenance staff and activities is relevant.

3.2 Existing Passenger Operations

3.2.1 Operations

In October, 2013, VIA Rail (VIA) reduced service frequency on its Ocean Limited between Montreal and Halifax from six times per week to three times per week. The Ocean departs Montreal and Halifax on Wednesdays, Fridays and Sundays. The schedule on the Bedford Subdivision is shown in Figure 3-4.

Figure 3-4: VIA Rail Ocean Service Schedule

Train	Days of Service	Station	Departure	Arrival
14	Mon, Thu, Sat	Truro	16:05	
		Halifax		17:35
15	Wed, Fri, Sun	Halifax	12:00	
		Truro		13:31

VIA owns and manages the station facilities in Halifax. It does not own other stations between Halifax and Enfield; nor are there any station stops.

3.2.2 Rolling Stock Equipment

VIA uses three Renaissance train-sets for its Ocean train service between Halifax and Montreal. Typically the locomotives are two GM F40PH locomotives, which all have been upgraded by CAD Railway Industries of Montreal to the F40PH-3 model. Cars consist of a mix of baggage cars, coach cars, a dining car, a service car and multiple sleeping cars.

3.2.3 Rolling Stock Maintenance

VIA has no maintenance shop. The last shop it owned was located on Marginal Road, close to its operations at Halifax. The building is currently used for purposes unrelated to rail.

Light maintenance work is completed in the exterior on its tie-up tracks at the station in Halifax. Most maintenance and servicing work is completed in Montreal.

3.2.4 Staffing

Excluding on-board service personnel, VIA has 24 train conductors and engineers in Halifax. In addition, there are 57 available on-board service personnel with a peak of 42 used in the busy seasons and a low of 27 in the slow seasons. VIA Rail is a potential option for the key activities of train operation and rolling stock maintenance.

Figure 3-5: VIA Rail Halifax Staff

Classification	Shift	Schedule	Total
Drivers	Train Schedule	S M W T F S	6
On board service personnel	Train Schedule 38 hrs per week	S M W T F S	42 Peak 27 Low, 30 Temps 57 Total Available
Electrician	Varies on train schedule	S M T W T F S	2
Mechanic	Varies on train schedule	S M T W T F S	2
General worker	Varies on train schedule and operation	S M T W T F S	5
Car mechanic	Varies on train schedule	S M T W T F S	2
Ticket agents	Inbound 1200-2000, Outbound 0730 – 1530	S M W T F S	3
General manager	0800-1700	M T W T F	1
Manager	Varies	S M T W T F S	3

3.3 Future for Rail Operations in Halifax

Rail freight traffic levels to and from Halifax have been essentially flat, at best, in recent years. We expect that trend will not change and may actually worsen in future years. VIA Rail's decision to reduce services to and from Halifax to thrice weekly in 2012 will likely not be reversed either (though extra trains have been added for the peak holiday season, and this may be repeated in future).

Rolling stock and infrastructure maintenance will likely not change significantly moving forward, as these are essentially the minimum-level necessary. CN has completed a long-term program of attrition in the past 10 years and is now hiring employees of most classifications. Staff levels are not to change significantly in the future. Without any significant growth potential, it is expected that the two railways' investment in infrastructure and systems will be minimal and essentially only that which permits the continuance of service at the current level of efficiency and safety.

It is possible that CN or VIA may have significant changes in plan for their operations in Halifax that could likely impact plans for commuter rail services. This could include "short-lining" – that is, selling a segment of the rail. However, this seems unlikely, as the recent trend has actually been of the reversing (re-acquiring "short-lined" subdivisions).

3.4 Capacity

3.4.1 Background

Krueger (1999)[9] defines rail line capacity – that is, the capacity between rail yards – as:

> *a measure of the ability to move a specific amount of traffic over a defined rail line with a given set of resources under a specific service plan.*

The key point in this definition is that capacity is not only a function of the physical infrastructure (i.e. the "defined rail line"), but also the level of service (i.e. the "service plan"). While a given rail line may theoretically be able to accommodate a certain number of trains, as the number of trains in the service plan increases, the level of service (e.g. travel times, reliability, etc.) will decrease. It is important to note that increased heterogeneity in train services offered (e.g. having both fast commuter trains and slow freight trains) also tends to degrade capacity.

[9] Krueger, H. 1999. Parametric Modelling in Rail Capacity Planning. Proceedings of the 1999 Winter Simulation Conference.

In the case of the proposed Halifax commuter rail service, the Bedford Subdivision has sufficient capacity to add trains to its existing line-up. This can be said with confidence as only a few years ago, more trains were in the schedule.

However, an issue in the case of the proposed commuter rail service is:

(1) Whether commuter trains could be operated at the desired level of service within the existing and future schedules of CN and VIA trains, and

(2) If not, what could be done to permit the efficient operation of trains without any (or minimal) impact to current operations?

We assess these questions by first reviewing general strategies to upgrade capacity (in Section 3.4.2). We then review available capacity on each relevant segment of track and outline potential capacity upgrades (in Section 3.4.3).

3.4.2 Infrastructure Changes to Increase Capacity

In general terms, there are three infrastructure changes that could be used to increase capacity for commuter rail service, including:

- Extension of centralized traffic control
- Double tracking (adding a second mainline)
- Installing passing sidings

The three initiatives could only be implemented by CN after discussion with users, such as the proposed Halifax Commuter Rail, as to how costs would be shared.

Centralized Traffic Control

Installation of a CTC system between mile 0 and 5.1 would greatly enhance safety (as broken rails and improperly thrown switches would be detected) and improve capacity of the line (on account of higher speeds and intermediate signals). CTC could potentially be installed at a low cost compared to a new system by relocating a controlled plant from a location that has had the siding removed and install it close to the VIA station in Halifax (which CN has previously done in the past).

Double Tracking

Double tracking increases track capacity by avoiding conflicts with trains heading in opposing direction and by allowing a train to overtake another. In the Figure 3-6, we present the possibility of double tracking (two main tracks) for each section.

Figure 3-6: Bedford-Elmsdale Subdivision Double Tracking Potential and Implications

Mile	Cost of double tracking	Reason/Explanation
0-1.8	High	This was single tracked some 20 years ago to permit double-stacked container trains, after the North Track had already been undercut.
1.8-4.3	High	
4.3-8.0	Low	Halifax Transfer Track could be converted to second main track without significant costs; though there would be operational impacts for local switchers at Rockingham.
8.0-15.6	High	The barriers to re-installing a second main track are: • The existing mainline track has been aligned to be at the centre of the double track roadbed at Rocky Lake • Erosion of roadbed where it forms shoreline of Bedford Basin (mile 6.7 -8.4) • Bridges have been modified for single track (miles 6.9, 10.7 and 11). • Crossing have been modified for single track (mile 10.32 and 15.09)
15.16-32.18	Very High	There has never been double track within this territory so installation would be a major endeavor.

From this, it seems that the introduction of double tracking would likely only be viable between mile 4.3 and 8.0. For the other sections, passing sidings would likely pose a better alternative.

Passing Sidings

Passing sidings increase capacity by resolving conflicts with trains heading in opposing direction and allow trains to overtake one another. However, unlike double track, the train that uses the siding must come to a stop and must wait for the opposing (or overtaking) train to pass.[10] Thus, though sidings are less costly than double track, they do not add as much capacity as double track.

To keep installation costs to a minimum, passing sidings should be located to avoid:

- Road crossings
- Bridges (both rail and road)
- Wash out locations (mile 6.7 and 8.4)

Although, this looks restrictive, there are many locations between Halifax and Windsor Junction that are suitable for short passing sidings. Should sidings be required west of Windsor Junction, the likely best locations are:

- Wellington (mile 23.2 to 23.6 approximately)
- Elmsdale (mile 31.6 to 32.1 approximately)

These were the locations of sidings in the past.

3.4.3 Capacity Analysis

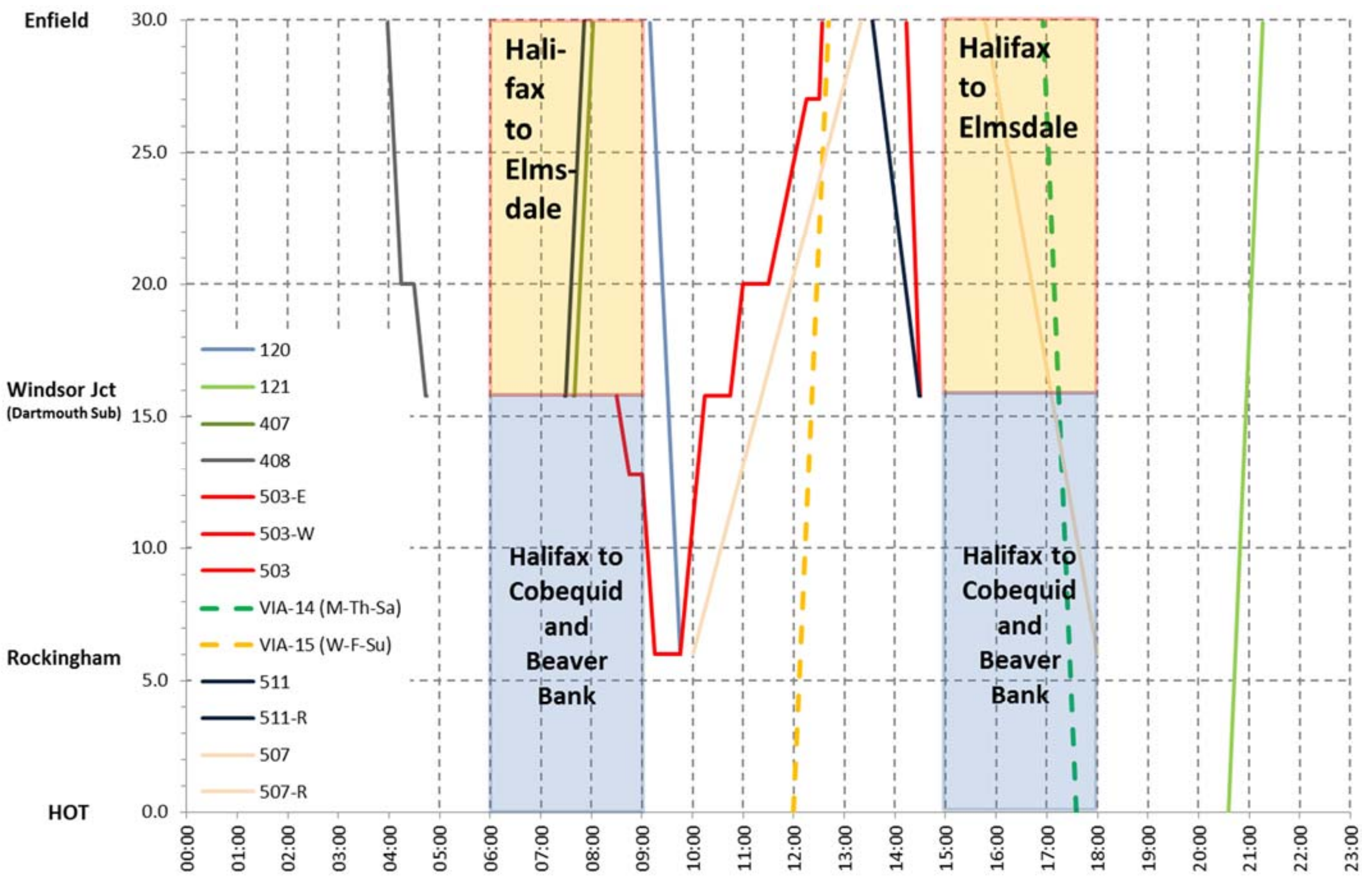
Figure 3-7 presents current freight and passenger services between Halifax and Elmsdale on the CN Bedford Subdivision, and overlays them with potential peak-period service blocks (0600-0900 and 1500-1800). There are currently no operations over the WHRC near Windsor Junction.

It is important to note that freight trains do not strictly follow the outlined schedule. In fact, deviations of several hours are not uncommon, especially in winter (when service disruptions are more frequent on account of weather).

The Bedford Subdivision's available capacity for commuter rail service decreases west of Windsor Junction, because of additional trains using the line west of the junction with the Dartmouth Subdivision (at Windsor Junction). The available capacity of each of the two sections is discussed separately.

[10] Dispatchers usually try to have two opposing trains arrive at the siding at nearly the same time (i.e. one just before the other), so that the duration that both trains are stopped is minimized. Ideally, meets would occur at sidings located at stations, where trains would have to stop regardless of the meet.

Figure 3-7 Existing Freight and Passenger Services (Bedford Subdivision)



Source: CPCS analysis of train operating schedules

Halifax to Windsor Junction

East of Windsor Junction, mainline trains are limited to a daily intermodal train in each direction (120/121), passenger trains thrice weekly in each direction and local switcher 507 daily (or as needed). In addition, there are transfers between Halifax and Rockingham on a daily basis.

Figure 3-8: Current Line-up of Trains Between Windsor Jct. and Halifax

Train	Location	Departure	Location	Arrival	Schedule (Days)	Length (ft.)
120	Windsor Jct.	0930	Rockingham	0945	S M T W T F S	11,000
121	Rockingham	2035	Windsor Jct.	2055	S M T W T F S	7,000-8,000
507	Rockingham	1000	Windsor Jct.	1030	S M T W T F S	500
507	Windsor Jct.	1730	Rockingham	1800	S M T W T F S	500
VIA 14	Windsor Jct.	1710	Halifax	1735	M, Th., Sa.	
VIA 15	Halifax	1200	Windsor Jct.	1225	W, F Su.	

Source: CPCS analysis of train operating schedules

Three trains currently operating during the peak commuter periods of 0600-0900 and 1500-1800: train 503, train 507 on its return from Milford; and VIA 14. Train 503 is a local switcher, which enters the Bedford Subdivision from the Dartmouth subdivision at the end of the morning peak to serve local traffic. Train 507 is a local switcher serving customers in Bedford and Milford, as well as transfer traffic to and from Kinsac for trains 407 and 408. As such, the schedules of trains 503 and 507 vary daily depending on traffic and typically there is some flexibility as to how and when the train is run.

VIA 14 arrives in Halifax during the afternoon peak; however, we note that prior to March 2015 it had been arriving after 1800. We anticipate there being some flexibility to work with VIA in scheduling its service around the peak-period; but regardless, on account of the quicker speed and generally higher predictability of passenger trains, the presence of VIA 14 is not a significant barrier to operating commuter service.

In Chapter 9, we discuss infrastructure needed for the safe and efficient operation of commuter trains during peak periods. This infrastructure would also permit safe and efficient operation outside of peak periods, as required, as service is less frequent and there are opportunities to set a schedule around current operations. In general, we anticipate that commuter rail service could be introduced with the addition of passing sidings and CTC in key areas.

Windsor Junction to Elmsdale

The current utilization of the line from Windsor Junction west to Truro is significantly higher than the segment from Windsor Junction east to Halifax. The segment east of Windsor Junction also includes a significant number of Dartmouth trains, many of which are scheduled in peak commuter periods.

Figure 3-9: Current Line-up of Trains Between Elmsdale and Windsor Junction

Train	Location	Departure	Location	Arrival	Schedule (Days)	Length (ft.)
120	Elmsdale	0900	Windsor Jct.	0930	S M T W T F S	11,000
121	Windsor Jct.	2055	Elmsdale	2125	S M T W T F S	7,000-8,000
507	Windsor Jct.	1030	Elmsdale	1100	S M T W T F S	500
507	Elmsdale	1700	Windsor Jct.	1730	S M T W T F S	500
VIA 14	Elmsdale	1649	Windsor Jct.	1710	M, Th., Sa.	500
VIA 15	Windsor Jct.	1225	Elmsdale	1245	W, F Su.	500
407	Windsor Jct.	0739	Elmsdale	0830	S M T W T F S	3,000-6,000
408	Elmsdale	0415	Windsor Jct.	0444	S M T W T F S	4000
511	Windsor Jct.	0710	Elmsdale	0800	M T W T F	3,000-4,000
511	Elmsdale	1305	Windsor Jct	1500	M T W T F	3,000-4,000

Source: CPCS analysis of train operating schedules

Within the peak hours of 0600 to 0900, trains 407 and 511 operate; and within the peak hours of 1500 to 1800, trains 507 and VIA 14 operate. The line-up of trains 407 and 511 poses a significant challenge to the introduction of commuter services. It is not expected that CN would significantly re-schedule these trains to accommodate commuter service (except perhaps the gypsum train 511, though this could only be done in conjunction with National Gypsum). To add complexity, train 407 often picks up traffic at Kinsac, which ties up both the mainline and siding. No flexibility in the schedule of train 120 can be expected from CN, which arrives shortly after the morning peak. Train 120 is a long intermodal train that would need to be scheduled around. The scheduling of Train 120 would also likely constrain any changes to the schedules of Train 407 and 511.

Though the section of track from Windsor Junction to Elmsdale is controlled with centralized train control (CTC) with intermediate signals, which permit follow-up movements, significant infrastructure changes would be needed to permit the safe and efficient operation of commuter trains throughout the entire peak period.

Overall, we do not anticipate that it would be viable to operate full peak-period services to Elmsdale, because doing so would almost certainly require the addition of a second main track. Given that a roadbed does not exist in this area for a second track, constructing a second track would be cost prohibitive. However, it may be possible to extend some train services from Cobequid to Elmsdale during times that do not conflict with existing freight traffic. The feasibility of doing so would require further discussion with CN regarding their operations.

Windsor Junction to Beaver Bank

Currently, there are no trains operating over the WHRC from Beaver Bank eastward. Should traffic resume, we do not anticipate any capacity constraints.

4 Station Locations

Key Message

Because the purpose of this study is to assess the feasibility of a commuter rail system – not make specific planning decisions – we have used several considerations to develop a list of 11 potential station locations. These stations would serve the following areas and communities:

1. VIA
2. South End
3. West End
4. Rockingham
5. Mill Cove
6. Sunnyside
7. Bedford Common
8. Cobequid
9. Wellington
10. Elmsdale
11. Beaver Bank

The potential station in Beaver Bank would only be used for train services continuing along the WHRC.

4.1 Possible Station Locations

The team used several siting considerations in assessing the suitability of a potential station. Though in some areas, a station site may be fairly obvious, in other areas, there may be several potential sites that could be considered. Because the purpose of this study is to assess the feasibility of a commuter rail system – not make specific planning decisions – we have only used these considerations to assess which communities could be served by a commuter rail station, and not to select specific sites.

Typical commuter rail station platforms similar (or the same) as what would be used in Halifax are shown below. Figure 4-1 shows the existing Halifax VIA Station and Figure 4-2 shows a typical GO Transit commuter rail platform in Toronto. Stations would be complemented with additional facilities such as park and rides, bus transit terminals, etc. as described in more detail in Chapter 9.

Figure 4-1: Existing Halifax VIA Station Platforms

Source: Rob Leblanc

Figure 4-2: Typical Commuter Rail Low Platform

Source: CPCS

The siting considerations depend on whether the station is adjacent to a 'destination' (e.g. near downtown or a university) or a 'source' (e.g. a rural park-and-ride facility). For the urban destination stations, station siting considerations include:

1) Proximity to existing connecting Halifax Transit bus stops/terminals
2) Proximity to key destination (downtown, universities, major commercial centres)
3) Availability of land to accommodate a bus terminal and staging area
4) Grade separation from the station to the surrounding area (much of the urban station locations sit in the deep Halifax rail cut, requiring elevator services)
5) Potential surrounding land use impacts (additional noise, safety, pedestrian traffic impacts, changes to street traffic congestion, etc.)

6) Accessibility by active transportation modes (e.g. existing or planned sidewalks and bike lanes)

7) Future intensification opportunities within the catchment area of the station.

This last point is particularly relevant when introducing a new commuter rail system. In many other cities with commuter rail, cities have used rail stops to intensify areas or create transit-oriented developments (TODs). These areas tend to have greater development potential, higher density zoning and mixed uses. This can translate into value capture opportunities that could help fund the commuter or transit rail project in question. For these reasons, potential station locations can significantly influence land values and create spin-off impacts to surrounding uses.

For the 'source' stations (rural, suburban), station siting criteria include:

1) Availability of land to accommodate station platform <u>and</u> park-and-ride facilities

2) Population within the catchment area of the station

3) Proximity to suburban growth centres

4) Accessibility and distance from arterial and highway networks

5) Potential surrounding land use impacts (additional noise, safety, pedestrian traffic impacts, changes to street traffic congestion, etc.)

6) Proximity to existing Halifax Transit feeder lines

7) Grade separation from the rail platform to the proposed bus terminal and park-and-ride facilities

8) Impacts to adjacent environmentally sensitive areas.

9) Accessibility by active transportation modes (e.g. existing or planned sidewalks and bike lanes)

10) Future intensification opportunities within the catchment area of the station.

Between the urban destinations and rural source stations, there are suburban stations that are both source and destination locations and share some of the same considerations between the urban and rural stations. In these locations, the proximity to existing Halifax Transit feeder services becomes more important and availability to park-and-ride facilities becomes less important.

In addition to the siting criteria discussed above, the sites were assessed in terms of the network efficiency. Having a station stop every 1 km impacts the speed, transit times and efficiency of the commuter rail operation. Commuter rail stations are typically located at a distance from two to three km in urban areas to 3 km or more in rural communities. Selecting the number of stops is a trade-off between providing more stations, increasing the number of users within walking distance, and providing fewer stations, thereby providing faster service to the remaining stations and attracting additional ridership at the remaining stations.

4.2 List of Stations Considered in Further Analysis

We have studied 11 potential station locations[11] as shown in Figure 4-3. These stations would serve the following areas and communities:

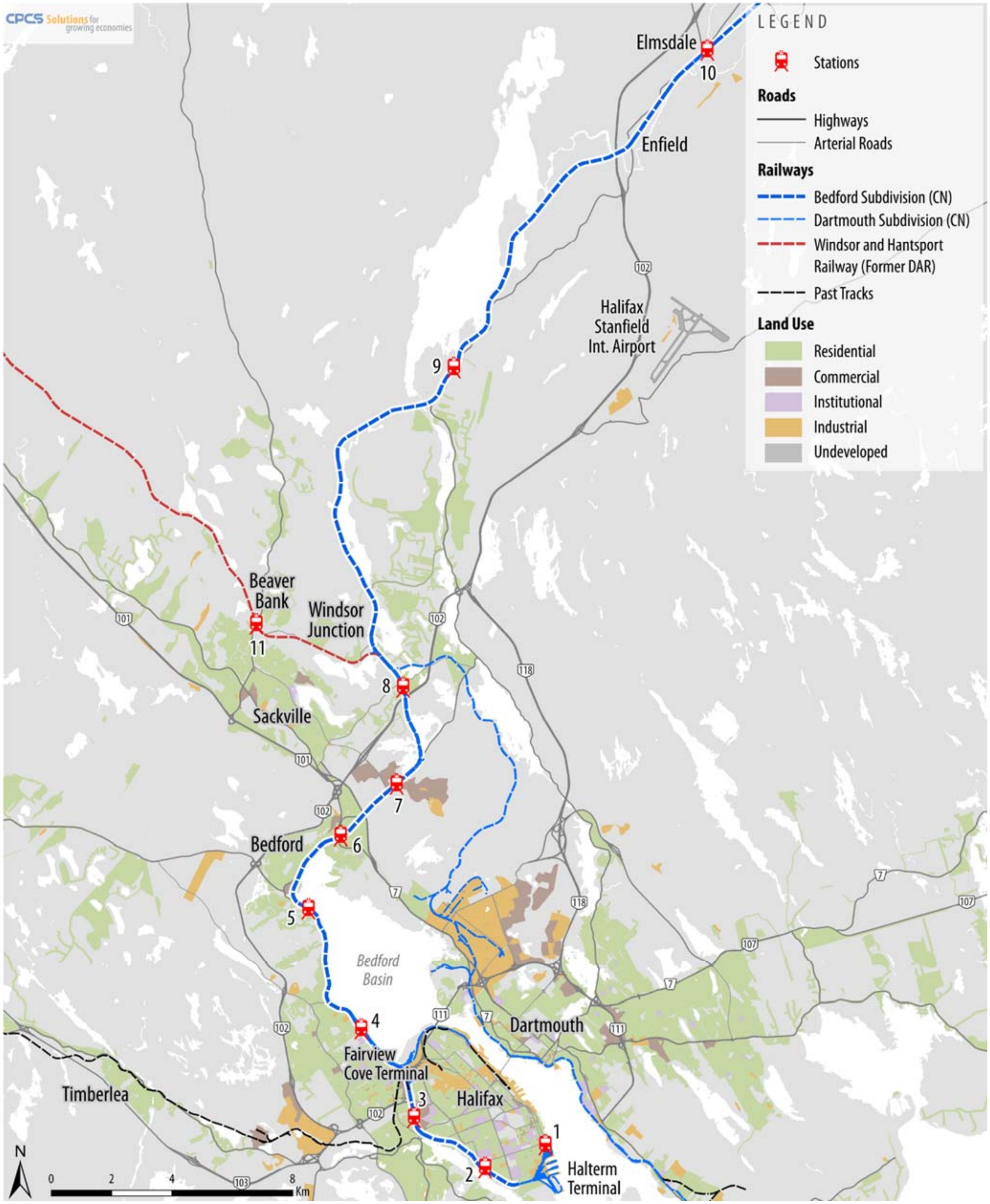
1. VIA
2. South End
3. West End
4. Rockingham
5. Mill Cove
6. Sunnyside
7. Bedford Common
8. Cobequid
9. Wellington
10. Elmsdale
11. Beaver Bank

Of note, Cobequid Station is just to the east of Windsor Junction and as such has been considered the terminus, i.e. the last station on the line, in one of the traffic forecast concepts. Elmsdale Station could be another potential terminus should service continue beyond Windsor Junction. However, as discussed in Section 3.4, commuter rail traffic continuing beyond Windsor Junction on the Bedford Subdivision would be in greater conflict with freight traffic originating in Dartmouth.

The potential station in Beaver Bank would be the terminus should commuter rail service continue along the WHRC. This service would *not* interfere with traffic to/from the CN Dartmouth Subdivision.

[11] Analysis of potential commuter rail service along the WHRC was included in the study after the initial station location analysis was completed. As a result, a potential station at Beaver Bank Road was not included in the original strengths and weaknesses analysis described in **Error! Reference source not found.**.

Figure 4-3: Station Locations Under Study



5 Regulatory, Commercial and Legal Considerations

Key Messages

This chapter provides an overview of relevant regulations and commercial and legal considerations salient to a potential commuter rail service in Halifax.

There are no regulatory impediments that would outright preclude commuter rail operations in Halifax, though existing safety regulations would need to be accounted for during the design, construction and operation of the system. Of note, in the immediate term, rolling stock used for the proposed Halifax commuter rail service would have to meet existing Transport Canada and United States Federal Railroad Administration regulations.

There are also regulations that can assist in setting up the commuter rail system. Because CN is a federally regulated railway, track access charges for CN-owned track are subject to provisions in the *Canada Transportation Act*. As a last resort, these provisions could be applied if the proposed Halifax commuter rail service authority would be unable to agree with CN on suitable track access charges.

5.1 Regulations

Outlined in the following sub-sections are the regulations that would be most salient in considering the feasibility of a commuter rail system in Halifax.

Regulations specific to rolling stock are discussed more extensively in Chapter 7.

5.1.1 Regulations Governing Rail Operations

Train operations in Canada are governed by the *Canadian Rail Operating Rules* (Transport Canada TC O-0167, updated December 26, 2013).[12] Rules specifically governing passenger trains that may be of relevance to providing commuter rail in Halifax are provided in the figure 5.1. As noted in Chapter 2, there are sections of track along the Bedford Subdivision governed by Rule 105. In designing stations, Rule 107 would need to be considered, i.e. passengers should not need to cross active tracks to entrain and detrain the vehicles.

Figure 5-1: Canadian Rail Operating Rules Relevant to Passenger Trains

Rule	Excerpt
105	Unless otherwise provided by signal indication, a movement using non-main track must operate at REDUCED speed and be prepared to stop short of the end of track or the red signal prescribed by Rule 40.1….. (b) Unless otherwise provided by signal indication or special instructions, movements operating on non-main tracks must not exceed fifteen (15) MPH. (c) In addition to moving at REDUCED speed, a movement using a non-signalled siding or using other non-main tracks so designated in special instructions, must operate at a speed that will allow it to stop within one-half the range of vision of a track unit.
107	Unless otherwise directed by special instructions, a movement must operate with extreme care when passing alongside a train carrying passengers that is discharging or receiving traffic. It must not pass between such train and the station or platform, unless the movement is properly protected. Passengers shall be allowed to entrain and detrain only after positive protection has been provided against movements approaching on any main track they must cross when moving between the station and the train.

5.1.2 Regulation on Railway Signal and Traffic Control Systems

Railway signal and traffic control systems in Canada are governed by the *Railway Signal and Traffic Control Systems Standards* (Transport Canada TC E-07.01). The standards are intended

[12] One definition of a train is an ". . . engine which is intended to operate at speeds greater than 15 [miles per hour] . . . with cars in passenger service."

to ensure that railway signal and traffic control systems are installed, modified and maintained in a safe manner. The standards require signal and traffic control systems to be installed and modified in accordance with the American Railway Engineering and Maintenance of Way Association Communications and Signals Manual of Recommended Practice (AREMA Communications & Signal Manual).

Unlike in the United States, there are no current requirements to implement positive-train control (PTC) technology on freight railway infrastructure in Canada. PTC technology can automatically stop a train that has exceeded its movement authority (e.g. failing to stop at a stop signal or travelling too fast). Implementation of this technology is mandated in the United States under the Rail Safety Improvement Act of 2008 for lines carrying significant passenger or hazardous material traffic. The Transportation Safety Board of Canada (TSB) has reviewed the benefits of PTC and found that it has the potential to significantly reduce the risk of collision between trains (TSB reports R07E0129, R08W0058, R09W0118 and R09V0230).[13] These investigations involved various types of collisions (head-on, side or tail-end) between freight trains. However, this requirement has not been mandated.

In July 2008, a non-main track collision occurred between VIA 14 and CN 121.[14] There were no passengers on-board as the VIA train was being turned. The VIA train was moving westward exiting the Halterm loop track before returning to the station. There were seven maintenance employees and two crew members on board. Simultaneously, CN 121 operating eastward with two crew members was reversing towards Halifax Ocean Terminals. At Mile 1.3 of the CN Bedford Subdivision, in an area where sightlines were restricted due to the curvature of the track and a rock cut, the two movements collided at low speed. As a result of the collision, there was substantial damage to the two locomotives and the first six cars of the VIA train. There was minimal track damage and there were no serious injuries. The cause was found to be the CN train was not operating at a speed to permit stopping within one-half the range of vision. Contributing factors included (1) the collision occurred in an area of restricted sightlines and (2) there was no communication between the two trains and neither expected to encounter the other. Additionally, neither train was advised of the presence of the other.

5.1.3 Regulations Governing Passenger Equipment on Freight Lines

The federal *Railway Safety Act* directly (or by way of reference in Nova Scotia's *Railways Act* if the eventual operator is provincially regulated) governs the equipment (rolling stock) design used for the proposed Halifax commuter rail service.

There are rules under these acts that govern equipment design. Of note are the *Railway Locomotive Inspection and Safety Rules* (TC O-112, as revised December 22, 2014) and the *Railway Passenger Car Inspection and Safety Rules* (TC O-26, as approved November 8, 2001). These documents reference AAR (Association of American Railroads) and APTA (American Public Transportation Association) standards, which reference FRA (United States Federal

---

[13] TSB Railway Investigation Report R10Q0011

[14] TSB Railway Investigation Report R08M0063

Railroad Administration) regulations under 49 CFR 238. In essence, Transport Canada rules are largely in harmony with those in the United States, so any rolling stock used for Halifax commuter rail service must be "FRA-compliant."[15] (In fact, Metrolinx recently procured rolling stock for its Union-Pearson Express airport commuter service using similar specifications as the Sonoma-Marin Area Rail Transit [SMART] commuter service near San Francisco.[16])

Currently, achieving FRA-compliance generally precludes using foreign-designed (International Union of Railways [UIC] standard) rolling stock. One of the key FRA requirements under 49 CFR 238 is that cars be designed to resist a minimum static end-compression load of 800,000 lb-force (3,560 kilonewtons), higher than most European standards.

However, design standards are currently changing in the US. The FRA is in the process of preparing a Notice of Proposed Rulemaking, which could codify alternative design criteria that may allow for the use of foreign-designed equipment incorporating crash-energy management (CEM) approaches. It is unclear if and when such regulations will be put into place.

In the interim, some agencies have been successful at requesting a waiver from the FRA to use foreign-designed equipment incorporating CEM design approaches on lightly used tracks. The Denton County Transportation Authority, a transit authority in Texas, has recently received a waiver from the FRA to use non FRA-compliant diesel multiple units (DMUs) from Staedler in mixed operation.[17] DMUs and electric multiple units (EMUs) are passenger cars that have an integral propulsion system; as a result, separate locomotives are not required to pull (or push) them.

Alternatively, Caltrain, a commuter rail authority in the San Francisco-Bay Area, has received a waiver from the FRA to use European-designed (EMUs).[18] The basis for this waiver was that Caltrain installs PTC to ensure non FRA-compliant and FRA-compliant rolling stock remain separated.

The closest example of this waiver process being applied in Canada is the Ottawa O-Train commuter rail service, which uses non FRA-compliant Bombardier DMUs. This service, however, operates under complete temporal separation from freight service using FRA-

---

[15] This term was also used in Hatch Mott MacDonald and IBI Group. 2010. Metrolinx Peterborough Rail Study: Final Report. February.

[16] See e.g. http://www.railwaygazette.com/news/passenger/single-view/view/toronto-airport-rail-link-dmu-delivered.html.

[17] Wilcox, K. 2012. Commuter Rail Lightens Up. ASCE *Civil Engineering*. Available at: http://www.asce.org/CEMagazine/Article.aspx?id=25769811158#.VCsekfldXX4

[18] Cruickshank, R. 2010. Caltrain Gets Its FRA Waiver. California High Speed Rail Blog. Available at : http://www.cahsrblog.com/2010/05/caltrain-gets-its-fra-waiver/

compliant equipment (i.e. the two services operate during separate blocks of time during the day).[19] Such an approach is likely not practical on the CN Bedford Subdivision.

In summary, in the immediate term, rolling stock used for the proposed Halifax commuter rail service must be FRA-compliant.

5.1.4 Regulations Governing Access to Freight Lines of CN/CP for Passenger Operation

In Canada, track access charges are negotiated with the host railway, which in this case, is CN. This negotiation should be done on a commercial basis, in a confidential contract between Halifax and CN.

Because CN is a federally regulated railway, track access charges for CN-owned track are subject to provisions in the *Canada Transportation Act*. These provisions could be applied if the proposed Halifax commuter rail service authority would be unable to agree with CN on suitable track access charges.

Under the *Canada Transportation Act*, a public passenger service provider[20] may, "after reasonable efforts to resolve the matter have been made," apply to the Canadian Transportation Agency (CTA) under Section 152.1(1) of the *Canada Transportation Act* for the CTA to rule on the amount that Halifax Transit would pay for the use of the railway company's facilities. Between 2009 and 2013, VIA Rail pursued three cases with the CTA under this section, none of which has involved CN as the other party.[21]

In determining the amount that the public passenger service provider would pay, the CTA considers (under Section 152.2(2)):

> *(a) the variable costs incurred by the railway company as a result of the public passenger service provider's use of the railway company's railway, land, equipment, facilities or services, including, but not limited to, its variable costs incurred to maintain safe operations and to avoid congestion and undue delay;*
>
> *(b) the railway company's cost of capital, based on a rate set by the Agency, applied to the net book value of the assets to be used by the public passenger service provider, less any amount to be paid by the public passenger service provider in respect of those assets;*

---

[19] See discussion in the House of Common's Standing Committee on Transport, Infrastructure, and Communities October 16, 2012 hearing on innovation the transportation industry. http://www.parl.gc.ca/HousePublications/Publication.aspx?Language=E&Mode=1&DocId=5755861

[20] Under Section 87, a "public passenger service provider" is defined as "VIA Rail Canada Inc., a passenger rail service provider designated by the Minister or an urban transit authority." Under the same section, an "urban transit authority" is defined as "an entity owned or controlled by the federal government or a provincial, municipal or district government that provides commuter services."

[21] Refer to CTA Decision No. 195-R-2013, Decision No. 333-R-2009 and Decision No. 118-R-2011, and a discussion of the process available here: https://services.otc-cta.gc.ca/eng/disputes-about-public-passenger-service-providers%E2%80%99-use-railway-lines-and-other-assets.

(c) the cost of any improvements made by the railway company in relation to the public passenger service provider's use of the railway company's railway, land, equipment, facilities or services;

(d) a reasonable contribution towards the railway company's constant costs; and

(e) the value of any benefits that would accrue to the railway company from any investment made by the public passenger service provider.

Because the Windsor & Hantsport Railway is provincially regulated, track access charges are not regulated by the CTA.

5.1.5 Provincial Regulation

The WHRC is a provincially regulated railway under the Nova Scotia *Railways Act*. In order to re-connect the line to the CN Bedford Subdivision and operate passenger traffic, the WHRC would need to apply to Nova Scotia Utility and Review Board for an amendment to their license, pursuant to the *Railway Notification and Licence Regulations*.[22]

5.2 Legal Considerations

The operator of the proposed commuter rail services would require sufficient third-party liability insurance to satisfy the provisions of either the *Canada Transportation Act* (if the operator is federally regulated) or the Nova Scotia *Railways Act* (if the operator is provincially regulated).

Whether the operator is federally or provincially regulated will depend on whether it operates in multiple provinces or solely in Nova Scotia.

If the proposed operator is federally regulated, it would need to receive a certificate of fitness from the CTA (*Canada Transportation Act* Section 92), a condition of which is adequate third party liability insurance.

Under the provisions of the *Railway Third Party Liability Insurance Coverage Regulations*, the CTA determines the adequacy of the insurance by:

(a) examin[ing] the risks associated with the proposed construction or operation of the railway by considering information that is provided by the applicant, including (i) passenger ridership, (ii) passenger and freight train miles, (iii) volume of railway traffic, (iv) class and volume of dangerous goods transported by rail, (v) types of population areas served, (vi) number of level crossings, (vii) speed of trains, (viii) train crew training, (ix) method of train control, and (x) overall safety record of the applicant; (Section 4)

[22] http://www.novascotia.ca/just/regulations/regs/railnoli.htm

Following a similar rationale, if CN were to operate the service, it would need to notify the CTA and adjust its insurance coverage as necessary.

If the operator were provincially regulated, it would need to obtain insurance as a condition of licensure under Section 17(1)(b) of the *Railways Act*. Under the *Railway Notification and Licence Regulations* this insurance coverage must provide for:

> *(c) third party liability, which shall provide a minimum total coverage of $15,000,000 and, without restricting the generality of the foregoing, include coverage of the following persons or topics: (i) bodily injury to or death of passengers, members of the public or the applicant's employees, (ii) evacuation expenses, (iii) fire suppression expenses, and (iv) pollution clean-up expense.* (Section 7(1))

The host railway, CN, could potentially require more coverage than the minimum specified by either set of regulations, increasing the cost of insurance requirements for the proposed commuter service. Currently in Canada, unlike in the United States, there is not a legislated cap on the liability of passenger train operators from an accident. In the United States, liability from a single accident is capped at $200 million for accidents involving the passenger rail operator Amtrak.[23] Initially, CN has indicated that it would require $100 million of insurance coverage, covering damage to CN infrastructure in the event of an incident on commuter rail.

[23] See comments by CP and the Association of American Railroads to the CTA during consultations regarding third-party liability insurance requirements. Currently, the CTA is consulting with stakeholders regarding the third-party liability coverage provisions, largely in response to the growth of crude oil by rail transport and the accident at Lac-Mégantic in 2013. https://www.otc-cta.gc.ca/eng/publication/consultation-review-railway-third-party-liability-insurance-coverage-regulations-what-we

6 Travel Demand Analysis

Key Messages

- In 2031, we forecast total ridership would range from a low of 1,588 weekday boardings to 4,287 daily boardings.
- All concepts have similar forecasted traffic levels at the low demand level, which is reasonable given that park and rides are not provided at suburban stations. In the medium scenario, the Beaver Bank concept would have the highest forecasted ridership, which suggests that the presence of the park and ride near Lower Sackville would be able to drive significant traffic onto the commuter rail system.

This chapter describes the approach used to forecast ridership for the proposed commuter rail system, and provides the estimates used in the subsequent operations, cost, financial and economic models.

6.1 Travel Demand Forecasting Approach

We used the Halifax Travel Demand Model to estimate commuter rail ridership. Because of the unique characteristics of the commuter rail system relative to existing transit in Halifax, we made several changes to the model inputs and adjusted the raw model outputs, as described in Section 6.3 and Appendix C. For example, we adjusted the model outputs in line with the fare structure indicated in Section 6.3.3 and elaborated on in Chapter 11.

We validated and adjusted the model outputs in line with professional judgment and observations from similar existing services. To ensure appropriate ridership estimates at the individual stations, we adjusted the forecasted ridership based on research into the observations of number of trips per capita from similar existing rail systems. Additionally, based on local knowledge and professional judgment we made several specific changes to the final forecasted demand figures between stations, as discussed in Appendix D. The Halifax Travel Demand Model was only one tool used, albeit an important one, in forecasting demand.

In order to begin optimizing the proposed system and consider the uncertainty associated with forecasting ridership, we developed nine demand scenarios, as presented in Section 6.4. The forecasted ridership for all of these scenarios is presented in Section 6.6. For context and comparison purposes, Sections 6.2 and 6.4 present the existing travel demand and existing transit service serving the same catchment area, respectively. Finally, in Section 6.7, we discuss overall mode shift trends.

6.1.1 Halifax Travel Demand Model Overview

We used the existing regional travel demand model maintained by Halifax, referred to as the Halifax Travel Demand Model, to develop raw estimates of travel demand.[24] This model brings together socioeconomic information on the region's residents and estimates the demand for transportation in a regional context. The model is calibrated against observed data to ensure its processes are valid and can be used in the forecasting of future demand based on changes in population, employment and transportation infrastructure. The model represents the PM peak hour transportation activity for the years 2013 and 2031.

The Halifax Travel Demand Model operates on a four-step modelling process, as follows:

- Trip Generation – The total number of trips generated and attracted to individual areas (zones) in the model is calculated

[24] The Halifax Travel Demand Model uses the VISUM software

- Trip Distribution – The generated trips are distributed throughout the model based on the attractiveness of the zones around them and the distance or travel time between the zones
- Mode Choice – Travellers in the model examine the options for travelling between their origin and destination (i.e., car, bus, bike, walk) and make a choice based on their perceived cost (e.g., value of time, travel time, distance, tolls, fare)
- Assignment – The travellers are assigned along the specific roads, rail, and bus lines from their origin to their destination. The final route chosen by the travellers is reactive to congestion along the way

The Halifax Travel Demand Model determines the share for the various competing travel modes by replicating the decision process taken by travellers. For each travel mode, the various cost elements related to each mode are combined into a perceived cost that allows the traveller to decide the mode that best suits their needs. This behaviour is calibrated against actual observations such that the behaviour and decisions shown by travellers in the model replicate those of real life residents.

This approach to modelling the behaviour and decision process allows these models to test changes to population, employment, amenities and transportation infrastructure and assess how the residents would adapt to the new conditions. For example, rather than testing what would happen if transit ridership doubles, the model allows us to determine what would need to happen to achieve a doubling of transit ridership, based on the real world observed behaviour.

As the Halifax model represents the PM peak hour, traveller behaviour has been calibrated to represent that portion of the day. This means that the typical travel patterns show a general movement of transportation demand outward from the employment and education centres such as Downtown Halifax, Downtown Dartmouth, the various universities and the Burnside and Bayers Lake Industrial parks. The PM peak hour also tends to be messier than its AM peak hour counterpart, as many other activities are ongoing during the PM such as shopping, sports and other non-commuting activities. The AM peak hour, for its part, tends to be focused on commuting activities to employment and education centres.

6.2 Travel Demand

6.2.1 Existing

The Halifax Travel Demand Model was reviewed to determine the likely catchment areas for potential stop locations along the proposed rail corridor. The Halifax Model, based in VISUM, models traffic flows during the PM peak hour (approximately 5:00 PM to 6:00 PM). Figure 6-1 provides the 2013 PM peak hour total person-trips for all existing modes between the areas where the commuter rail stations are proposed, based on a catchment defined by a 15-minute walk or transit trip.

Figure 6-1: Existing PM Peak Hour Travel Demand Between Stations (total person trips)

Station	VIA	South End	West End	Rockingham	Mill Cove	Sunnyside	Bedford Common	Cobequid	Wellington	Elmsdale	Beaver Bank	Total
VIA	-	2,250	3,003	1,676	777	167	145	115	52	409	707	**9,301**
South End	3,520	-	1,086	676	215	52	51	74	20	154	194	**6,042**
West End	1,390	756	-	1,095	369	66	33	75	22	106	255	**4,167**
Rockingham	291	169	757	-	321	44	14	37	5	41	163	**1,842**
Mill Cove	30	9	52	89	-	37	16	24	1	4	33	**295**
Sunnyside	27	5	47	103	362	-	267	181	36	56	544	**1,628**
Bedford Common	3	0	6	10	49	121	-	71	15	16	204	**495**
Cobequid	0	0	0	0	0	0	0	-	0	0	0	**0**
Wellington	0	0	0	0	0	0	0	0	-	0	0	**0**
Elmsdale	0	0	0	0	0	0	0	0	0	-	0	**0**
Beaver Bank	81	22	97	70	119	475	341	450	6	56	-	**1,717**
Total	**5,342**	**3,211**	**5,048**	**3,719**	**2,212**	**962**	**867**	**1,027**	**157**	**842**	**2,100**	**25,487**

Source: CPCS analysis

As the Halifax Travel Demand Model represents the PM peak hour, it is logical that Figure 6-1 shows largely an outbound distribution of trips from the downtown core near the VIA Station in Halifax's south end. Outbound trips estimated by the model are approximately 16,500, as opposed to 9,000 inbound trips – a ratio of close to 2:1 outbound to inbound. The trips produced also follow a logical progression indicative of the locations of densest employment and population in the downtown core, which lessens as distance increases from the core and development generally becomes less dense.

Zones in the rural areas (Cobequid, Wellington and Elmsdale) do not produce any trips during the PM peak hour, as there is not a significant population or employment base within a reasonable walking distance nor any transit service in the area of the proposed stations. However, these zones attract commuters returning from the employment centres to the south to these largely residential areas. As such, the lack of walking and transit access is indicative that some sort of park and ride access to these stations would likely be necessary.[25]

The above review of the existing travel demands and patterns shows that the Halifax Travel Demand Model produces logical results that are in line with the current settlement patterns, employment areas and movement of residents during the PM peak hour. This review suggested that the tool was valid for application for this exercise and demonstrated that special attention would likely be required in less densely populated areas with respect to access and forecasted ridership produced by the model.

6.2.2 Future Year (2031)

As discussed above in Section 6.1.1, the Halifax Travel Demand model also provides forecasts of future travel demand levels through projection of the population and employment totals expected in 2031. These socioeconomic variables are pushed through the models processes using the calibrated travel behaviour to estimate the demand for transportation infrastructure in 2031.

Figure 6-2 shows the 2031 PM peak hour total person-trips for all existing modes between the areas where the commuter rail stations are proposed, based on a catchment defined by a 15 minute walk or transit trip.

[25] In traffic modelling jargon, the residential area is typically the trip production zone and employment centre is the trip attraction zone. However, the nomenclature used in the body of the report aligns with the direction of travel during the AM peak. For ease of understanding, we have referred to the employment centre as the trip production area for the PM peak.

Figure 6-2: 2031 PM Peak Hour Travel Demand Between Stations (total person trips)

Station	VIA	South End	West End	Rockingham	Mill Cove	Sunnyside	Bedford Common	Cobequid	Wellington	Elmsdale	Beaver Bank	Total
VIA	-	2,160	3,275	1,794	1,193	132	155	129	74	405	438	**9,755**
South End	3,530	-	1,164	768	319	43	54	83	20	152	158	**6,291**
West End	1,261	738	-	1,072	479	48	27	73	22	107	226	**4,054**
Rockingham	312	181	859	-	455	38	13	36	5	42	151	**2,093**
Mill Cove	38	12	52	134	-	60	32	14	2	4	41	**389**
Sunnyside	20	3	37	106	550	-	331	197	37	55	497	**1,834**
Bedford Common	3	0	5	13	103	118	-	100	30	18	224	**614**
Cobequid	0	0	0	0	0	0	0	-	0	0	0	**0**
Wellington	0	0	0	0	0	0	0	0	-	0	0	**0**
Elmsdale	0	0	0	0	0	0	0	0	0	-	0	**0**
Beaver Bank	59	16	53	37	142	510	307	668	4	57	-	**1,853**
Total	**5,223**	**3,111**	**5,446**	**3,925**	**3,241**	**950**	**918**	**1,300**	**195**	**840**	**1,735**	**26,883**

Source: CPCS analysis

It can be seen from the table that the overall travel pattern remains largely similar in the future year with the employment and education centres being largely the same. There is an overall increase in activity of approximately 5% between the selected catchment areas. Growth in the table is shown to be concentrated in the areas of West End Halifax, Rockingham, Mill Cove, and Cobequid. The catchment area around Mill Cove sees the largest growth in trips attracted during the PM peak hour with an increase of approximately 1,000 trips. This result is logical, as the surrounding catchment area is slated as the target of development in the coming years.

It should be noted that the trips that remain within each of the catchment areas (i.e., trips from the South End to the South End) are not reported in this table for clarity of reporting the potential demand for rail service. Trips that are short enough to remain internal to the 15-minute catchment area will not use the transit service. These are indicated by the dashes ("-") along the diagonal of the table. With this in mind, some elements of growth in the urban areas are underreported in Figures 6-1 and 6-2 as they are not pertinent to the discussion of rail.

6.3 Model Inputs and Adjustments

We have adjusted a number of model inputs to factor in the implementation of commuter rail, which is a new travel mode. This section identifies the various assumptions that went into the development of travel demand forecasts for the model. Appendix C provides significant additional detail on model assumptions.

6.3.1 Mode Choice

The choice of mode in the model is based on the procedures developed by Halifax. As previously discussed, the model calculates the travel costs (i.e. time and money) associated with each mode of travel from each trip origin to destination. Based on these travel costs, a probability of trips taking one mode over another is derived, and the appropriate number of trips is then allocated to a specific mode of travel.

We understand that the base calibration of the model includes a factor that favours rail (and ferry) trips, by discouraging bus trips during the traffic assignment stage of the modelling process. This adjustment is in line with expectations that, assuming rail and bus service were to have similar service qualities that are explicitly modelled (i.e. travel time, cost and frequency), more riders would prefer rail due to its perceived higher reliability, comfort or other factors that are not easily modelled. This phenomenon is readily observed in many existing transit systems. We did not assess or adjust this specific calibration in the model, but the inclusion of the factor would lead to more optimistic forecasts for rail as compared to a conservative assumption with no modal bias. Overall, we anticipate that the forecast scenarios (low, medium, high) provide a reasonable estimate of the range of potential ridership.

6.3.2 Population and Employment Growth

Forecast population and employment growth in the 2031 horizon year travel demand model were based on the 2014 Halifax Regional Plan (RP+5) figures and applied by Halifax in its model.

While these official population and figures were used in the development of the rail corridor ridership forecasts, without adjustment, they do not explicitly consider potential intensification and/or growth over and above the RP+5 figures. For example, the area around the proposed Mill Cove Station has the potential for higher density, transit-oriented developments (TODs). However, this additional growth is not currently represented in the model, as the developments are currently not approved. Therefore, forecasted commuter rail transit ridership in the Mill Cove area is likely underestimated.

6.3.3 Passenger Fare

The fare for the commuter rail service was assumed to be a zonal fare structure as discussed in Chapter 11. Because the outputs of the Halifax Travel Demand Model are based on the average existing fare in Halifax ($1.64), the model outputs were adjusted to account for the zonal fare structure described in Chapter 11. The methodology for doing so is discussed in Appendix G.

6.3.4 Conversion to Peak Period, Mid-Day Trips

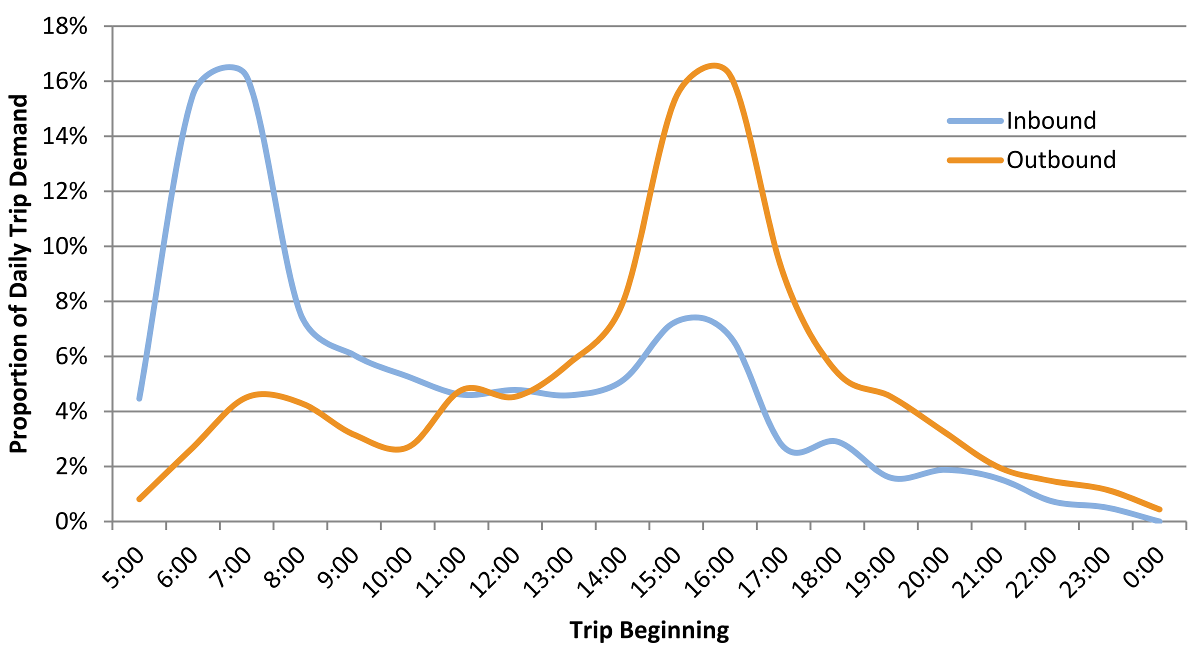
The regional transportation model, from which the ridership forecasts for the proposed commuter rail service are drawn, is calibrated to the PM peak hour. In order to efficiently design the service levels of the proposed commuter rail line during other periods (AM peak, midday, evening), an estimate of demand throughout the day was calculated based on ridership information provided by two transit operators. The hourly profile was developed using the following two sources:

- Existing Halifax Transit ridership on routes that duplicate part of the proposed commuter rail corridor – *1/3 weighting*
- Existing GO Transit (Greater Toronto Area commuter rail system) ridership – *2/3 weighting*

Halifax Transit Hourly Variation

Ridership figures, broken down by trip, were provided by Halifax Transit. Boardings and alightings were compiled for the six routes (80, 81, 82, 84, 86 and 90) deemed to most closely represent the commuter rail corridor. The hourly demand characteristics show peaks of approximately 16% of daily usage would occur during each of the peak hours, in the peak direction (Figure 6-3). In other words, approximately 16% of the total daily inbound demand would occur during the AM peak hour, while approximately 16% of the total daily outbound demand would occur during the PM peak hour. There is a moderate amount of counter-flow travel during the peak hours and relatively steady demand during the two peak hours. Demand in the evening falls noticeably after 8:00 pm, especially in the inbound direction.

Figure 6-3: Halifax Transit Hourly Demand Variation



Source: CPCS Team analysis of Halifax Transit data

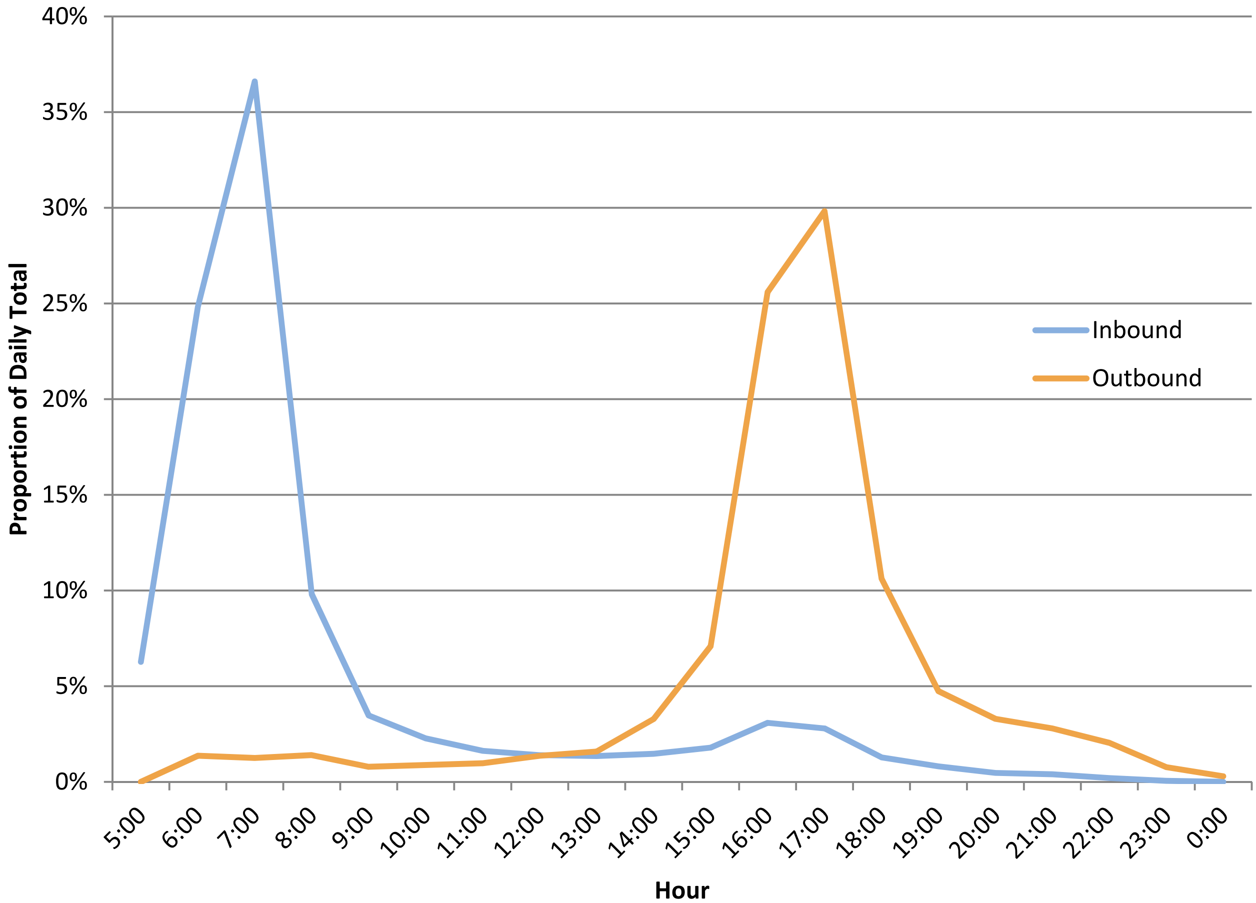
GO Transit Hourly Variation

GO Transit is the operator of commuter rail services in the Greater Golden Horseshoe Area of Ontario. It operates seven rail lines, of which five offer peak-hour/peak-direction service only, with the other two offering all-day, two-way and weekend service. Although the market it serves is larger and denser than Halifax, its commuter rail operations could act as an approximate predictor of demand characteristics for the proposed commuter rail service in Halifax.

Although GO Transit operates seven commuter rail lines, only the Lakeshore East and West lines were analyzed to determine the hourly demand variations, as they are the only lines that provide all-day two-way service. The hourly demand characteristics on the two lines show peaks of up to 37% of daily usage would occur during the peak hours (Figure 6-4). Approximately 78% of the total daily inbound demand would occur during the AM peak period (four hours), with 37% of the daily total concentrated within the peak hour. Approximately 73% of the total daily outbound demand would occur during the PM peak period (four hours), with 30% of the daily total concentrated within the peak hour.

The ridership figures provided by GO Transit show a much higher concentration of demand occurring during the peak periods. Due to the higher fares (as compared with conventional transit), the increased frequency provided during peak hours, and the relative lack of non-employment trip attractors, the commuter-based nature of the rail service would see more intense peaks in demand than traditional Halifax Transit service.

Figure 6-4: GO Transit Hourly Demand Variation



Source: CPCS Team analysis of GO Transit data

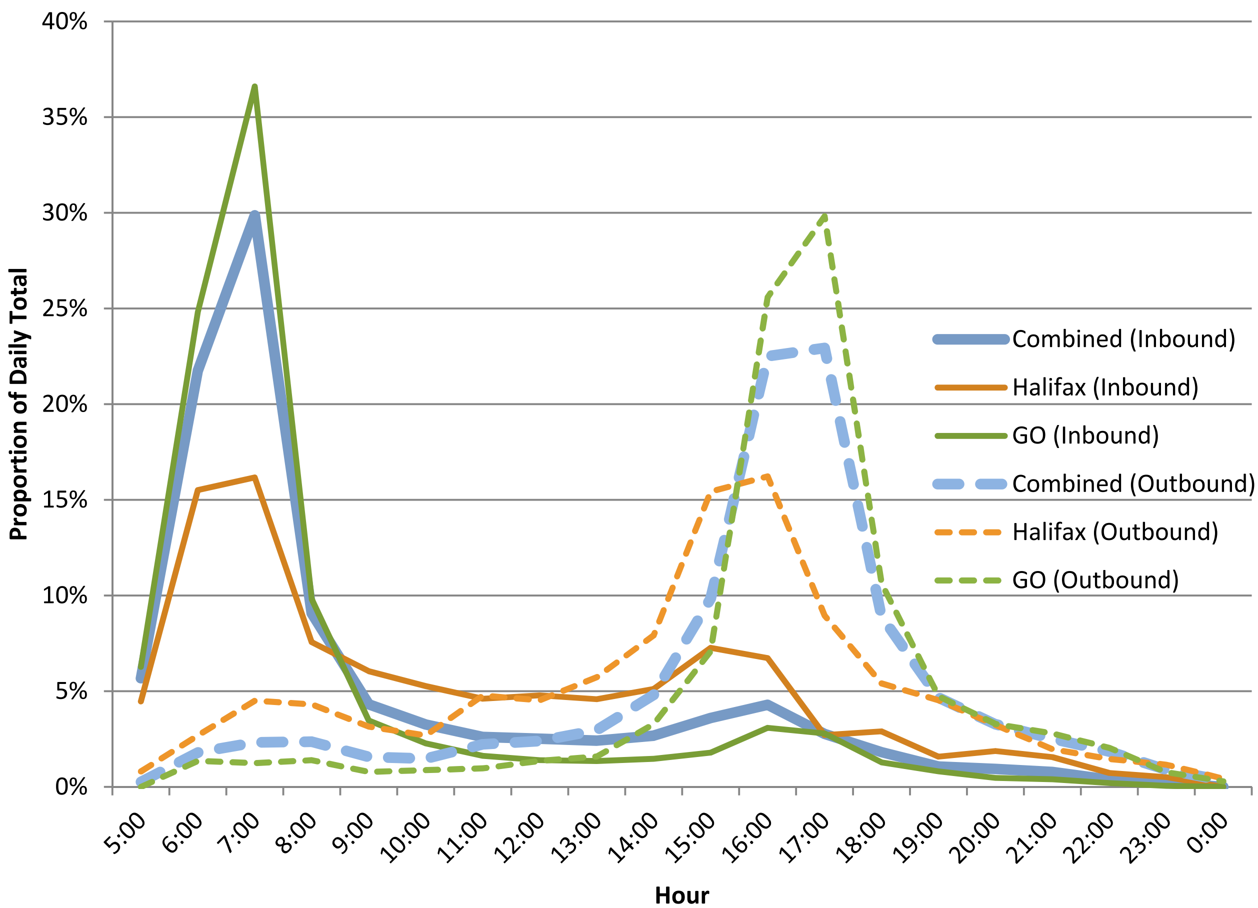
Combined Hourly Variation

In order to provide an accurate estimate of demand throughout the day, a weighted average of the Halifax Transit and GO Transit figures was calculated. Using either source in exclusivity would not be representative for two reasons:

- Halifax Transit data better represents local conditions; however, bus ridership includes more discretionary trip making that is not always representative of commuter rail ridership (which represents more nine-to-five workers).
- GO Transit data represents a service similar to the one being proposed; however, it occurs in a market with a much larger employment base and higher levels of highway congestion.

To represent potential daily rail ridership in Halifax, the hourly loading profiles for the proposed commuter rail service were calculated using a one-third weighting for the Halifax Transit data and a two-thirds weighting for the GO Transit data. This is presented in Figure 6-5 below.

Figure 6-5: Combined Weekday Hourly Demand Variation



Source: CPCS Team analysis of GO Transit data

PM Peak to Travel Period Conversion Methodology

The conversion of model results from PM peak hour to the various travel periods (AM peak, PM peak and mid-day) required calculation of factors based on the combined hourly variation, as described above. This conversion was based on the multiplication of the peak hour results based on the percentage that the PM peak hour makes up of the overall daily travel, as shown in Figure 6-6. The daily values are then transferred to represent the periods of interest by application of these same percentages.

As shown in Figure 6-6, the ridership for the PM peak hour model run would be approximately 23% of the daily ridership for outbound riders, and approximately 3% for inbound riders. Comparatively, the AM peak hour would be approximately 30% of the overall daily ridership in the inbound direction and approximately 2.5% of outbound riders. These percentages are used in the conversion of the PM peak hour ridership to a daily value.

As many of the origin/destination pairs in the model's output for the non-peak direction (i.e., inbound to downtown) are zero, it is not possible to directly expand the PM inbound results to a daily value using factors. This would not fairly represent the inbound traffic during the AM period. It was therefore necessary to assume that the AM ridership would be the inverse of the PM (i.e., the same riders that the model shows travelling home by rail would have also used rail to travel to work in the morning). This assumption is modified with an additional factor to account for the sharper peak of the AM (30% versus 23% of daily ridership), which results in a factor of 1.30 for AM ridership versus PM.

Based on the above, therefore, the daily ridership was estimated in two parts:

- The daily outbound volume was estimated by factoring up the PM Model output from 23% of daily outbound volume to 100% of daily outbound volume.
- The daily inbound volume was estimated by reversing the outbound volume and multiplying by a factor of 1.30 to create the AM peak hour inbound volume. This was then converted to daily volume by factoring the AM peak hour values from 30% to 100% of daily outbound volume.

The combination of these two parts forms the overall daily rail ridership. Conversion of the daily values to the individual periods was then accomplished by reducing the inbound and outbound portions of the ridership according to the appropriate combination of hours and percentages for each as shown in Figure 6-6.

Figure 6-6: Ridership Conversion Factors

From Period:	To Period	Direction	From Period: % of Daily	To Period: % of Daily	Factor
PM Peak Hour	AM Peak Hour	N/A	23.0%	30.0%	1.304
Daily	AM Peak Period (6-9 AM)	Inbound	100.0%	60.7%	0.607
		Outbound	100.0%	6.5%	0.065
Daily	PM Peak Period (4-6 PM)	Inbound	100.0%	10.7%	0.107
		Outbound	100.0%	55.3%	0.553
Daily	Midday Period (12-2 PM)	Inbound	100.0%	4.9%	0.049
		Outbound	100.0%	5.4%	0.054

Source: Dillon Analysis

6.4 Existing Halifax Transit Service

Halifax Transit provides public transit services in the Halifax metro area and offers the following types of services:

- Conventional local bus

- Urban express bus
- MetroX rural express bus
- MetroLink BRT-lite express bus
- Community transit bus
- Access-A-Bus paratransit bus service
- Ferry routes

Service in the proposed commuter rail corridor consists of a mix of conventional local buses and urban express bus routes, as detailed in the following section.

6.4.1 Routes

There are numerous existing routes that serve areas of the proposed commuter rail corridor. Some routes are local in nature, while others provide faster express service from further suburban and rural communities direct to downtown Halifax. In addition to new ridership induced by the convenience and perceived prestige of rail service, a portion of the commuter rail ridership would be comprised of existing (bus) transit users. Further, to attract new users to transit, it is important that the bus routes operating within the corridor and offering connections to the proposed rail corridor be optimized to best leverage the new service. Figure 6-7 provides an overview of each bus route currently operating parallel to the portions of the commuter rail corridor. In total, existing Halifax Transit routes shared by the potential commuter rail corridor have 11,082 daily weekday boardings.

Figure 6-7: Existing Bus Route Characteristics

Route	Name	From	To	Via	Weekday Service Hours	Headway (peak/off-peak)	Daily Weekday Boardings
80	Sackville	Sackville	Downtown	Bedford	6 AM – 12 AM	15 mins 30 mins	4,571
81	Hemlock Ravine	Larry Uteck		Bayers Road	6 AM – 8 PM	30 mins	1,424
82	Millwood	Sackville		Cobequid, Bedford	5:30 AM – 7:30 PM		1,109
84	Glendale Express	Sackville		Cobequid, Dartmouth	AM / PM Peak only	15 mins	1,110
85	Downsview Express	Sackville			AM/PM Peak Only	Two trips per peak only	155
86	Basinview Express	Rockmanor		Bedford	AM / PM Peak only	Two trips per peak only	145
90	Larry Uteck	Larry Uteck		Windsor Street	6 AM – 12 AM	30 mins 60 mins	1,050
185	Sackville Link	Sackville		Burnside	6 AM – 10 PM	10 mins 60 mins	1,346
400	Beaver Bank	Beaver Bank Village	Sackville Terminal	Highway 354	5 AM – 8:30 PM	~ 60 min *(no service midday)*	172
						Total Daily Boardings	11,082

Source: CPCS Summary of 2014/2015 Halifax Transit information

6.4.2 Service Level Comparison

In order to better understand the potential for migration from existing Halifax Transit services to commuter rail, Figure 6-8 compares travel times and frequency of existing Halifax Transit bus services with commuter rail.

For each of the commuter rail stations, a representative origin point depicting the approximate “centroid” of the catchment area was chosen for a comparison of bus and rail travel times. The outer stations, whose catchment areas are currently not served by transit, had their bus travel times calculated assuming a passenger would drive from the “centroid” origin point to the nearest park-and-ride terminal (Cobequid or Sackville Terminal), and take the bus to Scotia Square from that location. For the train travel time, it was assumed that a passenger would drive from the “centroid” origin point to the commuter rail station and take the train to the downtown VIA station, followed by a 16-minute transfer to Downtown Halifax (Scotia Square).

Stations located on corridors well-served by transit (up to and including Sunnyside) were used as the origin points for both bus and train journeys. Regardless of a passenger’s origin within the station catchment area, it was assumed that they would make their way to the commuter rail station or bus stop, both of which are located in close proximity. Because that travel time is the same regardless of mode chosen, it was not considered in the comparison.

By calculating the travel time between an origin point representing a station's catchment area centroid and Downtown Halifax rather than selecting a bus terminal or train station, the above table portrays an accurate and unbiased comparison between bus and train travel times.

Travel time and headway have a significant impact on choice of mode and are factored into the estimation of overall demand. The Halifax Travel Demand Model takes into account the actual timetable and running speeds for transit services, which allows the model to account for the scheduling realities related to transfers and related delays. In the model, travellers experience the entirety of the transit trip from station access, to waiting for the transit vehicle, to transfer waiting times, to completion of the journey after leaving the transit vehicle.

Buses tend to offer more direct service from origin to destination. For example, the major employment area in downtown Halifax is located in close proximity to the existing Scotia Square bus terminal, while the VIA Rail Station is located approximately one km (16-minute walk according to Google Maps) from the major employment area. This travel time is taken into account in the demand-forecasting model and in the travel times shown in Figure 6-8. (We also consider the possibility of a shuttle service between the VIA Station and downtown Halifax, as discussed in Section 6.5.

Figure 6-8: Comparison of Existing Bus Route Characteristics with Commuter Rail

Origin Station	Origin Point	Distance to VIA Station (miles)	Halifax Transit Route Number*	Total Bus Travel Time** (min)	Total Train Travel Time*** (min)	Bus Headway* (min)	Train Headway (min)
Elmsdale	Hwy. 2 at Elmsdale Rd.	32.1	Drive + 84	70	73	15	30****
Wellington	Hwy. 2 at Sunnylea Rd.	23.4	Drive + 84	60	60	15	
Beaver Bank	Beaver Bank Rd. at Glendale Dr.	18.6	Drive + 185	42	67	10	
Cobequid	Hwy. 2 at Fall River Rd.	15.0	Drive + 84	55	62	15	
Bedford Common	Cobequid Rd. at Glendale Dr.	12.7	Drive + 84	48	52	15	
Sunnyside	Bedford Hwy. at Dartmouth Rd.	10.6	80	40	37	30	
Mill Cove	Bedford Hwy. at Southgate Dr.	9.0		30	34	30	
Rockingham	Bedford Hwy. at Flamingo Dr.	6.0		25	28	30	
West End	Mumford Rd. at Romans Ave.	3.8	2 or 4	20	23	15 *(combined)*	
South End	Inglis St. at Bellevue Ave.	2.6	14	30	23	15 *(combined)*	

Note: *Where there are multiple Halifax Transit routes, the route with the fastest travel time and most frequency headway is noted. **Total bus travel time allows for travel time by car/walk from origin point to bus terminal or nearest bus stop ***Total train travel time allows for travel time by car/walk from origin point to train station and 16 minutes for a walking transfer from the VIA Station to downtown Halifax. ****Depending on the specific operating concept considered, the train headway is approximately 30 minutes plus or minus four minutes.

6.5 Scenario Development

We developed nine forecast scenarios to help to assess the most viable commuter rail service options. The scenarios were developed in terms of the three different operating concepts (service to Elmsdale, Cobequid and Beaver Bank) and three different levels of demand (low, medium and high). All of the traffic estimates are based on the service design outlined in Chapter 8 consisting of weekday peak-period service with one additional mid-day trip.

6.5.1 Rail Corridor Length

Elmsdale Station to VIA Station

This concept includes 10 stations on a 32-mile rail corridor. Total end-to-end travel time would be 57 minutes. For the purposes of this initial screening, a headway of 34 minutes was assumed using four trains during the AM and PM peak periods. As discussed in Section 3.4.3 – Capacity Analysis – full peak-period service to Elmsdale would **not be feasible** due to the increase in existing in existing freight traffic west of Windsor Junction, though it may be possible to extend some trains serving Cobequid as far as Elmsdale Station. However, in order to provide some indication of the traffic potential, we have reported estimated ridership figures using the same service design as the other concepts.

Cobequid to VIA Station

This concept is 15 miles in length and serves eight stations. Total end-to-end travel time in this concept would be 31 minutes. For the purposes of this initial screening, a 27-minute headway was assumed using three trainsets during the AM and PM peak periods.

Beaver Bank to VIA Station

This concept includes a station at Beaver Bank Road in addition to the eight in the Cobequid concept. The rail corridor is 18.60 miles in length and serves nine stations. Total end-to-end travel time in this scenario would be 41 minutes. For the purposes of this initial screening, a 31-minute headway was assumed using three trainsets during the AM and PM peak periods.

6.5.2 Demand Levels

Low Demand

This scenario assumes minimal additional costs to supporting capital infrastructure and operating costs for connecting Halifax Transit services. The following assumptions are included:

- Minimal changes to connecting Halifax Transit routes – stops for pass-by and adjacent routes only
- No Park-and-Ride stations assumed

The Low Demand Scenario represents the bare minimum level of infrastructure investment required to begin operating the rail service. It assumes that apart from station platforms, little additional infrastructure would be provided. Furthermore, the existing Halifax Transit bus routes would be only minimally modified for added connectivity between rail and bus, but not necessarily for the purposes of encouraging additional rail ridership. There would be little opportunity for current automobile drivers to switch modes, due to the lack of parking at stations. Additionally, existing transit users would not be not incentivized to switch to rail due to the lack of coordinated transfers, and the retention of competing direct bus routes.

Medium Demand

This scenario assumes increased investment in park and ride lots and some shuttle services to provide improved connectivity between the urban rail stations and major activity nodes. The following assumptions are included:

- Introduction of park and ride lots at the following stations:
  - Beaver Bank (Beaver Bank concept only)
  - Mill Cove (all concepts)
  - Cobequid (all concepts)
  - Bedford Common (all concepts)
- Introduction of a direct shuttle service between:
  - VIA Station and downtown Halifax (timed to meet the commuter rail service) and
  - South End Station and Dalhousie and St. Mary's universities (timed to meet the commuter rail service)

The park and ride lots would enhance connectivity to stations that are not well connected to Halifax Transit services and increase the catchment area for commuters to each station. These were placed in areas that the study team deemed feasible to accommodate a park and ride lot. The transit shuttles would improve connectivity to two major destinations along the corridor. Halifax's Central Business District is located approximately one km north of the VIA Station (10-minute walk). The shuttle was coded into the model to reduce overall end to end trip time. A second shuttle was assumed to connect the South End Station with the St. Mary's University and Dalhousie University campuses. Both campuses are also a seven- to 10-minute walk from the South End Station.

High Demand

The High Demand Scenario includes the infrastructure and service improvements present in the Medium Demand Scenario and implements several additional measures to increase ridership along the proposed commuter rail line. In essence, in the High Scenario, we are assessing whether these measures, which result in higher overall capital and operating costs, improve the viability of the commuter rail service through higher ridership and increased utilization of the infrastructure and rolling stock. In addition to changes made from the Medium Demand Scenario, the assumptions applied to the High Demand Scenario were the following:

- All infrastructure in place from Medium Demand Scenario (including park and rides, where applicable)
- Four new transit shuttle services, connecting various neighbourhoods to Cobequid Station (no shuttles were provided to Beaver Bank Station)
- The modification of existing transit routes, through routing, frequency and connection changes[26]
- Elimination or modification of competing Halifax Transit express routes and other park and ride areas

The two largest impacts to ridership on the High Demand Scenario were driven by elimination of bus services between the Sackville park and ride lot to downtown and the Fall River park and ride lot to downtown. These changes would result in an increase in the number of passengers driving or taking transit to the Bedford Common Station, Cobequid Station and Wellington Station.

Neighbourhoods in the proximity of stations that are currently underserved, or not served at all, by existing transit services would now be served by the introduction of community shuttle routes. These routes should be fully coordinated with train arrivals and departures, and allow for an increased catchment area for potential rail passengers who do not rely on an automobile to access the nearest station.

Additionally, the route structure and schedule of some of the existing bus routes have been modified in this scenario. Changes include better connections at commuter rail stations, frequency changes and route extensions. The goal of these changes is to funnel longer-distance downtown-bound passengers away from the buses and to the proposed commuter rail service.

Some existing bus routes have been truncated or eliminated entirely, because they serve the same destinations as the proposed commuter rail service. Their elimination encourages existing bus passengers and auto drivers accessing the Sackville and Fall River park-and-ride lots to use the parallel train service instead, and would offset some of the capital and operating costs of providing commuter rail service.

6.6 Forecast Demand

6.6.1 Total Ridership

In 2031, we forecast total ridership would range from a low of 1,588 weekday boardings to 4,287 daily boardings (Figure 6-9). All concepts have similar forecasted traffic levels at the low

[26] Shuttle service additions and bus route modifications studied are discussed in Appendix E.

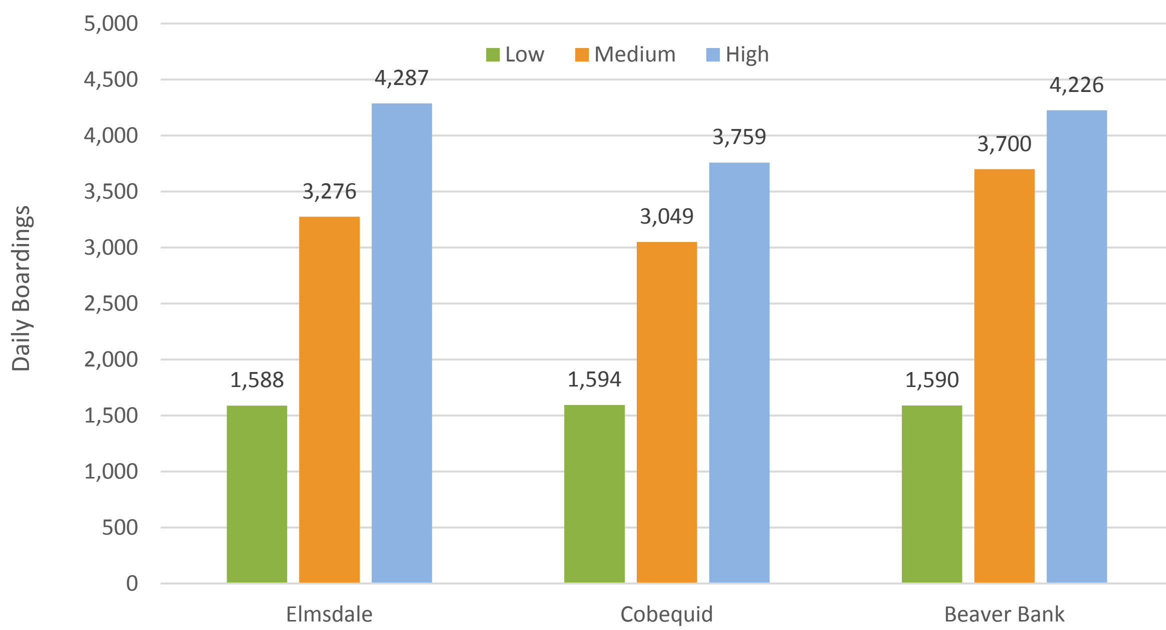
demand level, which is reasonable given that park and rides are not provided at suburban stations. In the medium scenario, the Beaver Bank concept has the highest forecasted ridership, which suggests that the presence of the park and ride near Lower Sackville would be able to drive significant traffic onto the commuter rail system.

The desire to make a connection from Lower Sackville to downtown correlates well with observations of the existing MetroLink service, which currently provides quality, dependable service and sees consistently high ridership. In reality, these two parallel services would draw from a largely similar pool of potential riders and use of either service would be dependent on the reliability and convenience of each.

These traffic forecasts are based on the service design outlined in Chapter 8 consisting of weekday peak-period service with one additional midday trip, and account for a zonal fare structure discussed in Chapter 11. Traffic is forecast to grow at an annual rate of 1.06% from the entry into service of the rail line in 2018 through the forecast period, based on the forecasted growth in the total number of trips in Halifax from 2013 to 2031.

Appendix D provides significant additional detail on traffic forecasts.

Figure 6-9: Weekday Daily Boardings by Scenario, 2031



Note: These figures have already been adjusted to account for the zonal fare structure proposed in Chapter 11.

6.6.2 Traffic by Station

Travel patterns in all three concepts are similar with respect to major origin and destination stations (Figure 6-10, Figure 6-11 and Figure 6-12). By terminating service at Cobequid, instead of Beaver Bank or Elmsdale, the overall commuter rail trips would decrease slightly somewhat. However, travel patterns between stations would remain consistent.

As anticipated, there is a general trend of person trips between urban stations on the Halifax peninsula and more suburban stations in and around the north of Bedford Basin. In the AM peak this travel is predominantly from the suburban areas to downtown and vice-versa in the PM peak. There are few suburban-to-suburban trips, defined as Rockingham Station outbound on the rail line.

The major urban station would be the VIA Station, which is the predominant destination in the AM peak for commuters working in the city centre. Making up the second largest destination would be South End, which primarily services the downtown universities in the area. In the Medium and High Demand Scenarios, downtown and university shuttle services, timed with commuter rail arrival, would provide a convenient way for commuters to efficiently reach their destination.

In the all medium and high scenarios, major suburban, AM peak origin stations would be the Bedford Common and Cobequid Stations around the Bedford area, which is the primary intended market for commuter rail trips (e.g. Figure 6-10). With the additional station at Beaver Bank (Figure 6-11), some traffic would be drawn away from these two stations; however, the Beaver Bank station also draws new traffic.

When comparing accessibility to transit and availability of park and ride lots between the Low, Medium and High Demand Scenarios, it is apparent that providing park and ride facilities would be significant in enticing a mode shift to commuter rail. When these travel amenities are not provided in the traffic modelling, such as in the Low Demand Scenario, ridership would drop off significantly.

Note that a final review of ridership forecasts indicate that the distribution of trips produced by the VIA, South End, and West End stations would likely rebalance away from the VIA station with a commensurate increase at the South End and West End stations because of the inherent mode bias in the model discussed in Section 6.3.1. The overall number of trips would not change significantly and the size of the park-and-ride facilities, which are not located at these stations, would be unaffected.

Figure 6-10: Traffic by Station, Cobequid Scenarios

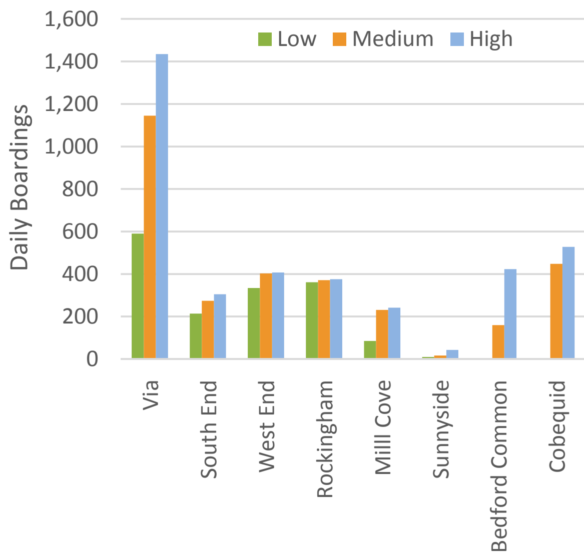


Figure 6-11: Traffic by Station, Beaver Bank Scenarios

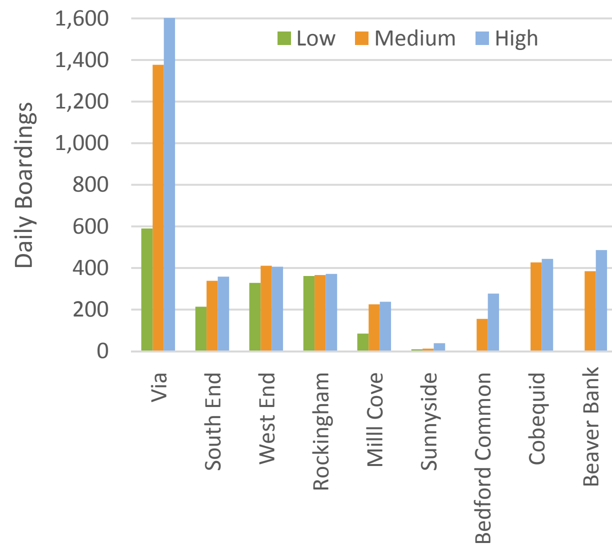
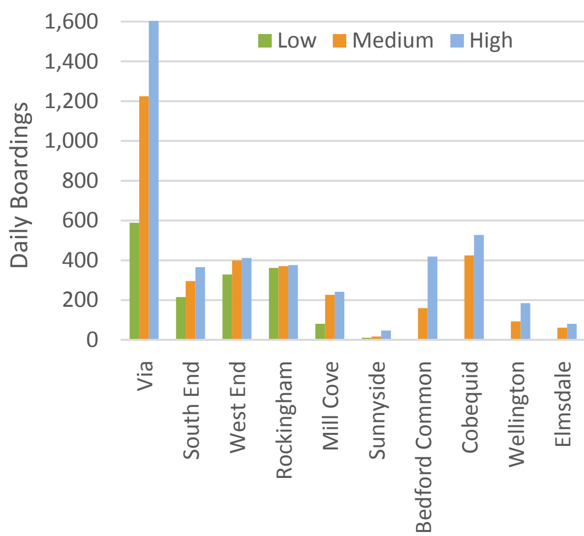


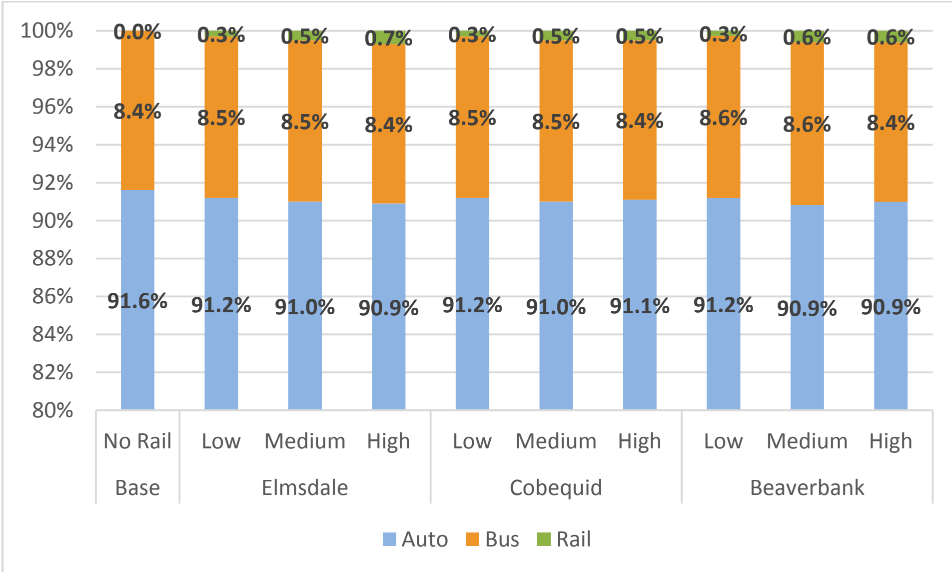
Figure 6-12: Traffic by Station, Elmsdale Scenarios



6.7 Modal Shift Trends

We compared future year transit use without rail service and the various service alternatives to examine the impacts on existing bus service. In total, there would be approximately 139,000 trips in Halifax across all modes. Overall, as shown in Figure 6-13, the percentage of rail users versus overall travellers would be under 1%, which would result in minimal change in overall mode share. When and if rail service is introduced, bus ridership remains approximately constant at an average of 8.5% (depending on the scenario), whereas auto share declines. In this case, it is likely that the destinations served by the rail line would be most convenient for travellers not yet using transit through the provision of park and ride lots.

Figure 6-13: Modal Split



The impacts to bus ridership would certainly be more focused on individual routes serving common destinations to the rail service. Longer distance services, such as MetroLink, would be in competition with the rail service. These MetroLink bus services have high service frequencies and comparable travel times, though with potentially lower reliability. Given the high frequency of these routes, the frequency would need to be reviewed in light of changing demands should commuter rail service be implemented.[27]

[27] The MetroLink fares should also be reviewed in line with the discussion in Chapter 11.

7 Rolling Stock Alternatives

Key Messages

- We consider six different rolling stock alternatives, including include new and rebuilt equipment, locomotive-hauled and diesel multiple unit (DMU) sets, and equipment that is and is not compliant with Canadian and US regulations.
- Given the relatively low traffic and higher frequencies anticipated, we anticipate that Budd Rail Diesel Cars (RDCs) would be the most promising rolling stock alternative, and this alternative is used in our analysis.

In this chapter, we outline rolling stock alternatives for the proposed Halifax commuter rail line. First, in Section 7.1 we identify rolling stock alternatives considered for the proposed Halifax commuter rail system and select an alternative for further study. We undertook this analysis in parallel with the development of the traffic forecasts. Second, we discuss some of the advantages and disadvantages of these alternatives. Third, in Section 7.3.1, we discuss some areas requiring further investigation with the selected alternative.

7.1 Alternatives Identified

We identified rolling stock used by commuter rail systems in Canada and the United States, and by some regional operators in Europe, in order to develop possible rolling stock alternatives for a proposed commuter rail system in Halifax. Broadly, the alternatives can be classified along the following three dimensions:

- **New and Rebuilt Equipment:** We identified alternatives considering both newly manufactured equipment and rebuilt used equipment.
- **Type of Locomotion:** We identified diesel-hauled locomotive consists (a set of cars) as well as diesel-multiple unit alternatives. Diesel-hauled locomotive consists would have a cab car at the opposite end of the train as the locomotives so that it can be pulled or pushed by the locomotive. Diesel multiple units (DMUs) are coaches with integrated diesel engines and control cabs.
- **Compliance with Canadian and US Regulations:** We identified some alternatives that are compliant with United States Federal Railroad Administration (FRA) and Transport Canada regulations, as well as European-designed alternatives that are not currently compliant with these regulations. The latter are low-floor DMUs, which could be provided level boarding with lower platforms than high-floor (FRA-compliant DMUs).

Based on this review, we have identified the following six typical alternatives for consideration.

7.1.1 Alternative 1: Push-Pull Locomotive-Hauled Consist (New)

A new locomotive-hauled push-pull train set with a Motive Power MP36/40-series locomotive (or similar) and Bombardier Bi-Level cars

This is an industry standard configuration used by many commuter railways in Canada and the United States. A three-car set could transport about 420 people (seated) and would cost around $18 million.

Figure 7-1: Example of Alternative 1

Source: www.blogto.com

7.1.2 Alternative 2: Push-Pull Locomotive-Hauled Consist (Rebuilt)

A refurbished locomotive-hauled push-pull set with EMD F59 series locomotives and refurbished single-level cars

Montreal's AMT recently retired 80 Hawker-Siddeley (ex-GO Transit) cars that have not been accounted for, and the Maryland Transit Authority may be retiring its fleet of single-level Nippon Sharyo cars soon. It is difficult to get precise costing data for such an alternative at this stage of analysis, though we would allow $7 million per train, assuming suitable used cars and locomotives could be found. This cost would cover refurbishment and some mechanical rebuilding of the equipment.

Figure 7-2: Example of Alternative 2

Source: Photoblair.ca

7.1.3 Alternative 3: FRA-compliant High-Floor DMU (New)

An FRA-compliant new high-floor[28] DMU such the Nippon Sharyo DMU (or a US Railcar DMU)

We will consider the Nippon Sharyo DMU as the basis for this discussion, as it has recently been procured for several US and Canadian commuter rail agencies, including Metrolinx in Toronto. A two-car configuration could transport about 158 people seated and cost on the order of $6 to $9 million. Metrolinx plans to use a three-car set, and sets of greater than three cars are also likely possible in two- and three-car increments,[29] but not currently used.

Figure 7-3: Example of Alternative 3

Source: Metrolinx

7.1.4 Alternative 4: Budd Rail Diesel Car (RDC) DMU (Rebuilt)

Built in the 1950s for passenger service in rural areas with low traffic density or in short-haul commuter service

They are of stainless steel construction and so, although most are in disrepair, they can be rebuilt in good condition. They can operate as a single car[30] or in trains of up to six cars. They are high-floor DMUs, though they have steps allowing for boarding at 15 inches above top of rail. Several are available in Moncton, New Brunswick. We have been told by the owner of the cars that he would rebuild and sell them for about $1.5 to 2.0 million each. As well, the Trinity Railway Express owns 10 units that are not currently in use. They were used by the Denton County Transportation Authority for commuter service as recently as 2012.

[28] A high-floor refers to a floor 48-inches above the top of rail (ATR)

[29] Cascadia Center of Discovery Institute. 2011. Seattle, Washington-Vancouver, British Columbia Diesel Multiple Unit Feasibility Study. May 31.

[30] Stakeholders have indicated that RDCs as single car sets have been known to not shunt signals. This issue would need to be studied more should single car operations be proposed.

Figure 7-4: Example of Alternative 4

Source: Wikipedia

7.1.5 Alternative 5: Non-FRA-compliant Low-Floor DMU (New)

Low-floor DMUs commonly used in Europe (and on the Ottawa O-Train) that do not meet FRA requirements for structural integrity and crash-worthiness and cannot be used on lines used also by freight trains

There are several manufacturers that build low-floor DMUs to European standards. The price is similar to that for a high-floor DMU.

Figure 7-5: Example of Alternative 5 and Alternative 6

Source: Wikipedia

7.1.6 Alternative 6: Non-FRA-Compliant European DMU (Rebuilt)

There are several hundred DMUs in service across Europe and, although we have not identified a particular train, very likely a single used three-car set could be purchased and rebuilt for something less than $5 million. The Ottawa O-Train also recently replaced its Bombardier Talent DMUs, which could be considered if they are for sale.

7.2 Discussion of Alternatives

7.2.1 Comparison of Locomotive-Hauled versus DMUs

In general, we anticipate that the DMU alternatives (3, 4, 5 and 6) to be more economically and financially viable than the new locomotive-hauled consist (Alternative 1). DMUs are generally more economic on low-traffic and/or high-frequency commuter rail, whereas locomotive-hauled consists are more economic for higher-traffic and/or low-frequency lines. We anticipate that if a new locomotive-hauled consist with bi-level coaches were selected that up to three passenger coaches would be required per trainset under the highest traffic scenario. If a new DMU alternative were selected, we anticipate that up to four (cars) DMUs would be required per trainset under the highest-traffic scenario.

As a result, we do not anticipate Alternative (1) would be more economically and financially viable than a new DMU for any of the traffic scenarios considered. Specifically, based on the initial traffic assessment, Alternative (1) would be more costly than any of the DMU alternatives from a capital cost perspective. For example, a four-car DMU set would cost up to approximately $18 million (as compared to $18 million for a similarly sized locomotive-hauled consist). Given that most of the traffic scenarios could use smaller trainsets, we do not anticipate Alternative (1) to be the least costly alternative.

Additionally, given the expected traffic growth rate, there is limited value to the potential economies of scale of a locomotive-hauled consist. The passenger capacity of a locomotive-hauled consist can typically be expanded more inexpensively than a DMU set. For example, a new bi-level coach holding 140 passengers (seated) would cost approximately $3.3 million, whereas a new DMU holding approximately 79 passengers (seated) would cost up to $4.5 million. However, because only modest traffic growth is expected over the 25-year forecast horizon (on the order of approximately 1% per year), it is not expected that the number of coaches/DMUs in a set would increase significantly. As a result, the economies of scale possible with a locomotive-hauled consist are unlikely to be beneficial in the case of the proposed Halifax commuter rail system. On this basis, we do not consider Alternative (1) further.

Alternative (2) is an affordable alternative. However, because it is unclear at this stage of analysis whether a sufficient number of cars would be available for the proposed commuter rail system or what the specifications might be, we do not consider it further. Nonetheless, it should not be excluded from subsequent analysis should Halifax choose to proceed with the implementation of a commuter rail system.

7.2.2 Comparison of DMUs

Each of the other DMU alternatives has potential advantages and disadvantages, including:

Alternative (3): The Nippon-Sharyo DMU, the most recently procured example of this class of vehicle, is FRA-compliant and Transport Canada compliant, and is, as of June 2015, being used between Toronto Union Station and Toronto Pearson International Airport. As a result, we would not anticipate any significant regulatory barriers to its implementation.

The Nippon Sharyo DMU is a high-boarding DMU, which would be accommodated by a platform 48-inches above the top of the rail (ATR). Such an arrangement would speed boarding, reducing dwell-times and enable access by people with limited mobility. However, because a high platform would encroach into a freight train's clearance envelope,[31] each station would either need to be equipped with a gauntlet track (Figure 7-6) or flip-down station edges (Figure 7-7) that can be raised before a freight train goes by (unless the platform is located on a siding or no freight traffic passes that location [e.g. at the VIA Rail station]). Such a configuration would add to the capital cost of building the proposed commuter rail system.

Alternative (4): Budd RDCs are used throughout Canada and United States; however, because of their age, would not initially meet Transport Canada regulations. During the rebuilding process, various components would need to be upgraded and/or allowed to be grandfathered, as the regulations at the time of the rebuild would allow. Because of the long and ongoing operational history of this equipment in Canada, we anticipate that ensuring regulatory compliance is achievable, but the specific issues discussed in Section 7.3.1 would need to be considered.

Like the Nippon Sharyo DMU, Budd RDCs are high-floor units. However, they also have stairs, which would permit boarding off of low platforms. As such, the need for high platforms would not be required, though approaches to provide accessibility for persons with disabilities would need to be considered.

Alternative (5): A non-FRA-compliant low-floor DMU would have the advantage of not requiring high platforms; a low-floor vehicle would have approximately 24" ATR. As a result, stations would be less costly as compared to high-floor vehicles. However, these platforms would still encroach into a freight train clearance envelope, so each station would either need to be equipped with a gauntlet track (Figure 7-6) or flip-down station edges (Figure 7-7) that can be raised before a freight train goes by.

Alternative (5) vehicles are not compliant with existing Transport Canada and United States Federal Railroad Administration (FRA) crash-worthiness requirements. However,

---

[31] Under Transport Canada's *Standards Respecting Railway Clearances* (TC E-05), a platform 48" ATR could not be within 5'-9" (1753 mm) of the centerline of track. A Nippon Sharyo DMU is approximately 10'-6" (i.e. 5'-3" from centerline of track), leaving a large gap between the station and the train.

similar vehicles have operated on North American freight railways under (1) temporal separation (e.g. Ottawa, where freight trains only run overnight), (2) where positive train control (PTC) has been installed (e.g. Caltrain in the San Francisco Bay Area of California) and (3) under an alternative-compliance waiver (e.g. Denton County, Texas, which is also using a Stadler GTW). Because we do not anticipate that temporal separation could be provided on the existing CN Bedford Subdivision given the existing freight usage of the corridor, and that there are no immediate plans to install PTC on the Bedford Subdivision, applying for and receiving the Canadian equivalent of an alternative-compliance waiver from Transport Canada would likely be the only approach to use such low-floor equipment.

Applying for an alternative-compliance waiver would be expensive and time-consuming. The process for the Denton County Transit Authority (DCTA) in Texas to receive an alternative-compliance was extensive. The process is based on a criteria developed by FRA's Rail Safety Advisory Committee. The onus was on Denton County to justify that the waiver was "in the Public Interest" and that it was not "inconsistent with Railroad Safety". These justifications required extensive testing by the vehicle manufacturer (Stadler) and the rolling stock consultant throughout from 2009 to 2012, when the waiver was finally granted. Ultimately, DCTA received 14 different regulatory exemptions as part of its waiver. Additionally, the rolling stock manufacturer had to upgrade and modify the base rolling stock to ensure compliance.

In Canada, there has not been an application to Transport Canada to receive an alternative-compliance waiver. (However, Transport Canada has previously assessed a request to use temporal separation to operate the Ottawa O-Train.) Transport Canada indicated it would need to consider any regulatory exemptions based on alternative-compliance on a case-by-case basis. Because an alternative-compliance process has not been used in Canada, any process would first need to be developed for use in Canada. In any case, as in the United States, the onus would be on Halifax Transit to justify why any waiver should be granted.

Finally, early consultations with CN have indicated that it does not allow vehicles under Alternative (5) to operate on its network. Should an alternative-compliance process be pursued, potentially, this alternative could be revisited with CN, but initially represents a barrier to its use.

Alternative (6): A rebuilt non-FRA-compliant European DMU would be less costly than Alternative (5), though at a high level, would have similar advantages and disadvantages. However, unlike with a new DMU, there may be less design information available on a used alternative, which would make it more difficult and costly to assess to what extent the specific alternative considered meets FRA and Transport Canada regulations.

Figure 7-6: Gauntlet track at high-platform station

Source: http://farm4.static.flickr.com/3153/2782694045_d7cf710322.jpg

Figure 7-7: Flip-down station edges on the Ottawa O-Train

Source: http://www.flickr.com/photos/zmtomako/710955661/

7.3 Selected Alternative

Because the projected traffic demand in Halifax is modest, we selected Budd RDCs (Rail Diesel Cars) for further analysis. We anticipate that these vehicles would be the least expensive alternative from a capital cost perspective capable of meeting the projected passenger traffic, and thus the most likely to be financially and economically feasible. However, in Section 7.3.1, we also discuss some potential issues affecting the feasibility and procurement cost of the Budd RDCs, which would need to be assessed in an engineering study.

We emphasize that by selecting this alternative for further analysis, we are not recommending or endorsing Budd RDCs for the proposed Halifax commuter rail system. Should this study reveal that a commuter rail system in Halifax is feasible using the Budd RDCs, we recommend further study into the advantages and disadvantages of the Budd RDCs and other rolling stock alternatives as well.

7.3.1 Areas Requiring Further Investigation

There are at least two issues that could affect the feasibility of the Budd RDC alternative.

First, it is unclear whether a new or rebuilt Budd RDC engine would meet the United States Environmental Protection Agency's (EPA's) "Tier-4" Nonroad Diesel Engine air emissions standards for locomotives.[32] These standards regulate the amount of pollutants emitted from locomotive engines (including hydrocarbons, nitrogen oxides [NOx], particulate matter [PM], and carbon monoxide [CO]) and have become progressively stricter in Tiers. Meeting these standards is not required in Canada, though the Railway Association of Canada "encourages" its members to reduce air emissions.[33] Because air emissions from the rolling stock would have an impact on the surrounding community, they would need to be considered in a potential future environmental assessment. Other alternatives that produce fewer emissions may ultimately be required to ensure that any impact is minimized.[34]

Second, the Budd RDCs do not meet all of current design standards referenced in Transport Canada rules, such as the provisions of *Railway Passenger Car Inspection and Safety Rules* (TC O-26, as approved November 8, 2001) and the *Railway Locomotive Inspection and Safety Rules* (TC O 0-187, as approved December 22, 2014). Currently, many of the design provisions of these rules would not apply because the Budd RDCs were manufactured before April 1, 2001. (Cars manufactured after this date must meet the latest Association of American Railroads [AAR] and American Public Transportation Association [APTA] standards.) However, some of the requirements also apply to remanufactured equipment (e.g. Section 17.1 of TC O-26, which relates to the strength and loading design criteria used to design car components). Complying with these existing and potentially new requirements could add cost to the procurement of the RDCs and would need to be investigated further in an engineering study, should Halifax proceed with the implementation of the proposed commuter rail system.

---

[32] LTK Engineering. 2009. Use of Budd RDCs as an Interim Fleet. Report prepared for the Sonoma-Marin Area Rail Transit District.

[33] http://www.railcan.ca/assets/images/TC_RAC_MOU_2011-2015_EN.pdf

[34] The owners of the RDCs in Moncton have investigated several propulsion systems in the past. Ultimately, the specific propulsion system chosen would need to meet the latest regulations at the time of rebuilding.

7.4 Operational Parameters Assumed

Figure 7-8 contains the operational parameters for the Budd RDCs used in this analysis.

The fuel usage estimate is primarily based on figures from an analysis for the State of Vermont legislature when considering an RDC purchase (which notes that uncertainty remains over the estimate).[35] Their analysis suggests that the fuel usage of the Budd RDCs for intercity passenger usage is between 0.33 US gallons per mile per RDC and 0.40 US gallons[36] per mile per RDC. The higher estimate of fuel usage is using older engines currently installed in RDCs used by the Trinity Railway Express, whereas the lower figure is based on a rebuilt VIA RDC trial run in Northern Ontario in 2006.

As additional points of comparison, one study estimates the fuel usage of a Colorado Railcar DMU currently in service in Portland, Oregon, at approximately 0.65 gallons per mile per vehicle (with standing passenger loads) and a potential FRA-compliant DMU married-pair (i.e. two DMUs) at approximately 0.91 gallons per mile per married pair (or approximately 0.45 gallons per mile per vehicle).[37]

Because we anticipate that the Budd RDCs' fuel usage would be higher in commuter operations, with frequent starts, than in intercity operations, we have estimated the fuel usage to be 0.50 gallons per mile per vehicle (or approximately 1.9 litres per mile per vehicle.) However, the ultimate fuel usage could differ by this estimate depending on many factors, including notably the propulsion system used in the refurbished RDC.

Figure 7-8: Budd RDC Operational Parameters

Item	Value	Unit
Length	25.9	metres
Width	3.048	metres
Tare (empty) weight	53,200	kilograms
Fuel usage	1.9	litres / mile / RDC

Source: CPCS summary of various sources, including VIA Rail: http://www.viarail.ca/en/about-via-rail/our-fleet/rail-diesel-car-1.

[35] Schickner, N. 2007. AOT's Proposal to Purchase Colorado Railcar Equipment Joint Fiscal Office Analysis. Joint Fiscal Office Analysis.
[36] 1 US gallon = 3.78 litres
[37] LTK Engineering. 2009. Vehicle Technology Assessment: Final Draft Report. Report to the Sonoma-Marin Area Rail Transit District.

8 Service Design, Operating and Maintenance Requirements

Key Messages

- In order to offer frequency of service that could be competitive with existing long distance bus routes, which are typically at headways of 30 minutes or less during the peak periods, while minimizing additional rail infrastructure requirements, we have studied a service that involves trains running every approximately 30 minutes during the peak periods, with an additional mid-day trip.
- In order to achieve this level of service, three trainsets would be required in the Cobequid and Beaver Bank Scenarios, with varying numbers of cars per set depending on the time and day of service.
- At least one RDC per trainset should be configured to accommodate mobility device loading.

In this chapter, we introduce the service design that forms the basis for our traffic assessment, and operations and capital costing.

8.1 Service Design

As discussed in Chapter 6, we have undertaken traffic projections for three service operating concepts.

- Halifax-Cobequid
- Halifax-Beaver Bank
- Halifax-Elmsdale

For all three operating concepts, we have calculated trip times based on a blend of all rolling stock under consideration and also for the recommended Budd RDC cars. For the Budd RDC, we used the parameters shown in Figure 8-1.

Figure 8-1: Operating Parameters for Budd RDCs

Parameter	
Dwell times (min)	1.5
Maximum speed (mph)	45
Average rate of acceleration (ft/sec/sec)	2.00
Average rate of deceleration (ft/sec/sec)	3.50

Source: CPCS

As discussed, it would not be viable to operate full peak-period service to Elmsdale; however, it may be possible to extend some train services from Cobequid to Elmsdale during times that would not conflict with existing freight traffic. The feasibility of doing so would require further discussion with CN regarding its operations. For the purposes of developing a reference travel demand estimate, we have used the trip times and headways discussed below; however, we have not studied the specific trainset requirements in-depth.

8.1.1 Trip Times

Based on the parameters in Figure 8-1, we calculated one-way trip times, as shown in Figure 8-2, Figure 8-3 and Figure 8-4. These times do not include meets (with other commuter trains or freight and VIA trains) nor do they include turn times at each end.

Figure 8-2: One-way Trip Times Halifax-Cobequid (no consideration of meets)

No.	Stations	Mile	Arrive (min)	Depart (min)
1	VIA	0.00		0
2	South End	2.60	3.85	5.35
3	West End	3.80	7.33	8.83
4	Rockingham	6.00	12.15	13.65
5	Mill Cove	9.00	18.03	19.53
6	Sunnyside	10.50	21.91	23.41
7	Bedford Common	12.70	26.73	28.23
8	Cobequid	15.00	31.68	

Source: CPCS analysis

Figure 8-3: One-way Trip Times Halifax-Beaver Bank (no consideration of meets)

No.	Stations	Mile	Arrive (min)	Depart (min)
1	VIA	0.00		0
2	South End	2.60	3.85	5.35
3	West End	3.80	7.33	8.83
4	Rockingham	6.00	12.15	13.65
5	Mill Cove	9.00	18.03	19.53
6	Sunnyside	10.50	21.91	23.41
7	Bedford Common	12.70	26.73	28.23
8	Cobequid	15.00	31.68	33.18
9	Beaver Bank	18.60	40.57	

Source: CPCS analysis

Figure 8-4: One-way Trip Times Halifax-Elmsdale (no consideration of meets)

No.	Stations	Mile	Arrive (min)	Depart (min)
1	VIA	0.00		0
2	South End	2.60	3.85	5.35
3	West End	3.80	7.33	8.83
4	Rockingham	6.00	12.15	13.65
5	Mill Cove	9.00	18.03	19.53
6	Sunnyside	10.50	21.91	23.41
7	Bedford Common	12.70	26.73	28.23
8	Cobequid	15.00	31.68	33.18
9	Wellington	23.40	44.76	46.26
10	Elmsdale	32.10	58.24	

Source: CPCS analysis

8.1.2 Cycle Times and Headways

Based on the one-way trip times and additional dwell times at either end of the service (e.g. VIA Station in the east), we estimate average equipment cycles times would be:

- Halifax-Cobequid service – 76 minutes
- Halifax-Beaver Bank service – 93 minutes

In order to offer frequency of service that could be competitive with existing long distance bus routes, which are typically at headways of 30 minutes or less during the peak periods, while minimizing additional rail infrastructure requirements, we have studied a service that would involve trains running every approximately 30 minutes during the peak-periods (defined as approximately 0600 to 0900 and 1500 to 1800 on weekdays). The service plan also includes one mid-day trip; however, it does not govern the service design in terms of rolling stock requirements.

Using the identified cycle times, three trainsets would be required to offer either Halifax-Cobequid or Halifax-Beaver Bank service.

8.1.3 Trainset Requirements

Based on traffic forecasts, we calculated the required trainset capacity for each period for each of the traffic scenarios (Figure 8-5 and

Figure 8-6). In the case of Budd RDC cars (with a capacity of 96 persons seated), we estimated cars per train set as per the following figure (using year 2031 as an example). We have assumed an average load factor of 100% throughout each of the periods (based on the seating capacity of the vehicle).

Figure 8-5: RDCs per Trainset for Halifax-Cobequid Service (2031)

Period	High Traffic Scenario	Medium Traffic Scenario	Low Traffic Scenario
Morning Peak (0600-900)	3	3	2
Afternoon Peak (1500-1800)	3	2	1
Mid-day Non-peak (1200-1400)	2	2	1

Source: CPCS analysis

Figure 8-6: RDCs per Trainset for Halifax-Beaver Bank Service (2031)

Period	High Traffic Scenario	Medium Traffic Scenario	Low Traffic Scenario
Morning Peak (0600-900)	4	3	2
Afternoon Peak (1500-1800)	3	3	1
Mid-day Non-peak (1200-1400)	2	2	1

Source: CPCS analysis

8.2 Accessibility for Passengers with Disabilities

At least one RDC per trainset should be configured to accommodate mobility device loading (i.e. three cars). In discussions with the owners of the RDCs in Moncton, there are several configurations that could be feasible. The ultimate configuration would depend on the number of cars in the trainset, as some possible configurations have the wheelchair lift in the operator cab. (Such a configuration would only be possible if the given RDC were controlled from another unit in the trainset because there would not be room for the operator). We also understand that some modifications to the interior of the car may be required to accommodate large motorized wheelchairs, but similar modifications are not without precedent. In any case, all three cars could be fitted with an electric/hydraulic lift and tie-down points. With three cars, it is possible to provide accessible service for all train runs.

8.3 Operating Plans

Appendix B provides a summary of commuter rail services operated in Canada: GO Transit (Metrolinx) in the Greater Toronto Area, Agence métropolitaine de transport (AMT) in Montreal, and West Coast Express (TransLink) in the Greater Vancouver Area.

This information suggests possible contracting arrangements for the proposed Halifax commuter rail services. Many aspects of commuter rail operations in Canada are contracted. The following subsections discuss the various options available in Halifax.

8.3.1 Corporate Structure

There would be essentially two options for the corporate structure associated with commuter rail: a separate company or an integrated operation with Halifax Transit. In Vancouver, the West Coast Express Limited is an operating company of the BC Rapid Transit Company Ltd., a subsidiary of TransLink. (TransLink also has other subsidiaries operating urban bus and rail services). GO Transit is a division of Metrolinx, but not a separate corporate entity. However, Metrolinx is separate from the Toronto Transit Commission, which operates urban bus and subways in Toronto. The AMT commuter trains are not operated under a separate corporate entity; however, it is a separate entity from the SMT (Société de transport de Montréal), which operates urban bus and rail services. In Ottawa, the O-Train is operated by OC Transpo personnel. OC Transpo is a City of Ottawa government department. However, the commuter rail operations themselves are operated as Capital Railway, a City of Ottawa-owned company. As such, we can see that a wide variety of corporate structures are employed across Canada in the development and operation of commuter rail.

8.3.2 Operating Structure

Commuter rail operations in Canada are currently undertaken within a variety of structures in Canada. At GO Transit in the Greater Toronto Area, and West Coast Express in Metro Vancouver, Bombardier is contracted for train operations. In Montreal on the AMT system, operations are provided by CN Rail on the CN lines and CP Rail on the CP lines. In 2016, AMT will tender the operations as CP has indicated that it is no longer interested in the work. Ottawa's O-train is operated by OC Transpo, the urban transit service of the City of Ottawa.

For the provision of train operations, we have looked at all possible options including:

- Contracting to an operating railway in Halifax (CN Rail and VIA Rail)
- Contracting to a third party not currently providing train operations in Halifax (such as Bombardier and the WHRC)
- Operations undertaken by Halifax Transit

We have inquired with respect to interest of CN, VIA Rail and WHRC, but at this very early stage there was generally interest but not a robust embrace of the opportunity. The one exception was CN Rail, which has unequivocally indicated that it would not provide operating services. Though VIA Rail indicated some interest in providing operating services, it may not be best-suited to do so given its current ownership and mandate to operate intercity passenger services. WHRC likely lacks the capacity or interest to meet the demanding service requirements, but may be well suited for rolling stock maintenance.

If these companies do not operate the proposed service, two other options could be considered. Halifax Transit could follow the approach of OC Transpo in Ottawa. This approach would require first becoming a provincial or federal railway and the significant institutional and regulatory work associated with doing so. Instead, it is our recommendation that the approach to be taken would be contracting operating services to a third-party operator following a detailed tender process. In addition to Bombardier Transportation, Keolis[38], France's largest private sector transport group, is just one of a number of European firms seeking such opportunities in Canada. Herzog Railroad Services Inc.[39] of the US is also exploring the market for commuter and urban rail operations in Canada. The procurement process should be well publicized to maximize national and international exposure, but should be designed to not preclude participation by a newly formed local venture.

[38] http://www.keolis.com/en.html
[39] http://hrsi.com/

8.4 Operations Staff

Trains would be staffed by two locomotive engineers and one on-board service personnel.[40] One locomotive engineer would drive, and the other would call signals, operate switches and undertake routine equipment inspections. He or she would also assist with doors and on-board issues as needed. The on-board personnel would monitor passenger embarking and disembarking, check tickets and supervise on-board activities. Halifax has a good source of qualified or previously qualified locomotive engineers to either work on trains or as supervisors or to act as trainers.

Locomotive engineers would need to be qualified in accordance to Section 227 of the *Railway Act*, which sets the minimum qualification standards for locomotive engineers, transfer hostlers, conductors and yard foremen. The Act requires the railway to provide employee training and to certify employees. Companies exist to provide the necessary training and CN or VIA could administer the required certifying test. Extensive programs of recruitment/selection and training would need to be implemented for both locomotive engineers and on-board personnel.

Transport Canada Work/Rest Rules for Railway Rules for Railway Operating Employees (TC O 0-140) govern work/rest requirements for operating employees. Operating employees are allowed to be on duty up to 12 hours (Section 5.1.1 a). The on-duty time can be in two distinct periods to allow for split shifts. A minimum of eight hours is required between on-duty periods. In principle, these rules allow a crew member to work a split shift to cover both the morning and evening peak-period train runs, but an additional crew member would be required to cover the mid-day run.

8.5 Rolling Stock Maintenance, Servicing and Stabling Plans

The Budd Rail Diesel Car would need to re-built, maintained and inspected in accordance with:

- *Railway Safety Appliance Standards Regulations* (C.R.C., c. 1171); and
- *Railway Passenger Car Inspection & Safety Rules* (TC O-0-26)

Division 21 of the *Railway Safety Appliance Standards Regulations* applies specifically to Rail Power Cars such as RDCs. All of the *Railway Passenger Car Inspection & Safety Rules* (TC O-0-26) would apply to the RDC in service on the commuter service.

[40] We understand that the three-person crew is standard on most GO Transit lines. However, on the GO Transit Milton Line, one of the crew members acts as a service employee, so only two employees are required in total. Should such a configuration be possible, it would assist in lowering operating costs. Both remaining crew members would need to be qualified operating employees as discussed.

Budd RDCs are designed to be serviced by a heavy-truck mechanic in remote areas. They are designed to be based around bolt on-off assemblies and components so that down time and the mean distance between failures is minimized by switching out bad-order parts. Running and scheduled maintenance (fluids, filters, OEM requirements, etc.) as well as cleaning and stabling of rolling stock would be undertaken at the depot. Most work would be undertaken in the operating off-peak hours, though all rolling stock would need to be inspected on entry and exit from the depot. Job classes required would include electrician, mechanics, Carmen/women and general cleaners. At all operating times, employees would need to be engaged in work or available on call to respond to service failures. Fuelling would be direct from truck. Specialized maintenance such as 90-day inspections, rebuilding of electrical components and heavy-duty mechanical work would need to be outsourced locally.

Rolling stock maintenance on most commuter rail operations in Canada is currently undertaken by contract with Bombardier Transportation. This includes GO Transit (Metrolinx); West Coast Express (TransLink); Agence métropolitaine de transport (AMT) in Montreal; and Ottawa's O-train. We would recommend that the similar contracting approach be taken with a potential commuter rail system in Halifax. However, before proceeding to a tender for such services, we recommend that discussions be held with Industrial Rail Realty (IRR) in the event the decision is made to procure re-built RDCs from the company. It has expressed an interest[41] in undertaking such services and, after re-building the cars, it would be a natural choice.

With the exception of CN, which has indicated that it is not interested in providing rolling stock maintenance services, VIA Rail and the WHRC could also be considered for the provision of maintenance services. VIA Rail has expressed some interest in providing maintenance during preliminary discussions but, ultimately, we do not anticipate that these operations would fit within its core business. In addition, the WHRC has expressed an interest in an opportunity, and should be considered.

CN Rail would undertake maintenance of the mainline track and any other shared non-mainline track infrastructure. However, the access track into the depot would be the responsibility of the depot itself. Initially maintenance would be limited to regular inspections and light maintenance (switch lubrication and bolt tightening to start) but over time more significant maintenance would be needed. Local contractors are available to assist with the both the light maintenance and inspections work as well as more significant programs. The most significant extraneous cost would be likely for snow removal within the depot and we have priced for this separately.

[41] Meeting with Chris Evers, General Manager of IRR, on November 3, 2014.

8.6 Station Operations

As previously stated, stations would be designed to meet functional requirements and minimize required maintenance. Platforms would be equipped with:

- Shelters
- Ticket dispensing machines,
- Remote video monitoring (RVM)
- Lighting
- Benches
- Trash receptacles

Bus and kiss-and-ride waiting areas would be similarly equipped.

In our operating cost projections, we have allowed for the following contracts for stations:

- Garbage collection and general cleanup
- Snow and ice removal on platforms, in park-and-ride areas and all drive areas (including bus lanes and kiss-and-ride spots)
- Security services, including the provision of RVM and incident response as well as routine activity monitoring

It is possible that there may be demand to justify commercial activities at some stations, especially with the successful implementation of park and ride. However, the costs and revenues of commercial activities have not been included in our analysis.

9 Fixed Infrastructure Requirements

Key Messages

- For service to Cobequid and Beaver Bank, upgrade requirements would include passing sidings, crossing upgrades, signal upgrades and new switch infrastructure.
- In order to serve a potential station at Beaver Bank, the 2.9 miles of WHRC mainline track would require extensive rehabilitation.
- A new rolling stock depot would be required for light duty maintenance. An ideal location for the rolling stock depot is at Windsor Junction for Halifax-Cobequid and Halifax-Beaver Bank service.
- Station concepts are developed including platforms, park-and-ride facilities, kiss-and-ride facilities and bus stops all with a view to keeping cost to a minimum.

For the infrastructure, requirements would encompass the following:

- Additions or upgrades to mainline track including track and signal systems
- Station infrastructure
- Rolling stock maintenance depot

The requirements for each are discussed in this chapter.

9.1 Upgrades to Mainline Tracks

CN would require upgrades to infrastructure to largely mitigate any resulting disruptions to their service from Halifax to Windsor Junction, which is the core route for both Halifax-Cobequid and Halifax-Beaver Bank service. In addition, infrastructure changes would be needed to assure efficient and safe commuter service operations. The changes presented here are our assessments of the requirements, which may be less or more demanding than those ultimately required of CN Rail or Transport Canada.

For continuing service to Beaver Bank, the infrastructure requirements between Halifax and Windsor Junction would be similar to the infrastructure requirements for service ending at Cobequid. In addition to the upgrades between Halifax and Windsor Junction required for service to Cobequid, approximately 2.9 miles of WHRC track would also require rehabilitation.

9.1.1 Halifax to Windsor Junction

Figure 9-1 shows the infrastructure requirements for service from Halifax to Cobequid.

Installation of CTC

CTC would need to be installed east of mile 5.1 to near mile 0.0 on the Bedford location. For operational reasons, CN would likely not want to continue the CTC to mile 0.0, as it is not conducive to conducting yard operations such as train marshalling. Controlled locations (complete with dual control switches) would need to be installed at:

- Mile 1.6 – for connection to Halifax Ocean Terminal (HOT)
- Mile 4.3 – for connection to Rockingham Yard
- Mile 5.0 – for connection to Rockingham Yard

In a CTC system, dispatchers control train movements by wayside signal and remote (or dual) control switches at control locations. The basic concept of CTC is to divide the track into sections (or blocks) and use signals to control entry into sections of track. Track circuits are used to identify the location of trains to control centres and systems remote from the track sections. Track circuits are low-voltage currents applied to the railway track. The current flow would be interrupted by the presence of the wheels of a train, and this information is used to identify the location of a train.

Traditionally, pole line has been used to communicate data between controlled locations and with the control centre. However, in recent years, VHF (very-high frequency) radio communications has been used and installing this type of system is what we would recommend for the miles 0 to 5.1.

Signal equipment at each controlled location would consist of:

- Switch machine
- Wayside signals
- Hot air blower
- Communication tower – an 80-foot free standing tower with antenna to transmit and receive data to main tower then transmitted to RTC control office
- An 8 x 10 foot aluminum building (bungalow) to house signal equipment to execute controls and send indications, and batteries for backup

Most of the track between Rockingham and Halifax once had automatic block system (ABS) installed, so it is bonded track. It appears that most of the track remains continuously welded rail (CWR); however, upgrades would be needed to the track to assure track circuit continuity and isolation including installation of bonding, track cuts, insulated joints and switch circuit controllers to check location of switch points at hand-throw switches, cable and AC power.

Track cuts are used at the beginning and ends of track circuits. They are spaced at about 1 mile to 1½ mile with insulated joints at each end. A low-voltage battery is applied at one end and a relay at the other end. AC power is used to feed track cuts and to feed power underground to remote locations. All signal equipment is run by a DC voltage, mostly 12 volt, which consists of a bank of 1.5-volt cells; track circuits are usually 1.5 or 3 volt. AC power is used to operate battery chargers to keep batteries charged.

Passing Sidings

Three 600-foot passing sidings should be installed between Halifax and Cobequid. Each siding would be equipped with dual controlled switches at each end. Controlled locations would be installed at all turnouts in the manner described above except only one communication tower per siding. Turnouts would be #12 high-speed turnout and all track components would be between 115 to 140 lb/yd rail weight. Recommended locations for the passing sidings would be, as follows:

- Mile 2.30 to mile 2.60
  - Location is on straight track between bridges.
- Mile 12.10 to mile 12.75
  - Old north track bed is available for use. Track is straight and there is plenty of ballast to work with.
- Mile 14.1 to mile 14.5
  - Track is on a slight curve (1.34 degree) but old north roadbed is available for use.

Passing sidings would be of lengths that could be used for commuter trains, VIA trains and local switchers and yard assignments. The locations that were selected are free of physical barriers such as road crossings, bridges and any infrastructure that would impose clearance restrictions.

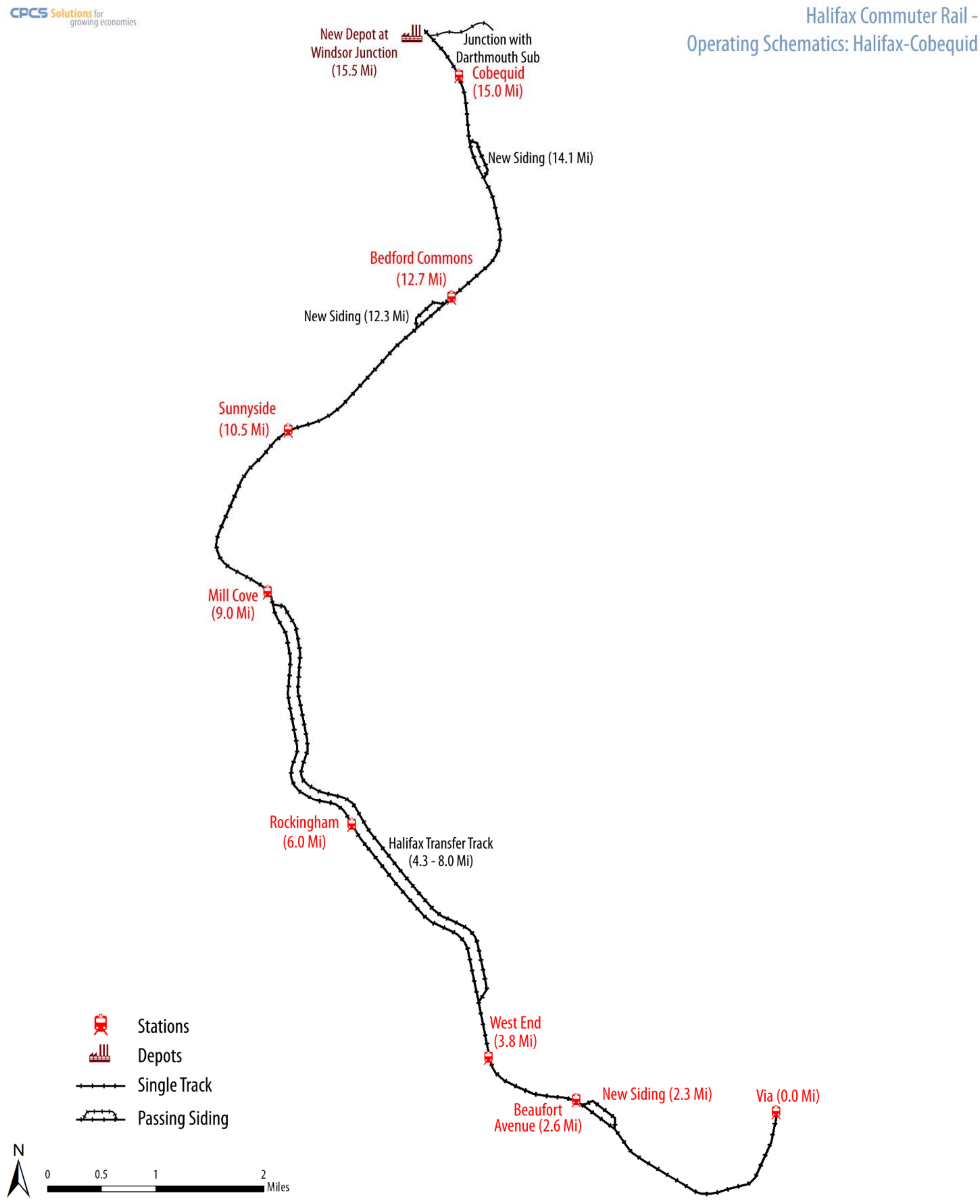
Accessing the Mainline from Depots

In the Halifax-Cobequid and Halifax-Beaver Bank Scenarios, Windsor Junction would be the ideal location for a rolling stock depot. Access to the depot would be through a mainline switch located at approximately mile 15.5 (just east of the Dartmouth Subdivision switch). The lead to the depot would be approximately 2,000 feet. The depot is described in more detail in Section 9.3.

Crossing Upgrades

The line between Halifax and Windsor Junction (15.7) has only one private crossing (to Princes Lodge at mile 7.59). As access is restricted by locked gate at the Bedford Highway, there does not seem to be any reason to enhance protection on the crossing. There are only two public crossings on the route and both are protected with automatic crossing protections. Both would need to be protected with a Grade Crossing Predictor (GCP) to minimize nuisance ringing while the passenger train is stopped at nearby stations. In addition, in order to provide access to the proposed depot site at Windsor Junction, the crossing at mile 15.65 would need to be equipped with automatic protection in the form of lights and gates as well as GCP.

Figure 9-1: Halifax-Cobequid Infrastructure Schematic



9.1.2 Windsor Junction to Beaver Bank

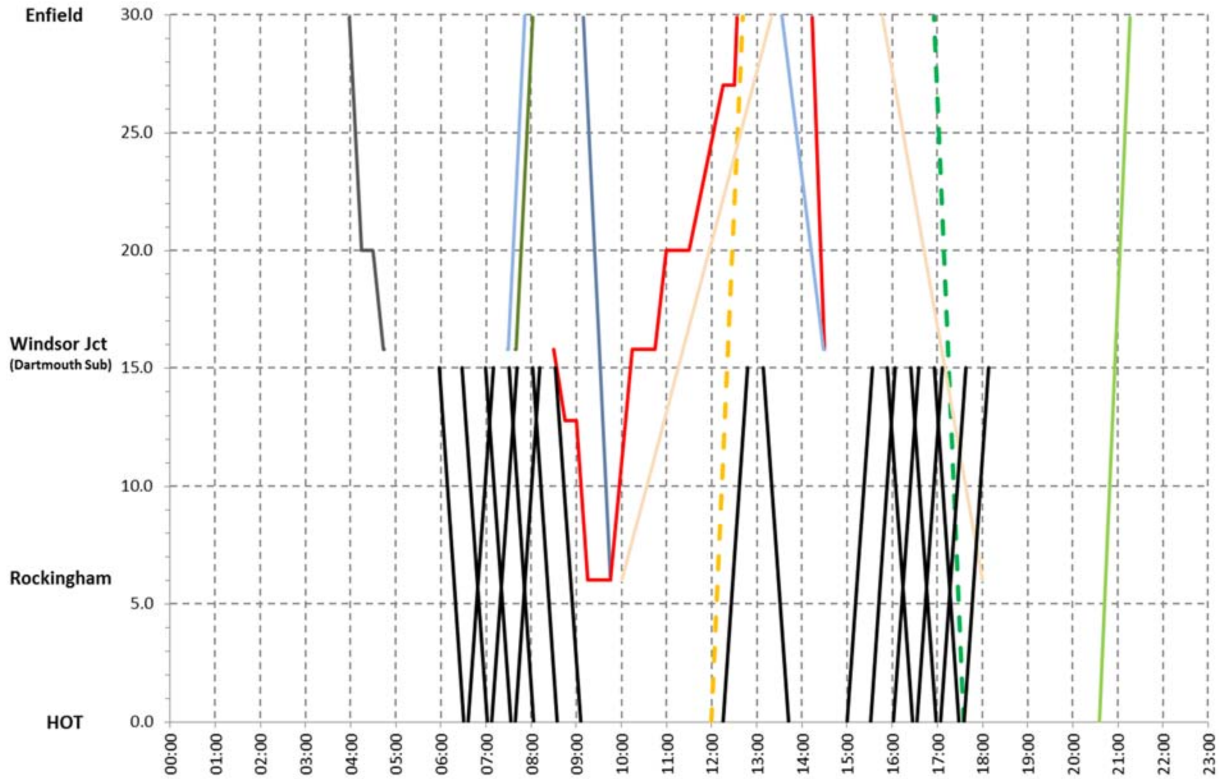
In order to serve a potential station at Beaver Bank, the 2.9 miles of WHRC mainline track would require extensive rehabilitation. Notably, approximately 1.9 miles of 85-lb rail would need to be replaced with heavier-duty rail; the 100-lb rail would need to be visually and ultrasonically inspected (and may require replacement as well). Additionally, approximately 50% of the ties would need to be replaced. Ballast would also need to be cleaned and vegetation would need to be removed.

Figure 9-2 shows existing train service (coloured) and proposed commuter rail service (black). Because there is no existing service over the WHRC in this area and all commuter rail meets would occur over the CN Bedford Subdivision, no additional capacity upgrades (e.g. sidings) would be required beyond the upgrades identified in the Cobequid Scenarios. (Some sidings in the Cobequid Scenario may need to be relocated to accommodate the Beaver Bank service schedule, which would not likely have any significant cost implications).

Centralized traffic control would not be required on the WHRC; however, the dispatch system over this segment of track would need to be upgraded from Rule 105 (of the Canadian Rail Operating Rules) to Occupancy Control System (OCS). Under OCS, separation between trains is maintained through written train orders communicated by radio from the Rail Traffic Controller (RTC) to the train operator. An arrangement would need to be made with CN to provide dispatch services from their RTC centre in Montreal. We anticipate the radio coverage to install OCS could be provided by existing radio towers in the area, so there would be no capital cost implications.

In order to allow service to continue to Beaver Bank (as well as to provide access to the proposed maintenance depot), a new mainline turnout and dual-control switch onto the CN Bedford Subdivision would also be required. A short segment of new track (over existing grade) would also be added such that traffic coming from Beaver Bank would not interfere with traffic coming from the CN Dartmouth Subdivision. There is an allowance for this infrastructure in the maintenance depot costs.

Figure 9-2: Beaver Bank Service Schematic



Source: CPCS analysis

9.2 Stations

In this section, we discuss facilities that would be provided at some or all of the proposed railway stations. In keeping with the objective of affordability, facilities are conceptualized as the minimum that would be required to ensure the safety and security of passengers, to meet necessary serviceability requirements and to be suitable for the site.

The basic elements of stations are, as follows:

- Platforms
- Park and ride
- Kiss and ride facilities
- Bus stops

Each is discussed below, along with the need for enhanced pedestrian and cycling facilities and amenities.

9.2.1 Platforms

Platforms would be required for the full length of trains as a minimum. In the case of Budd RDCs, cars are 26 m long. The required platform length is a function of cars per trainset as presented in Figure 9-3.

Figure 9-3: Plaform Lengths (Based on 2031 Trainset Length)

	Halifax-Cobequid		Halifax-Beaver Bank	
	Cars per train set	Length of Platform (m)	Cars per train set	Length of Platform (m)
High Scenario	3	78	4	104
Medium Scenario	3	78	3	78
Low Scenario	2	52	2	52

Source: CPCS

All stations would be configured for platforms on one side only except for Mill Cove and Sunnyside stations which would be configured for access on both sides.

The width of the platform should be sufficient to hold maximum passengers at peak period plus the maximum number of passengers expected on an approaching train (in the event of an emergency evacuation). We have determined that a 4-m platform width would meet this requirement for all stations. The height of the platform should be 38 cm (15-inches) above the top of the rail for Budd RDC cars. Platforms can be constructed from a variety of materials; but for costing purposes, we have assumed asphalt.

Ticket sales at stations would be from a ticket vending machine (TVM), except at heavily used stations such as VIA Station where sales could be integrated though a retailer. TVM machines would need to be served with low-voltage electricity and broad bandwidth fibre optic. They would need to be of a design for exterior use. They would also be designed to be barrier free. All platforms would need to be appropriately lit and equipped with remote video monitoring (RVM). In addition, stations would need to include benches and shelters, sized for each station based on anticipated usage, as well as trash receptacles. Signage would need to be installed to advise passenger of train and bus schedules.

9.2.2 Park and Ride

The proposed rail line would include four park-and-ride lots for the Medium and High Demand Scenarios. These would be all located in the suburban and rural stations.

To identify the number of parking spaces required, the PM Peak Hour person trips connecting to each of the rail stations with park-and-ride facilities was calculated. An automobile mode share of between 85% and 90% was assumed for each station along with a vehicle occupancy rate of 1.35 to account for multiple occupants in vehicles to calculate the number of parking spaces required. Daily parking requirements were then calculated using the same conversion factors applied to calculate daily commuter rail ridership.

For most commuter rail stations, the majority of passengers who use the park-and-ride lots park their vehicles during the AM peak period and leave during the PM peak period. Seventy-nine (79) percent of trips arriving at each rail station are projected to occur between 6:00 AM and 9:00 AM while 83% of trips depart between 3:00 PM and 6:00 PM. For the midday run, there would be a more equal distribution of arrivals and departures at each station.

To calculate the unconstrained demand for park-and-ride spaces at each station, the number of vehicles arriving at the each station was calculated between 6:00 AM and 1:00 PM (represents 85% of all daily arrivals). This was adjusted by factoring in the number of passengers projected to depart the station during this same period (thereby freeing up a parking space). During the AM peak period 10% of passengers are projected to depart each station while 8% are projected to depart during the midday period. To be conservative, only the 8% reduction factor during the midday period was used to adjust demand (given the peaking characteristics of AM peak period travel).

Unlike at the other stations, the size of the Mill Cove park and ride was estimated based on the GO Transit catchment rate for suburban areas of eight riders for 1,000 population, as opposed to the approach described in Chapter 6.[42] We converted this expected ridership into an appropriate number of park-and-ride locations, and then constrained the size of the park and ride based on availability of land suitable for a park and ride adjacent to the station. The additional ridership expected to result from the addition of this park and ride, beyond the ridership estimated in Chapter 6, was assigned to Mill Cove station and assumed to travel to the VIA station.

[42] This approach was utilized as the decision to include a park and ride at Mill Cove was made after the travel demand modelling work had been completed. The trip rates are derived from ridership statistics on GO Transit's Stouffville Line. Station catchment areas were defined as being within a 5.5 km radius of the station (10-minute drive). When dividing the boardings and alightings by the catchment area population, a trip rate of 9 boardings/1,000 population was recorded in the AM peak hour, and 8 alightings/1,000 population was calculated in the PM peak hour. The lower value was chosen for analysis.

The unconstrained park-and-ride requirements are illustrated in Figure 9-4

Figure 9-4: Unconstrained Park-and-Ride Requirements

Station	Scenario			
	Cobequid		Beaver Bank	
	Medium	High	Medium	High
Mill Cove	150	150	150	150
Bedford Common	179	416	179	265
Cobequid	376	376	325	323
Beaver Bank			509	623

Park-and-ride requirements are also partially determined by the availability of competing modes and availability of parking spaces at each station. If Halifax plans to accommodate the unconstrained demand for service, there would be little incentive for rail passengers to take alternative modes of travel to the rail station. Commuter rail stations can also be a source of localized congestion, with high volumes of rail passengers arriving and departing at the same time (based on train schedules). Encouraging alternative modes of travel to rail stations is recommended as part of this plan and one strategy is to reduce the number of parking spaces available.

Appendix E identifies new or modified transit routes that would connect to each of the commuter rail stations in the High Demand Scenario. These changes are summarized for three of the stations with park-and-ride lots in Figure 9-5 below. (As discussed above, the capacity of the Mill Cove park and ride was determined separately.)

Figure 9-5: Transit Connections and Proposed Park-and-Ride Adjustment Factors

Station	Connecting Transit Routes	Park-and-Ride Reduction Target *
Bedford Common Station*	Route 88 (modified)	5%
Cobequid Station	Fall River (new) Beaver Bank (new)	10%
Beaver Bank Station*	Route 400 (modified) Route 82 (modified)	5%

*High Demand Scenario only

For each of these stations, a realistic park-and-ride reduction factor is proposed to encourage more passengers to use the connecting transit routes. Based on this reduction, adjusted park-and-ride requirements are illustrated in Figure 9-6.

Figure 9-6: Adjusted Park-and-Ride Requirements

Station	Scenario			
	Cobequid		Beaver Bank	
	Medium	High	Medium	High
Mill Cove	150	150	150	150
Bedford Common	174	395	174	252
Cobequid	357	338	309	291
Beaver Bank			509	592

*Note: The reason for the significant increase in the High Scenario is the elimination of transit services to the Falls River and Sackville park-and-ride lots.

Fencing would be required at some locations where vandalism and trespassing is a problem and all parking areas would need to be lit and monitored by remote video monitoring (RVM). An appropriated number of spots would need to designated and designed for easy accessibility.

9.2.3 Drop-Off and Kiss and Ride

All stations, except VIA Station, would be designed with passenger drop-off facilities. Drop off spaces only allow drivers to drop off passengers connecting to the rail service. There is no designated space that will allow drivers to wait to pick up returning passengers. (By contrast, Kiss-and-Rides, described below, allocate space for drivers to wait in their vehicle for alighting passengers returning on the train.)

The drop-off locations should be separated from any public road and should be separate for spaces allocated for taxis and bus stops. Passenger drop-off should be located as close as possible to platforms and should be connected with lit paths. Drop-off areas should include benches and protective shelters.

Kiss-and-ride requirements were calculated for each rural and suburban rail station in the network. Kiss-and-ride requirements were based on a review of other kiss-and-ride stations in existing commuter rail corridors in Canada. A review was conducted of existing rural and suburban GO Transit park-and-ride lots to determine the ratio of kiss-and-ride spaces to park-and-ride station. Typically, there are four kiss-and-ride spaces for each 100 park-and-ride spaces. Park-and-ride lots with fewer than 250 spaces typically did not have kiss-and-ride spaces in the GO Transit rail network. This is likely due to the availability of parking spaces and the shorter walking distance from the rail platform to the parked vehicle. The Toronto Transit Commission uses a ratio of 1 to 1.5 kiss and ride to 100 park-and-ride spaces at its suburban subway stations.

For Halifax, a conservative factor of three kiss-and-ride spots to 100 park-and-ride spaces was used. The estimated number of kiss-and-ride spaces for each of these stations is provided in Figure 9-7. The ability to include each of these spaces would be partially dependent on availability of land and a more detailed review of demand and access mode to the station.

Figure 9-7: Kiss-and-Ride Requirements

Station	Scenario			
	Cobequid		Beaver Bank	
	Medium	High	Medium	High
Mill Cove	4	4	4	4
Bedford Common	5	12	5	8
Cobequid Station	11	10	9	9
Beaver Bank			15	18

In addition to these stations, opportunities should be sought to identify for a kiss and ride in the remaining stations along the corridor that would not have a park and ride. The one exception may be VIA Station, as this is primarily a destination station that is more oriented to local transit and active transportation connections. The number of parking spaces devoted to each kiss and ride would be dependent on the availability of land at each station.

Based on the projected ridership, three to six parking spaces at each kiss and ride should be accommodated at each commuter rail station without park-and-ride lots (subject to availability of land). The West End Station and Rockingham Station should have closer to six parking spots given the higher passenger volume while the remaining stations should have closer to three kiss-and-ride parking spots.

The space requirements for a kiss-and-ride area are dependent on the layout and the availability of land. There are two standard layouts for a kiss and ride:

Kiss-and-Ride Lineal Parallel Lanes

In this layout, vehicles enter a continuous kiss-and-ride lane and queue behind the vehicle ahead of them. Vehicles progress through the queue and drop off passengers and pick them up. They cannot leave the queue until the vehicles ahead of them have dropped off or picked up their own passengers. The design is a lineal, parallel layout accommodating up to six vehicles per lane. Where possible, shorter lanes are preferred to allow for easier vehicle access and egress. The space required per vehicle is three metres wide and seven metres long.

The advantage of this design is that it requires less space for travel lanes. This is ideal in areas where there are constraints on space and there are larger kiss-and-ride requirements. The disadvantage of this design is that it may increase waiting time for vehicles picking up passengers (e.g. a vehicle in the queue would have to wait for the passenger being picked up by the vehicle at the front of them, even if their own passenger has arrived). This is not recommended for stations that have a minimal (e.g. three waiting spaces or less) kiss-and-ride requirement. Figure 9-8 illustrates this layout.

Figure 9-8: Kiss-and-Ride Lineal Parallel Lanes Example

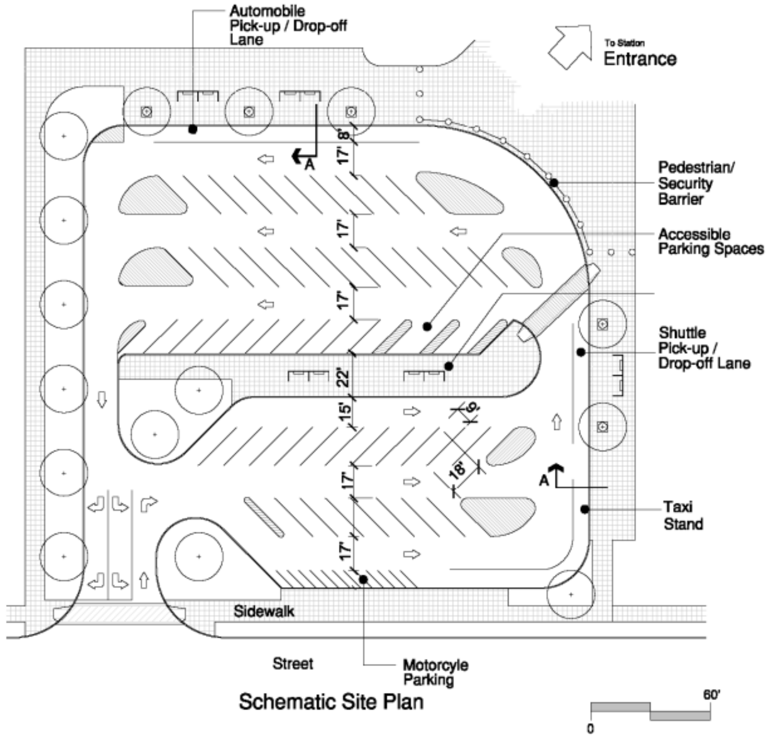
Source: Lisgar GO Station, Mississauga Ontario

Kiss-and-Ride Flow-Through Design

In this layout, kiss-and-ride spots are based on flow-through design, meaning that vehicles are able to enter and leave a vehicle waiting area based on their passenger arrival and departure, and are not delayed by the vehicle ahead of them in the queue. The space required per vehicle is 2.75 metres wide and six metres long for each vehicle in the kiss-and-ride area. Travel lanes are also required to accommodate vehicle flow.

The advantage of this layout is that it reduces the waiting time of vehicles and also reduces the amount of time that the waiting area is occupied (thereby increasing capacity). The disadvantage is the need to build additional travel lanes to accommodate the flow-through design. Figure 9-9 illustrates an example of this layout.

Figure 9-9: Kiss-and-Ride Flow-Through Design Example



Source: Dillon Consulting

9.2.4 Bus Stop and Terminal Requirements

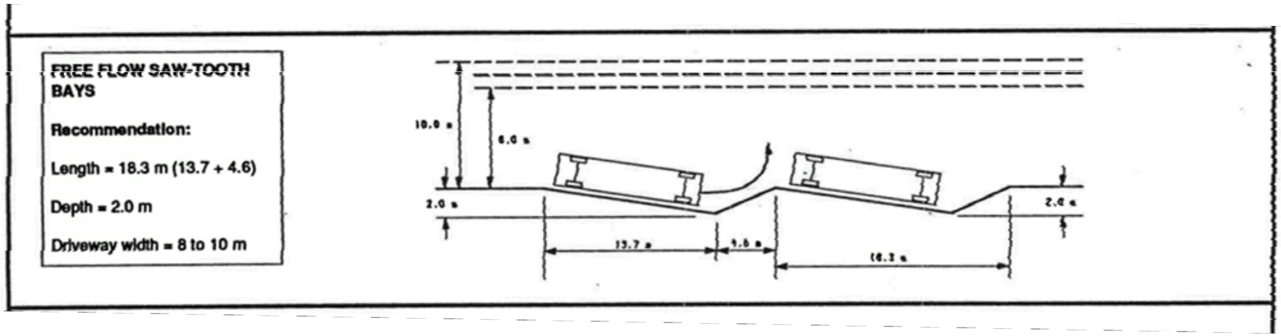
Transit connections to each of the proposed commuter rail stations would be important to attract ridership and reduce parking requirements at park-and-ride facilities. Transit route adjustments are proposed for each station to help increase ridership on both Halifax Transit and the proposed commuter rail corridor. Based on this strategic assessment, the following bus stop or terminal requirements are recommended.

Standard bus stops (for 40-ft buses) require a 9 m long by 1.5-3 m wide bus pad. The 9 m length allows passengers to step on a hard surface on both the front and rear doors while the size of the width provides sufficient space for queuing riders and manoeuvring of mobility devices. The clearance space for the bus should be 14 to 15 metres long (e.g. no on-street parking allowed within this space).

Figure 9-11 identified any new bus stops and bus bays that are recommended as part of this plan.

For transit terminals, free-flow saw-tooth bus bays are recommended. The recommended curb length for each saw-tooth bay is 18.3 metres. Figure 9-10 below illustrates a typical design standard for a standard saw-tooth bay.

Figure 9-10: Recommended Design Standards for a Saw-Tooth Bay



Source: Ministry of Transportation Ontario Transit Terminal Planning Design Guidelines

Figure 9-11: Halifax Transit Bus Stop Requirements by Station

Station	New / Modified Routes (with stops)	Applicable Scenario	Peak Bus Require-ments	Recommended Facility Type	Notes
VIA	Downtown Shuttle (new)	Medium / High Demand	2-3	Bus Stop	Requires one bus stop with shelter near the VIA Station with space for two to three buses to queue behind the lead bus.
South End	University Shuttle (new)	Medium / High Demand	1-2	Bus Stop	Bus stop with shelter. If demand warrants, a second route in the reverse direction should be implemented requiring a second bus stop.
West End	None	High Demand	0	N/A	Existing Mumford Terminal located nearby the proposed station.
Rockingham	None	High Demand	2	Bus Stop	Eight bus routes already pass by the proposed station. Need to ensure bus stop with shelter in place per direction.
Mill Cove	Route 90 (modified)	High Demand	1	Bus Stop	Need a bus stop and shelter at the station.
Sunnyside	Route 66 (modified) Route 80/80A (modified) Route 82 (modified) Route 86 (modified) Route 87/87A (modified)	High Demand	4-6 (depending on schedule)	Free-Flow Saw-Tooth Bays	Suggest providing a terminal similar to the Cobequid Transit Terminal at this station. Would require a small terminal to be built to facilitate transfers.

Station	New / Modified Routes (with stops)	Applicable Scenario	Peak Bus Require-ments	Recommended Facility Type	Notes
	Route 89 (modified)				
Bedford Common	Route 88 (modified)	High Demand	1	Bus Stop	Bus stop and shelter in the station.
Cobequid	Fall River (new) Beaver Bank (new)	High Demand	2	Bus Stop	Bus stop and shelter in the station.
Beaver Bank	Route 82 (modified) Route 400 (modified)	High Demand	1-2 (depending on schedule)	Bus Stop	Bus stop and shelter in the station.

9.2.5 Enhanced Pedestrian and Cycling Facilities and Amenities

The stations along the commuter rail corridor should have appropriate pedestrian and cycling facilities to encourage non-motorized access. Encouraging commuters to access rail stations using active transportation modes would result in reduced park-and-ride requirements, increased commuter rail ridership and is also in line with the sustainability objectives of the region.

Recommended pedestrian facilities include:

- Provision of sidewalks within the station area and connected to adjacent roads
- Pedestrian crossings and/or signalized intersections across major roadways parallel to the rail corridor that provide pedestrian access to neighbourhoods and other land uses adjacent to the station
- Clearly marked walking paths in the park-and-ride lots
- Illumination of sidewalks, walking paths and waiting areas
- Heated shelters along train platforms and at kiss-and-ride locations to enhance the customer experience

The provision of cycling facilities would increase the catchment area for active transportation around stations. Cycling facilities are encouraged both in dense urban areas, as well as less dense areas that may not have frequent transit.

Recommended cycling facilities include:

- Curb-separated bike lanes leading to and within the station
- Painted bike lanes, if curb-separated lanes are not possible or feasible
- Designated cycling routes on lower-traffic streets

- Ample secured and covered bike parking stalls within the station

These measures would need to be planned in more detail as part of a station area planning exercise.

9.3 Maintenance, Servicing and Stabling Depot

An ideal location for the rolling stock depot would be at Windsor Junction for the Halifax-Cobequid and Halifax-Beaver Bank service. (Should additional train runs continue as far as Elmsdale, a depot in Elmsdale could also be considered.)

The depot would need to be equipped to undertake running maintenance and scheduled maintenance (fluids, filters, OEM requirements, etc.). Required equipment includes:

- A fuelling site complete with drip trays and oil-water separators
- Drop tables for component change-outs
- A concrete pit (or elevated track) for undercarriage service
- An overhead steel building complete with compressed air and pneumatic tools and lunch room, office and washroom facilities
- Cleaning and washing equipment

The depot at Windsor Junction would be laid out with at least three tracks of approximately up to approximately 100 m in length but modified to fit the available land. Both CN and WHRC have brownfield land in the area that could be used for the facility. Road access would be across the mainline from Windsor Junction Road on an existing private crossing used by CN Rail (mile 15.65). We have allowed for upgrade of the crossing with automatic crossing protection. The estimated cost of the depot also includes an allowance for a short extension of the existing WHRC wye track to bypass traffic entering onto the Bedford Subdivision from the Dartmouth Subdivision (built over existing grade), and a dual control switch from the WHRC to the Bedford Subdivision.

9.4 Public Impact Assessment

We have performed a preliminary assessment of the public impacts associated with implementing commuter rail.

9.4.1 Halifax – Windsor Junction

The negative impacts to the public for commuter service introduction between Halifax and Cobequid Station would be relatively insignificant. The proposed commuter equipment is quiet and short in length relative to the freight and passenger trains on the corridor. In addition, where the alignment does pass in close proximity to a residential neighbourhood, it is within the rock-cut, which acts as a barrier to noise.

The line has only one private crossing (to Princes Lodge at mile 7.59). As access is restricted by locked gate at the Bedford Highway, there does not seem to be any reason to enhance protection on the crossing. There are only two public crossings on the route. Both crossings would need to be protected with Grade Crossing Predictor (GCP) to minimize nuisance ringing while the passenger train is stopped at nearby stations. In addition, in order to provide access to the proposed depot site at Windsor Junction, the crossing at mile 15.65 would need to be equipped with automatic protection in the form of lights and gates.

The construction of new passing sidings between Halifax and Windsor Junction would impose few impacts on the public because the construction would be on existing roadbed that has been used by CN Rail within the last 15 years. In addition, the depot at Windsor Junction would be built on land that has a long history of railway activity. In addition, the depot would not be directly adjacent to any residential areas.

Stations would be the most significant impact on the public. Road traffic would increase around all stations with the most noticeable increase likely at the South End. Park and ride facilities are being proposed for three stations in the high and medium scenarios: Mill Cove, Bedford Common and Cobequid Stations. The Bedford Common Station would be within an industrial area, remote from any residential areas. The Cobequid site is currently unused and mostly wooded, but is in closer proximity to residential land uses. A portion of the site (closest to the track) was once used as a lumber mill.

There are several locations where trespassing is a known issue on this segment of track: between the West End Mall and the Dutch Village Road; behind the Sunnyside Mall, Bedford Commons, and Mill Cove Shopping Centre; and in areas of Windsor Junction and Fall River. Trespassing is usually addressed through three E's: Education, Enforcement and Engineering.[43] Notably, we anticipate that there are several locations where fencing would be required (engineering) to discourage trespassing, and have allowed for 3,600 metres of fencing (about 15% of the length from Halifax to Cobequid).

[43] Operation Lifesaver. http://www.operationlifesaver.ca/wp-content/uploads/2012/01/OL_Brochure_EN.pdf

9.4.2 Windsor Junction – Elmsdale

Should service continue westward on the Bedford Subdivision beyond Windsor Junction, the operational risks would be much higher because of 11 private or farm crossings, all without automatic crossing protection and many on curves and within rock cuts. Mitigation measures would be limited on account of the rights of landowners to the crossings. In addition, there are nine public road crossings. All have some form of automatic protection in the form of lights; however, GCP would need to be installed at all crossings and gates would likely need to be installed at three crossings.

The environmental and social impacts of the construction of an additional main track between Windsor Junction and Elmsdale, which would be required should service at a half-hour headways continue beyond Windsor Junction to Elmsdale, would be significant on account of the proximity of the alignment major lakes, rivers and residential areas. Mitigation of the impacts would be a significant component of the design and construction of the line.

9.4.3 Windsor Junction – Beaver Bank

Though the proposed commuter equipment is relatively quiet and short in length, the introduction of service would increase noise at a few properties located along the length of Windgate Drive given that no existing rail traffic exists. These impacts would be limited to the peak periods, however.

There are six private road crossings along the length of the corridor. Based on the road and rail traffic criteria in Transport Canada standards, none of the crossings require any additional warning systems based on traffic levels alone. However, we anticipate that two of the crossings would require upgrades with lights and bells because of their proximity to rail curves, which would increase noise nearby the properties. The remaining four crossings are located on straight stretches of railway and thus road traffic should have adequate sightlines. Additionally, the close proximity of parallel Windgate Drive to the crossings would need to be considered as part of a potential future design phase to ensure the safety of traffic exiting or entering onto Windgate Drive.

9.5 Electrification Potential

Our analysis did not analyze electrification of the system in-depth, as the capital costs would be prohibitively expensive. One estimate of the cost is approximately $4.8 million per track-mile ($3 million per track kilometre) to install overhead catenary (Figure 9-12).[44] To install

[44] Cambridge Systematics. 2012. Analysis of Freight Rail Electrification in the SCAG Region.

such a system from Halifax to Cobequid only (approximately $72 million) would exceed the entire capital cost of the proposed system, as discussed in Chapter 10.

Electrification does offer some benefits such as reduced local emissions and noise and shorter travel times, but given that the proposed Halifax commuter rail system would operate only the peak periods (with one-midday trip), these benefits would be small. Typically, the benefits from electrification only offset the costs in systems with frequent (e.g. 15 minutes or less between trains) all-day service[45] or where the nature of the technology dictates that electrification is required (e.g. high-speed rail).

Figure 9-12: Overhead Catenary Wires

Source: Freefoto.com

[45] For comparison, the single electrified Edmonton LRT line had 97,000 boardings per day, which is approximately equal to boardings on the entire Halifax Transit system. http://www.edmonton.ca/transportation/2012_LRT_Passenger_Count_Report.pdf

10 Operating and Capital Cost Projections

Key Messages

- The estimated capital costs would range from a low of $36 million for the Cobequid Low Scenario to a high of $62 million for the Beaver Bank High Scenario.
- The estimated operating costs would range from a low of $9.0 million in the Cobequid Low Scenario to a high of $10.8 million the Beaver Bank High Scenario.
- The annual operating costs for the Beaver Bank concept would be higher than that of the Cobequid concept for all demand levels, as expected.
- One of the most significant cost uncertainties relates to track access charges. Track access costs are the most significant operating cost component after labour. While labour costs can be estimated with some certainty given the operating characteristics, track access charges represent a significant uncertainty, as they would be based on negotiations with CN.

This chapter details the operating and capital cost (OPEX and CAPEX, respectively) estimates used in the financial and economic modelling.

10.1 Operating Costs (OPEX)

10.1.1 DMU Maintenance Costs

Figure 10-1 contains the DMU operating and maintenance costs assumed for the operating cost model. At the time of modelling, Halifax Transit's projected diesel cost from January to March 2015 was $0.70 per litre. The U.S. Energy Information Agency is anticipating a rebound in diesel prices of about 16% between early 2015 and 2017.[46] We have assumed a diesel price of approximately $0.82 per litre in response to this potential rebound. [47]

Figure 10-1: DMU Operating and Maintenance Cost

Item	Value	Unit
Diesel fuel cost	0.82	$ / litre
Oil & other (% of diesel fuel costs)	5%	%
Parts costs per DMU per year	17,000	$ / yr
Cleaning supplies cost per DMU per year	1,000	$ / yr

Figure 10-2 contains the estimated labour cost and productivity of the DMU maintenance and cleaning staff. These estimates include salary, benefits and overhead.

Figure 10-2: DMU Maintenance Employees

Item	Value	Unit
DMU per maintenance employee per work day	**2**	**DMU / employee / day**
- Minimum number of maintenance employees	12	employee / yr
- Salary, benefits and overhead per employee per year	105,000	$ / yr
- Shifts per employee per year	225	shifts / yr
DMU per cleaning employee per work day	**6**	**DMU / employee / day**
- Minimum number of cleaning employees	2	employee / yr
- Salary, benefits and overhead per employee per year	70,000	$ / yr
- Shifts per employee per year	225	shifts / yr

[46] http://www.eia.gov/forecasts/steo/realprices/
[47] We understand that Halifax Transit's latest projection is approximately $0.80 per litre, in line with our estimate.

10.1.2 Operating Labour Costs

Figure 10-3 and Figure 10-4 contain the labour costs and productivity for the train operating and service staff, respectively. We have assumed that operating and service crews could work split shifts to cover both the morning and evening peak services; however, an additional crew member would be required for the mid-day train run.

Figure 10-3: Operating Employees

Item	Value	Unit
Employees per crew	2	employees / crew
Train shifts per employee per year	175	shifts / yr
Salary, benefits and overhead per employee per year	126,000	$ / yr

Figure 10-4: Service Employees

Item	Value	Unit
Employees per crew	1	employees / crew
Train shifts per employee per year	200	shifts / yr
Salary, benefits and overhead per employee per year	70,000	$ / yr

10.1.3 Track Access and Insurance Costs

Figure 10-5 contains our estimates of insurance and track access charges.

Figure 10-5: Insurance and Track Access Costs

Item	Value	Unit
Insurance charge	858,000	$ /year
Track access charge per mile of track (Halifax-Cobequid)	130,000	$ / track-mile / year
Track access operating charge, per train-mile	18.39	$ / train-mile

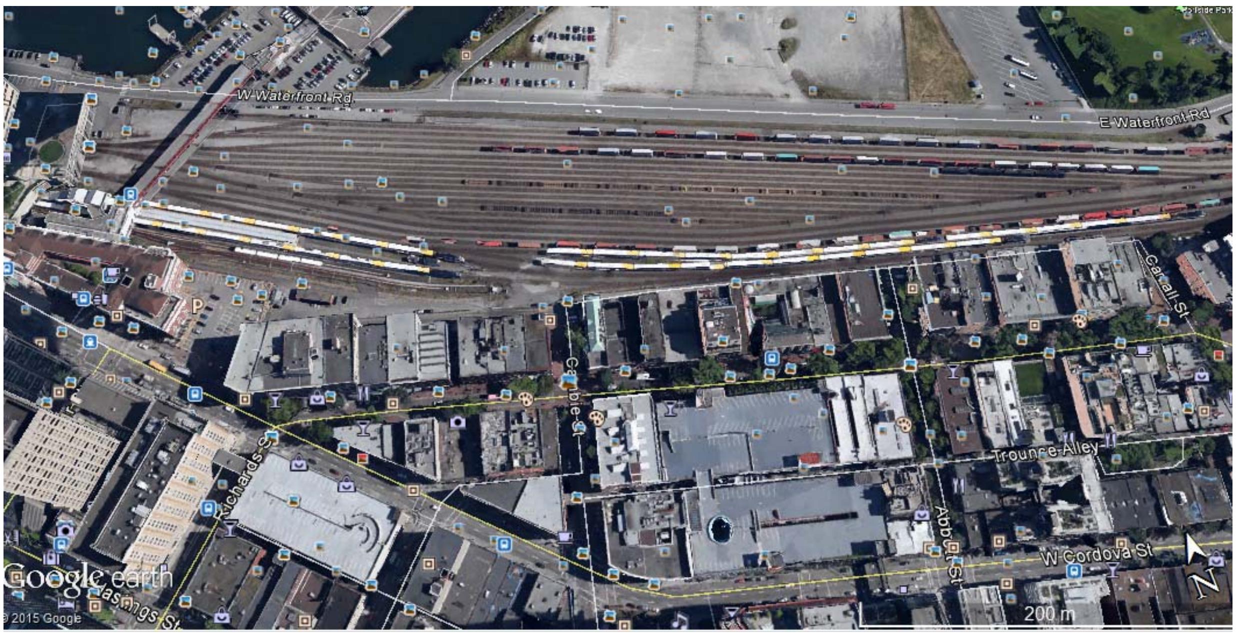
Source: CPCS analysis of "Purchase of Services Agreement between CP Rail and British Columbia Transit" dated October 1, 1995

Track Access Charge

We based the estimate of track access charges on the "Purchase of Services Agreement between CP Rail and British Columbia Transit" dated October 1, 1995 and amended from time to time thereafter. This agreement details the track access charges paid by TransLink to CP for operation of the West Coast Express commuter rail service. The agreement also has provisions for BC Transit to provide liability insurance.

In the morning, West Coast Express operates five one-way trains from Mission, BC, to Waterfront Station in Vancouver (43 track miles) over an approximately three-hour period (from first departure to last arrival). Each service is operated by a separate trainset. The trainsets layover at Waterfront Station during the day (see Figure 10-6 showing all five trainsets at Waterfront Station). In the evening, West Coast Express operates five one-way trains back from Waterfront Station to Mission over an approximately three-hour period. The service only operates during the week. In total, West Coast Express operates 108,360 train-miles per year.

Figure 10-6: West Coast Express Trains at Waterfront Station



Source: Google Earth

In the agreement, access charges are priced using two components. There is a Charge for Shared Infrastructure Use, which is a payment for use of CP's railway infrastructure, including "existing track, signals, bridges, rail traffic control centers, and right-of-way." This component of the access charge appears based on the capacity usage of the infrastructure: the agreement notes that the commuter rail service uses approximately 20%[48] of the useable track capacity of the 43.0 mile stretch of line and that the commuter rail service "is precisely scheduled,

[48] This estimate is based on the fact that the train service operates in an approximately six-hour period every day (approximately 25% of 24 hours). The estimate has been reduced somewhat because the time between the first and last departure is only 1.5 hours in the morning and 2.0 hours in the evening (3.5 hours total or 15% of 24 hours). Immediately following the last departure in the morning or evening, a freight train could follow the commuter rail service.

occupies a finite block of time and represents a significant operating constraint around which the balance of freight and railway maintenance operations must work."

There is a separate Charge for Operating, which includes a dedicated CP Manager of Commuter Rail Service, as well as charges that cannot be fully allocated to commuter rail service, including track inspection, testing and maintenance, rail traffic control, signal testing and maintenance, etc. With the exception of the employment of a salaried Manager of Commuter Rail Service, which would be fixed regardless of the number of trains that operate, many of the components of this charge would vary somewhat depending on the commuter rail traffic.

Assuming that CN were to price access to infrastructure similarly to the agreement between TransLink and CP, we have developed an infrastructure access charge using a fixed capacity access charge (that does *not* vary by number of trains that operate) and a variable access charge (that varies per train-mile of commuter rail service) (Figure 10-5).

We have pro-rated the fixed capacity access charge based on the expected capacity utilization of the proposed Halifax commuter rail system. In 2014, CP priced access to 20% of the capacity of a 43-mile stretch of track at $86,000 per track-mile per year. By comparison, the proposed Halifax commuter rail service would use approximately 30%[49] of the track capacity from Halifax to Cobequid for peak-period service and a mid-day trip, which would suggest that the capacity charge should be priced around $130,000 per track-mile per year. Because Halifax Transit would be responsible for providing 100% of the capacity to serve Beaver Bank on the WHRC through the cost of infrastructure upgrades, we have assumed no fixed charge for this stretch.

We have assumed that the operating charge would be similar to the rate charged by CP. In 2015, it would charge approximately $1.99 million for 108,360 train-miles, which equates to $18.39 per train-mile.

It is important to note that there is significant uncertainty with this estimate as it relates to its application in Halifax, given that Vancouver and Halifax likely have different traffic patterns, and that CP and CN likely have different pricing methodologies in terms of developing access charges. Additionally, some aspects of the pricing agreement between TransLink and CP appear to be arbitrarily negotiated (as opposed to being based on a costing framework): notably, in 2002, there was an agreement between the parties to reduce the Charge for Operations and Charge for Shared Infrastructure Use by $1 million per year each. Given the importance of the track access charge to the viability of commuter rail service, it would be

[49] The commuter rail service would occupy approximately seven hours per day of track capacity (approximately three hours per peak period and one hour in the mid-day).

crucial that Halifax explore access charges with CN in more detail as part of any subsequent discussions.

Insurance

In Canada, there are no regulatory liability limits for commuter rail insurance coverage; each host railway is free to set its own requirements. In consultations with CN, it has indicated that at least $100,000,000 in insurance coverage would be required to operate over its track. This value is the same as that specified in the agreement between CP and TransLink. TransLink is required to maintain a Comprehensive General Liability Insurance policy with "an inclusive limit of not less than $100,000,000, or such other increased amount as [CP] may require from time to time, in respect of bodily injury, including injury resulting in death, and property damage . . . ."[50]

In the United States, third-party liability for passenger rail service is capped at $200 million from a single accident for services provided by Amtrak, the federally owned passenger rail provider similar to VIA Rail. As part of the Canadian Transportation Agency's (CTA's) current review of *Railway Third Party Liability Insurance Coverage Regulations*, which mandates minimum insurance coverage for federally regulated railways, some stakeholders (e.g. CP) have expressed a desire that a similar cap be considered in Canada.[51] While no limit is forthcoming to our knowledge, Halifax Transit should consider monitoring this process for any developments that would provide more certainty as to the liability limits required.

Halifax Transit Risk Management provided the order of magnitude insurance costs to operate commuter rail service. These costs are based on the discussion above and the characteristics of the Cobequid Scenario system. The insurance estimate covers:

- Liability ($200 million limit)
- Professional liability
- Environmental
- Property – rail rolling stock
- Property – fixed assets (e.g. buildings.)

---

[50] TransLink may also obtain Comprehensive General Liability Insurance in the amount of $25,000,000 and "obtain an undertaking from Her Majesty the Queen in the Right of British Columbia" to indemnify TransLink for any claims between $25,000,000 and $100,000,000.

[51] Association of American Railroads Comment to the Canadian Transportation Agency. 2014. http://www.otc-cta.gc.ca/eng/publication/consultation-review-railway-third-party-liability-insurance-coverage-regulations-what-we

The main cost driver is the liability coverage, which makes up over 80% of the incremental coverage. As the original estimate was based on a $200 million liability cap, a modest reduction in premium may be possible should $100 million in coverage ultimately be required by CN. The variable components of the insurance coverage based on property values (rolling stock and fixed assets) are relatively minor factors in affecting the total cost of the estimate.

10.1.4 Station and Depot Operating Costs

Figure 10-7 contains station operating cost values. There would be one maintenance depot for commuter rail operations. Though these values are particularly uncertain until station concepts are developed in more detail, station-operating costs is only a very small component (less than 5%) of the total cost of operating a commuter rail service.

Figure 10-7: Station Operating Costs

Item	Value	Unit
Halifax-Cobequid, Number of Stations	8	
Halifax-Beaver Bank, Number of Stations	9	
Platform Width (VIA)	5	metres
Platform Width (other than VIA)	4	metres
VIA Station Lease	100,000	$ / station / year
Station Cleaning	12,000	$ / station / year
Station Snow Removal (including park and rides)	10.0	$ / sq. m
Station Security Costs	25,000	$ / station / year
Station Maintenance Costs	20,000	$ / station / year
Depot Electricity Costs	25,000	$ / depot / year
Depot Snow Removal	25,000	$ / depot / year

10.1.5 Supervisory, Management and Other Fixed Costs

Figure 10-8 contains estimates of the supervisory and management roles required to operate the proposed commuter rail system. These values include salary and benefits. Further to discussions with the Halifax Transit Technical Team, we have assumed that other administrative roles (e.g. finance, human resources, etc.) would be provided by existing personnel. Given that only peak-period service is proposed, we have also assumed that the General Manager could serve as a relief operations supervisor in cases when the operations supervisor is away for annual leave.

Figure 10-8: Supervisory and Management Employees and Other Fixed Costs

Item	Value	Unit
Facility maintenance supervisors	**2**	**employees / year**
- Salary and benefits per year	105,000	$ / year
Operations supervisors	**1**	**employees / year**
- Salary and benefits per year	154,000	$ / year
General Manager	**1**	**employees / year**
- Salary and benefits per year	210,000	$ / year

10.1.6 Net Change in Bus Operating Costs

As introduced in Chapter 6, in the medium and high scenarios, the traffic forecasts included changes to existing Halifax Transit bus routes and the addition of various shuttles. The specific changes and their associated costs are outlined in Appendix E. As noted in these sections, the high scenario was designed to study the hypothetical maximum ridership on commuter rail and the resulting financial and economic implications.

10.2 Capital Costs (CAPEX)

10.2.1 Track Capital Costs

Figure 10-9 and Figure 10-10 contain the track capital cost estimates for the Halifax to Windsor Junction and Windsor Junction to Beaver Bank segments, respectively. Signals and track were developed based on CN Rail undertaking the proposed work; and all other costs are developed as undertaken by a local contractor.

Because the volume of CN traffic is relatively light from Halifax to Windsor Junction, only three passing sidings would likely be required to operate commuter rail service from Halifax to Cobequid. These sidings would be required to allow commuter trains to pass and as well as to pass VIA passenger trains or freight switchers. The largest expense on this segment of track is the cost to install centralized traffic control (CTC) between mile 0.0 to 5.1 to ensure reliable operations of the proposed commuter rail service into and out of VIA Station.

Figure 10-9: Track Capital Costs, Halifax to Windsor Junction

	Halifax-Cobequid	Halifax-Beaver Bank
Installation of CTC between mile 0.0 and 5.1:	2,000,000	2,000,000
Installation of dual controlled switches and controlled locations:		
Mile 1.6 – for connection to Halifax Ocean Terminal (HOT)	1,250,000	1,250,000
Mile 4.3 – for connection to Rockingham Yard	1,250,000	1,250,000
Mile 5.0 – for connection to Rockingham Yard	1,250,000	1,250,000
Mile 15.5 – for connection to Windsor Junction Depot	1,750,000	1,750,000
Installation of 600 feet passing siding with dual controlled switches and controlled location at both ends:		
Mile 2.30 - M 2.60	1,800,000	1,800,000
Mile 12.10 - Mile 12.75	1,800,000	1,800,000
Mile 14.1 - Mile14.5	1,800,000	1,800,000
Grade Crossing upgrades:		
Installation of Grade Crossing Predictor (GCP) at Cobequid Road crossing (15.09)	100,000	100,000
Installation of protected crossing at mile 15.65 (access to Windsor Jct. depot)	300,000	300,000
Installation of Trespasser Chain Link Fencing along 15% of Right of Way	$360,000	$360,000
Total (Halifax to Windsor Junction)	**$13,660,000**	**$13,660,000**

Source: CPCS analysis

Extensive track rehabilitation would be required over the WHRC from Windsor Junction to Beaver Bank. We have assumed that approximately 50% of the existing ties would require replacement, and sections of 85 lb. rail would also need to be replaced. In addition, clearing and brushing would be required to restore the right-of-way. We have estimated that the additional cost of track upgrades to operate service to Beaver Bank (beyond the Cobequid concept) would be approximately $2.9 million.

Figure 10-10: Track Capital Costs, Windsor Junction to Beaver Bank

	Halifax-Cobequid	Halifax-Beaver Bank
Track Rehabilitation (2.9 miles)		$2,700,000
Installation of Crossing Warning System (Lights & Bells)		
Mile 0.05		$100,000
Mile 0.50		$100,000
Total (Windsor Junction to Beaver Bank)	**$0**	**$2,900,000**

Source: CPCS analysis

In total, the capital cost of track upgrades to operate service to Cobequid and Beaver Bank is estimated to be approximately $13.7 million and $16.6 million, respectively.

10.2.2 Station Capital Costs

Figure 10-11 and Figure 10-12 contain the estimated capital cost of building new stations for the Halifax-Cobequid and Halifax-Beaver Bank Scenarios, respectively, including the anticipated land acquisition costs. We separately assumed the lease cost for the VIA Station in Section 10.1.4. Appendix F includes estimated quantities and unit costs used to derive station costs.

Figure 10-11: Halifax-Cobequid Scenarios Capital Costs

	High	Medium	Low
South End	$1,513,611	$1,183,679	$746,237
West End	$834,187	$774,187	$517,920
Rockingham	$813,226	$813,226	$517,920
Mill Cove	$2,620,575	$2,570,956	$858,818
Sunnyside	$1,307,009	$1,038,151	$858,818
Bedford Common	$2,906,201	$1,351,861	$384,734
Cobequid	$2,306,055	$2,335,642	$384,734
Total	**$12,300,000**	**$ 10,100,000**	**$4,300,000**

Figure 10-12: Halifax-Beaver Bank Scenarios Capital Costs

	High	Medium	Low
South End	$1,647,405	$1,183,679	$746,237
West End	$890,887	$774,187	$517,920
Rockingham	$869,926	$813,226	$517,920
Mill Cove	$2,682,579	$2,570,956	$858,818
Sunnyside	$1,369,013	$1,038,151	$858,818
Bedford Common	$2,149,183	$1,351,861	$384,734
Cobequid	$2,065,119	$2,077,601	$384,734
Beaver Bank	$3,749,702	$3,145,512	$384,734
Total	**$15,400,000**	**$13,000,000**	**$4,700,000**

10.2.3 Depot Capital Costs

Figure 10-13 shows the estimated capital cost of a depot to provide day-to-day maintenance of the commuter rail rolling stock. We estimate that this facility would cost approximately

$2,200,000 in the Halifax-Cobequid and Halifax-Beaver Bank concepts. We have accounted for the cost of a dual-control switch to access the depot separately in the analysis.

Figure 10-13: Depot Capital Cost

Item of Works	Cost
Site development (earthwork, drainage, services and paving)	$250,000
Maintenance shed	$400,000
Concrete pit (or elevated track)	$100,000
Drop table	$100,000
Lightings and power outlets	$125,000
Fuelling site complete with drip trays and oil-water separator	$275,000
Firefighting system	$25,000
Cleaning and washing equipment	$25,000
Compressed air system and pneumatic tools	$150,000
Track work	$360,000
Miscellaneous tools and equipment	$50,000
Road vehicle	$90,000
Land acquisition (one hectare)	$350,000
Total	**$2,300,000**

10.2.4 Rolling Stock Capital Costs

Figure 10-14 contains our allowance for the purchase of the Budd RDC purchase cost in each scenario. We have estimated the number of RDCs required based on 2031 traffic projections and an average seated load factor of 100% during the peak period.[52] We have also allowed for two spare units in all scenarios.

Based on discussions with the owners of Budd RDCs in Moncton, we have allowed an average of $2 million per RDC in capital costs.[53] This value would allow for one RDC per trainset to be configured with a wheelchair lift (as mentioned in Section 8.2), which would cost between $250,000 to $400,000 per RDC equipped with this capability, and one significant maintenance overhaul approximately 10 years after the RDCs enter service, which would cost between $250,000 and $300,000 per RDC. The ultimate cost of the RDCs depends significantly on the

[52] During the peak-of-the-peak, there would be periods during which the actual seated load factor exceeds 100%. At the fringes of the peak, there would be periods during which the actual seated load factor is less than 100%. In the operations model itself, we have assumed an average load factor of 115% to account for the reduction in ridership from the raw output from the Halifax Travel Demand Model (based on an average fare of $1.64) to the adjusted ridership based on the higher zonal fare structure (discussed in Chapter 11).

[53] Emails with Chris Evers, Heritage Management, November 2014.

condition of the units, the installed features, and the regulations that exist at the time of order.[54]

Figure 10-14: Rolling Stock Purchase Costs

Scenario	Number of RDCs	Capital Cost
Halifax-Cobequid High	11	$22,000,000
Halifax-Beaver Bank High	14	$28,000,000
Halifax-Cobequid Medium	11	$22,000,000
Halifax-Beaver Bank Medium	11	$22,000,000
Halifax-Cobequid Low	8	$16,000,000
Halifax-Beaver Bank Low	8	$16,000,000

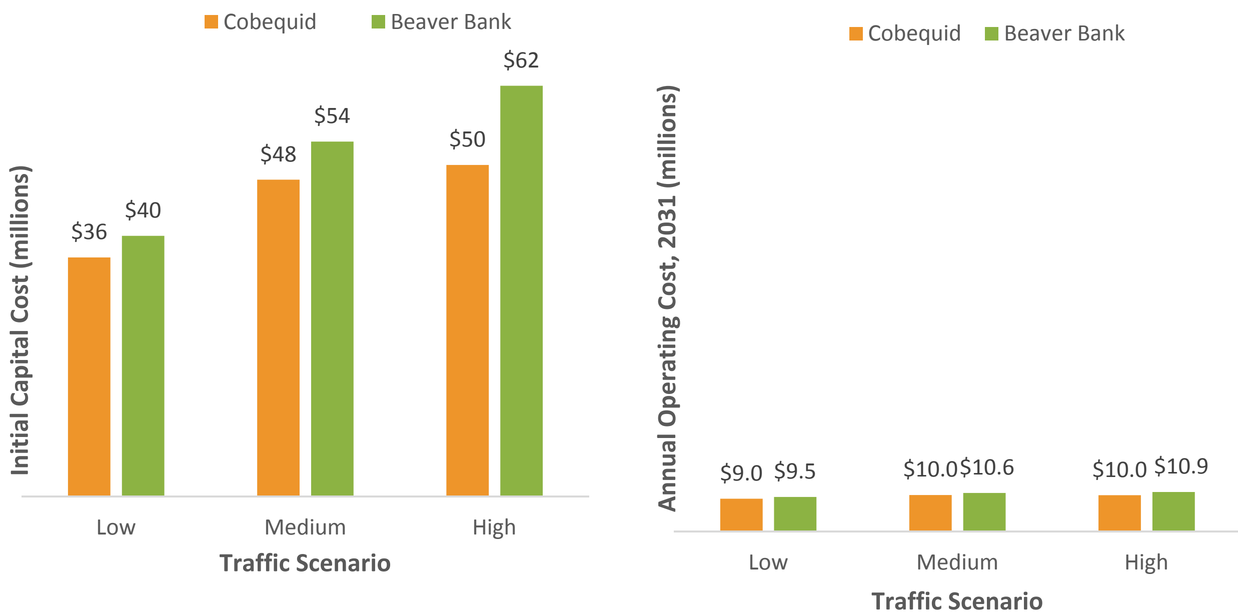
10.3 OPEX and CAPEX Summary

Figure 10-15 contains a summary of the CAPEX and OPEX for each of the scenarios. The estimated CAPEX ranges from a low of $36 million for the Cobequid Low Scenario to a high of $62 million for the Beaver Bank High Scenario. For comparison, the estimated CAPEX of the Elmsdale Scenarios would range from approximately $110 million (low scenario) to $130 million (high scenario), i.e. over twice the CAPEX of the Cobequid or Beaver Bank Scenarios. The estimated OPEX ranges from a low of $9.0 million per year in the Cobequid Low Scenario to a high of $10.8 million per year in the Beaver Bank High Scenario. Because the OPEX model changes the length of the trainset as required to accommodate demand, the operating cost per year (in real dollar terms) would increase modestly between 2018 and 2040.

The annual OPEX for the Beaver Bank concept is higher than that of the Cobequid concept for all demand levels. There is a more significant CAPEX and OPEX difference between the concepts at the high demand level ($12 million and $0.9 million/year respectively) than at the medium and low demand levels, as an additional RDC per trainset is required to accommodate the additional demand in the Beaver Bank High Scenario as compared to the Cobequid High Scenario.

[54] For comparison, one 2009 study estimated that the purchase cost of the Budd RDCs could be upwards of $3.5 million per unit, but note that Industrial Rail Services (the former owners of the RDCs in Moncton) would offer a lower cost to rebuild the units. Ultimately, if the procurement cost for the Budd RDCs were to approach this range, new rolling stock options would be preferable.

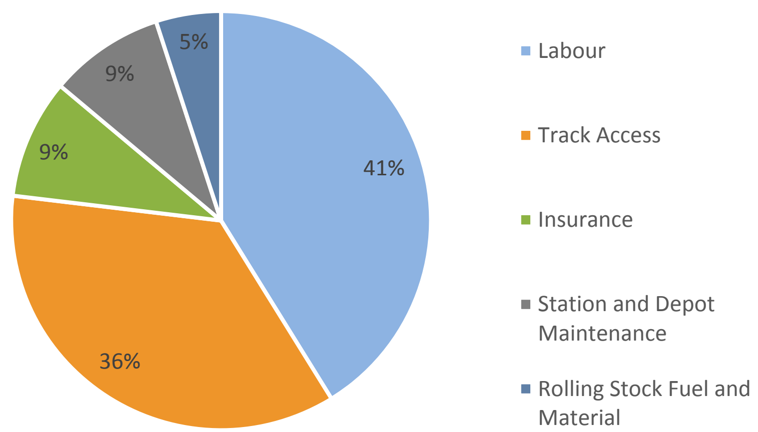
Figure 10-15: CAPEX and OPEX Summary by Scenario



Source: CPCS analysis

One of the most significant cost uncertainties relates to track access charges. As shown in Figure 10-16, track access costs (36%) are the most significant OPEX component after labour (41%). While labour costs can be estimated with some certainty given the characteristics of the operation, track access charges represent a significant uncertainty, as they would be based on negotiations with CN. Any modest increases or decrease in these charges would noticeably enhance or diminish the financial and economic performance of the system. By contrast, most of the other cost components (other than labour) are relatively small.

Figure 10-16: OPEX Breakdown for Cobequid Medium Scenario



Source: CPCS analysis

11 Fare Analysis

Key Messages

Based on the review of fare structure options above and discussions with the Project Staff Technical Team, the simplified three-zone, downtown-oriented fare structure similar to AMT in Greater Montreal was used to calculate revenue.

This fare system strikes a balance between a simple flat fare (which does not account for the associated differences in cost for increasing distances travelled) and a distance-based fare (which calculates the fare based on the specific distances between each station travelled).

In this chapter, we discuss possible fares for the proposed commuter rail system. In order to determine an appropriate fare structure for Halifax, we review and assess various fare structures at other commuter rail agencies in Canada. We then compare these fare levels to the pricing of existing transit services in Halifax. Based on this review, we select a fare structure and fare levels for the proposed commuter rail system for the subsequent revenue analysis. Finally, we provide a rationale for the fare levels selected, and the range of possible fares that could be selected should commuter rail service be implemented.

Ultimately, selecting a fare level would be a trade-off between generating more revenue through higher fares (to cover operating costs) and encouraging the social and economic benefits that transit service provides by supporting lower fares (and maximizing ridership). As fares increase, revenues typically also increase to a point[55], reducing the ongoing operating funding required from other sources, which are discussed in Chapter 12. However, increasing fares also results in fewer people using the system, decreasing the economic benefits of providing transit (e.g. travel time savings, carbon emissions, etc.), which are discussed in Chapter 13. As a result, the ultimate fare level selected is a policy decision that must weigh the competing objectives of improved financial or economic performance.

11.1 Fare Structure and Revenue Generation

11.1.1 Fare Structure Review

There are several different fare structures that could be considered for a commuter rail service. Three models were reviewed and assessed for their potential application on the Halifax commuter rail corridor.

- Single fare system
- Zone fare system
- Fare by distance system.

These are described in more detail below.

[55] Transit fares are typically inelastic with respect to price; that is, a 10% increase in price would result in less than a 10% decrease in ridership. The implication of this behaviour is that an increase in fares would result in an increase in revenue. See e.g. "Transit Price Elasticities and Cross-Elasticities" by Todd Litman, available at: http://www.vtpi.org/tranelas.pdf.

Single Fare System

A single fare system is one in which passengers pay a flat fare, regardless of the distance travelled along the commuter rail corridor. This type of fare model is not typical for commuter rail lines but is in place in a number of transit systems that offer bus, light rail and subway service. For example, travel from one end of Toronto to the other on the Bloor Subway and Scarborough Rapid Transit Line is approximately 50 kilometres, which is a similar distance to a number of commuter rail corridors. This trip can be made with a single flat fare.

Zone Fare System (Downtown Destination)

The Agence Métropolitaine de Transport (AMT) in the Greater Montreal Area operates on a zone fare system; the fare structure is based on the proximity to downtown as the final destination. There are eight zones in the system with downtown Montreal as the central zone. The commuter rail service operates within seven zones. Single ticket one-way fares range between $9.75 (Zone 7) and $3.75 (Zone 1).

The fare structure is based on travel to/from Zone 1 (downtown), and there are no discounts for travel that occurs between adjacent zones (e.g. passengers travelling between Zone 7 and Zone 5 are charged a Zone 7 fare, which assumes the passenger is travelling to Zone 1 covering downtown Montreal).

Fare by Distance

GO Transit in the Greater Toronto Area operates on a fare by distance formula. In this system, there are no distinct zones, however, a fare calculator identifies a fare based on the kilometres between each station. This is similar to the TransLink system, but without the delineated zones. A base fare of $5.20 is used for an adult one-way trip for all travel within approximately 10-12 km. After that, a fare by distance formula is applied which increases the fare based on distance travelled between stations.

11.1.2 Fare Level Pricing

Existing Canadian Commuter Rail Systems

Figure 11-1 compares the one-way adult fares in each of the existing commuter rail systems in Canada based on the approximate kilometres of travel. As shown, each system operates based on a zone fare or fare by distance formula. The proposed stations in Halifax that would approximately be at the same travel distance are also included below as a point of comparison.

Figure 11-1: Fare Comparison of Passenger Rail Travel

Distance from Downtown *(Comparison of Halifax Station)*	AMT	TransLink	GO Transit
~50km (Elmsdale)	$9.75	$9.00	$9.05
~35km (Wellington)	$8.50	$9.00	$7.45
~25km (Cobequid)	$7.00	$7.25	$6.05
~20km (Bedford Common)	$7.00	$7.25	$6.05
~15km (Mill Cove)	$5.25	$7.25	$5.30
~5km (Rockingham)	$3.75	$5.50	$5.20

Source: CPCS Team analysis of transit agency fares

As identified above, the lowest fare is from AMT at $3.75. Fares for commuter rail services are typically higher than fares charged by local transit operators, primarily due to the higher level of service provided on commuter rail. The high fares in each of the three existing commuter rail services are also reflective of the high costs of downtown parking in the downtown areas of these larger metropolitan areas. All three regions also experience significant congestion during the peak periods, making commuter rail an attractive option.

In these metropolitan areas, commuter rail fares for service within the boundary of the local transit agency are just under double the cash fare of the local transit agency. For example, as shown in Figure 11-2, the fare to ride GO Transit within the City of Toronto (which approximately corresponds to the service boundary of the Toronto Transit Commission [TTC], the local transit operator) is $5.30 to $5.60 per ride, or approximately 1.8 to 1.9 times the TTC cash fare of $3.00.

Figure 11-2: Cash Fares Covering Urban Transit Service Boundary

Metropolitan Area	Local Transit Agency Cash Fare	Commuter Rail Agency Fare (for trips within Local Transit Agency Service Boundary)	Ratio Commuter rail fare / Transit Agency Fare
Toronto	$3.00 (TTC)	$5.30-$5.60 (GO Transit)	1.8-1.9
Montreal	$3.25 (STM)	$5.50 (ATM)	1.7
Vancouver	$5.50 (TransLink)	$9.00 (WCE)	1.6

Source: CPCS analysis of transit agency websites

Existing Halifax Transit Fares

In order to determine appropriate commuter rail fares in Halifax, we have compared the local transit fares in the three regions to the existing transit fares in Halifax. Halifax Transit has three types of fares based on the service it provides.

- The conventional bus, ferry and access-a-bus service costs $2.50 for an adult fare. These are local services and focus more on accessibility to stops than speed of service.

- Halifax Transit also offers two types of long-distance limited stop services. MetroLink routes provide peak period limited stop services for commuters in the Portland Hills and Sackville areas. This is a similar distance to the Sunnyside and Bedford Common Station. A one-way adult fare for this service is $3.00.

- MetroX provides peak period limited stop services that transports passengers between rural areas within the region such as the Airport and Fall River to downtown Halifax. Distances on these services are similar or farther than the potential Elmsdale Commuter Rail Station. A one-way adult fare for this service is $3.50.

Comparison Between Halifax Transit and Other Jurisdictions

Halifax Transit's existing conventional service fare ($2.50) is less than the fares of local transit agencies in cities with commuter rail in Canada (as shown in Figure 11-2). Additionally, Halifax Transit's express fares for express and longer distance commuting ($3.00 for MetroLink or $3.50 for MetroX) are less than the comparable express bus fare in Toronto, which in that case is double the base TTC cash fare ($6.00). However, some comparable jurisdictions in Canada in terms of population have comparable fares to Halifax. For example, cash fare in Victoria, BC (population 360,000) for conventional bus service is $2.50.

Should Halifax's existing $2.50 fare exist when commuter rail is implemented, the equivalent commuter rail fare within the Halifax Urban Transit Service Boundary based on the ratios in Figure 11-2 would be approximately $4.00 to $4.75.[56] This value is less than the fare charged by GO Transit and AMT ($5.30-$5.60) for service within the municipal boundaries, but is reflective of the lower conventional bus fare in Halifax. It is also less than the fare charged for comparable distances, i.e. $7.25 in Vancouver (Figure 11-1)

11.1.3 Fare Structure Options for Halifax

Based on the above analysis, the following fare structure options were developed and assessed for commuter rail in Halifax. The proposed fare structure is based on examples elsewhere in Canada, modified to reflect the Halifax market.

Option 1: Single Fare

In this option, a single flat adult fare trip would be used, no matter what the distance commuters are travelling. This approach is similar to that already used in Halifax, which charges flat fares for its premium or longer distance MetroLink routes. The single fare

[56] The Urban Transit Service Boundary includes all potential stations except for Cobequid, Wellington and Elmsdale. Though Cobequid is not included in the service boundary, it is only approximately 2 km from the boundary. Should service continue to Beaver Bank, the proposed station would still be within the service boundary. Thus, for fare analysis purposes, Cobequid and Beaver Bank have been included in the urban service boundary. http://www.halifax.ca/regionalplanning/documents/Map7UrbanTransitServiceBoundaryRP5.pdf

structure allows for seamless integration with the rest of the network and is easiest to understand and monitor. Should fares levels be set in line with existing Halifax Transit express services (i.e. $3.00), it would have the greatest ability to attract ridership from competing bus services (due to the low cost). If the fare were set higher, it would improve the financial performance of the commuter rail system, but discourage rail ridership, particularly for shorter distance trips. Given Halifax Transit's existing $2.50 fare, the highest flat fare that should be charged is approximately $5.00 (to Beaver Bank or Cobequid), i.e. double the conventional transit fare.

Regardless of the flat fare level selected, we do not recommend a flat fare if service is to extend as far as Elmsdale, given the higher capital and operating costs required to operate service past Windsor Junction.

Option 2: Zone Fare (Downtown Orientation)

In this option, two zones would be used between Beaver Bank Station and VIA Station (Beaver Bank Scenarios) and between Cobequid Station and VIA Station (Cobequid Scenarios). (Should service continue to Elmsdale, three zones are proposed along the rail corridor between Elmsdale Station and VIA Station). Zone 1 would extend to and include Rockingham (the last station without a park and ride) and Zone 2 would extend to and include Beaver Bank. (Zone 3 would extend beyond Cobequid towards Wellington and Elmsdale). This approach adds complexity in terms of passenger use and proof-of-payment monitoring, but ensures that shorter distance trips are not overly discouraged by a higher flat fare.

Given that the majority of trips are to downtown Halifax, the fare structure would be based on travel to/from the VIA Station. For example, travel with an origin or destination in Zone 3 would cost the same whether the passenger stays within Zone 3 or travels to Zone 1 or 2. This is similar to the AMT Zone Fare system and presumes the majority of travel is destined to Zone 1 (the downtown area).

Option 3: Fare by Distance

In this option, three fare zones are assumed based on distance of travel. The proposed distances are indicated in Figure 11-3. The zones are based on distance of travel between stations and *not* proximity to the downtown. This structure is similar to the GO Transit and TransLink models.

Figure 11-3: Fare by Distance Formula

Distance (miles)
0 - 7
7.1 - 16
16.1 - 34

The distances identified above were designed to replicate the same zone categories as Option 2 (Zone Fare System – downtown orientation) for trips to/from VIA Station. The difference between this option and the zonal fare option is that it does not penalize passengers who are not destined to downtown Halifax and travelling to intermediate stations.

11.1.4 Fare Integration with Halifax Transit

Regardless of the fare structure selected, an integral measure to enhance the attractiveness of the transit system as a whole is an integrated fare system. In other words, the proposed commuter rail and existing bus systems should not have fare systems completely independent of each other. Rail fares should include free (or heavily discounted) transfers to connecting bus services. Implementing this simple measure would result in the expansion of catchment areas, both on the origin and destination ends of a trip. Bus and train services should not be competing for the same passengers; rather, they should act in a complementary manner, with trains transporting passengers over longer distances, and buses making the crucial local connections between the train stations and the origin/destination.

TransLink in the Greater Vancouver Area offers full integration of fares with the purchase of a West Coast Express Commuter Rail trip. Fare formulas are based on the zone of travel and allow a passenger to transfer to any other transit mode (e.g. SkyTrain and bus) to complete their trip.

GO Transit offers partial fare integration for its customers connecting to GO Rail stations via local transit services. GO Transit operates separately from the local transit providers in the municipalities it services; therefore each has its own fare structure. To help reduce parking requirements at suburban park-and-ride lots, GO Transit offers a fare integration program for customers who connect by local transit of up to 75% of the local transit adult passenger fare. As an example, in the Town of Milton, Milton Transit customers connecting to the GO Train station pay only $0.65 for their local transit trip instead of the regular $3.25 adult passenger fare (or $26.00 for a monthly integrated pass instead of $70.00 for a regular adult pass). GO Transit pays the balance of the fare to the local transit operator. This structure has two advantages:

- It reduces the overall fare for the customer, making transit a more affordable choice
- It reduces the number of parking spaces required at park-and-ride lots, reducing the overall cost to GO Transit to accommodate passengers

Within Halifax, fare integration between the commuter rail and local Halifax Transit services should be in place. TransLink offers the most convenient model, as passengers do not have to worry about paying multiple fares to complete their trip.

11.1.5 Fare Affordability Considerations

Halifax Transit may wish to consider affordability when setting transit fares. A discussion of fare affordability specific to the context of Halifax is beyond the scope of this analysis. However, in a CPCS analysis of nine large international jurisdictions with metro systems, we found that that a single cash fare for adult riders as a share of minimum wages varies between about 10%[57] and 35%.[58] Some cities offer further discounts through fare concessions (discounts) targeted at groups that are low income (means tested) or likely to be low income (but not means tested, e.g. persons with disabilities), or other mechanisms. By comparison, Halifax Transit's base fare of $2.50 per ride is approximately 24% of the experienced minimum wage, and thus falls in this range.

11.2 Fare Structure Proposed for Revenue Analysis

11.2.1 Proposed Fare

Based on the review of fare structure options above, the three-zone downtown-oriented fare structure similar to AMT in Greater Montreal was used to calculate revenue. This fare system strikes a balance between a simple flat fare (which does not account for the associated differences in cost for increasing distances travelled) and a distance-based fare (which calculates the fare based on the specific distances between each station travelled).

Three zones are proposed along the rail corridor, should service extend to Elmsdale. Two zones are proposed along the rail corridor for the Beaver Bank and Cobequid concepts. The proposed zones and potential single-ride adult fares (along with the estimated average fares) are provided in Figure 11-4.[59]

[57] This figure excludes Tallinn Estonia, which offers free fare public transit to its residents.

[58] Our analysis did not specifically consider commuter rail service.

[59] The Halifax Travel Demand Model includes an assumption that fares for the proposed commuter rail service would be equivalent to the existing Halifax Transit average fare paid of $1.64. The average fare is a calculation of total passenger revenue divided by total ridership and takes into account fare concessions such as monthly passes, U-Passes and reduced fares for seniors and students. The average fares for the zonal fare structure were calculated using the same ratio between the existing Halifax Transit adult fare ($2.50) and the existing Halifax Transit average fare ($1.64), which was used in the demand-forecasting model.

Figure 11-4: Zonal Fare (downtown orientation) Considered in the Revenue Analysis

Station	Distance from VIA Station (miles)	Zone	Adult Cash Fare	Average Fare
VIA	0.0	Zone 1	$3.00	$1.97
South End	2.6			
West End	3.8			
Rockingham	6.0			
Mill Cove	9.0	Zone 2	$4.50	$2.95
Sunnyside	10.5			
Bedford Common	12.7			
Cobequid	15.0			
Beaver Bank	18.6			
Wellington	23.4	Zone 3	$6.00	$3.94
Elmsdale	32.1			

The fare formula is based on travel to/from Zone 1. Since most trips on a proposed commuter rail system in Halifax would be between suburban stations and the downtown, a downtown orientation is reflective of the dominant usage of the system.

We recommend and assume that commuter rail fares be fully integrated with existing Halifax Transit bus fares, such that individuals arriving by bus, U-Pass or with an existing Halifax Transit monthly pass would only be required to top-up the difference between the original fare paid (or the fare level corresponding with the pass) and the commuter rail fare. For example, if a traveler with a U-Pass arrives at Zone 3, he/she would be required to pay an additional $3.50 to ride the commuter rail service since the U-Pass has a value of $2.50 per trip. This approach is consistent with Halifax Transit's approach to pricing other longer distance bus services, including MetroLink and MetroX. **This approach also does not penalize customers taking Halifax Transit to access the rail service by charging them a higher fare than passengers driving to/from the rail stations.**

11.2.2 Fare Level Considerations

We set the fare levels in Halifax at the lower end of the range of existing commuter rail fares in Canada. Commuter rail fares for comparable distances to Cobequid or Beaver Bank from the VIA station (Zone 2) can be as high as $7.25, though most commuter rail fares covering the same area to an urban transit system are closer to $5.30 to $5.60. Comparable fares in other jurisdictions for similar distances as Zone 1 can between $3.75 and $5.50. Ultimately, for the Zone 2 fare, we set the fare at approximately 1.8 times the conventional bus fare in Halifax (i.e. $4.50). The Zone 1 fare was set at the same level as the MetroLink bus fares (i.e. $3.00), $0.50 higher than the conventional bus fare.

The primary consideration for selecting this fare level is the recognition that Halifax Transit has lower bus fares than jurisdictions with commuter rail in Canada. While we considered using $3.00, the MetroLink fare as the base fare by which to multiply by the 1.8 factor, the MetroLink is also a premium transit service with higher frequency than commuter rail, similar travel times at comparable distances, though with arguably less reliability than commuter rail due to potential roadway congestion. As discussed, the TTC charges twice the base fare for such express bus services, which is more in line with GO Transit commuter rail fares. Our research would suggest that Halifax Transit MetroLink service should be priced more in line with commuter rail fares, should commuter rail be introduced.

Fare Selection: Methodological Considerations

A key test of the economic viability of a project is achieving a benefit-cost ratio greater than one. As will be shown in Chapter 13, the benefit-cost ratios for all scenarios are less than one; that is, the economic benefits are less than the economic costs. Increasing the fares would further decrease the benefit-cost ratios calculated. As such, we selected a fare at the lower end of the reasonable range of fares to confirm with some confidence that a benefit-cost ratio of one or greater could not be achieved.

Ultimately, should Halifax Transit move forward with the implementation of commuter rail, it might wish to consider higher fares for commuter rail than those considered by this feasibility study. However, before doing so, it should study the question of fares from a system-wide perspective to ensure that transit offerings are all priced competitively to reflect their respective service quality.

12 Financial Analysis

Key Messages

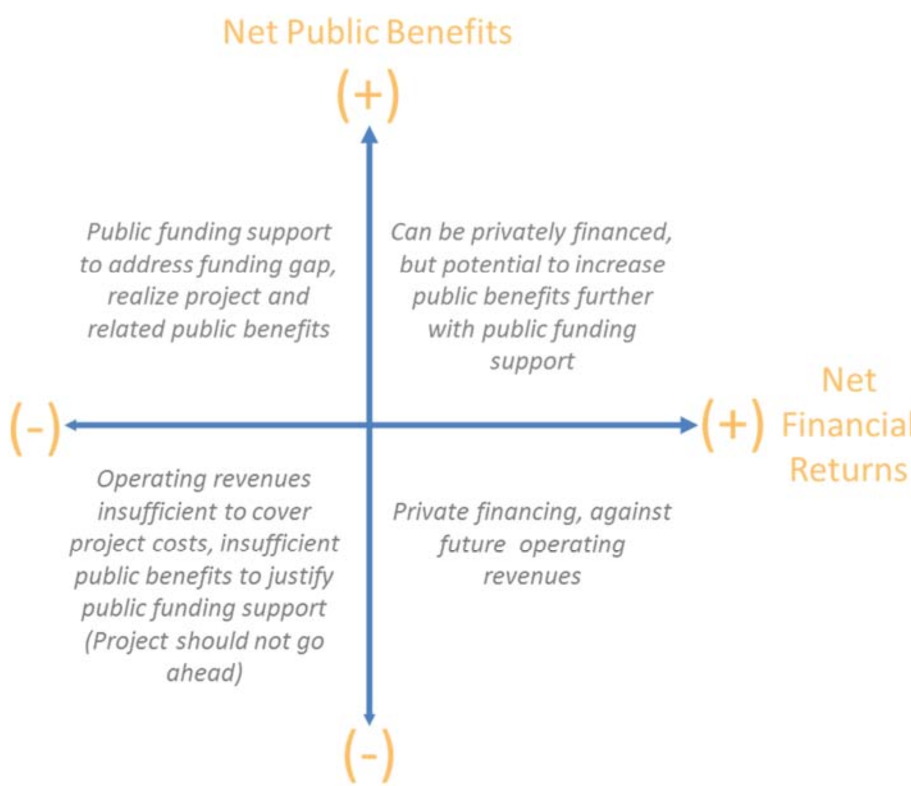
- Revenue forecasts vary between $0.8 million per year (both low demand scenarios) to $2.7 million per year (Beaver Bank High Scenarios). In the medium and high scenario, the addition of a station at Beaver Bank would provide $0.5 (medium) to $0.4 (high) million per year in additional revenue beyond the Cobequid service.

- Should a commuter rail system be operating in 2031, we anticipate that it would have a recovery ratio between 9% and 27%. The recovery ratio would increase by approximately five percentage points in each scenario between 2018 and 2040 as a result of ridership growth. For comparison, farebox cost recovery from existing commuter rail operating in the US varies from 3% to 63%. Most operators achieve less than 50%. The recovery ratio in the Cobequid and Beaver Bank Medium Scenarios (in 2031) would result in a higher recovery ratio than approximately one-quarter of the existing commuter rail operations in the US.

- In all six scenarios the financial net present value (FNPV) is negative, and varies between -$164 million and -$187 million. This result reflects relatively high upfront capital costs, high operating costs and relatively modest revenues during the operating phase of the project. The Cobequid Scenarios have a slightly less negative FNPV than the Beaver Bank Scenarios.

The implications of a transportation infrastructure project can be thought of along two key dimensions, as shown in Figure 12-1. In this matrix, the vertical axis represents the social benefits of a project; projects in the upper two quadrants have social benefits (e.g. travel time savings, automobile cost savings and environmental benefits) that exceed the cost of the project. The horizontal axis represents the financial returns of the project; that is, the benefits that accrue solely to the entity that implements the project (i.e. the commuter rail agency). Projects in the two right quadrants have financial returns that exceed the cost of the project. Projects in the left quadrants have negative financial returns.

Figure 12-1: Matrix of Public and Financial Benefits



Source: CPCS and others

The quadrant that a proposed project is in determines what type of action should be taken. Commuter rail projects are generally located in one of the left two quadrants; that is, the commuter rail agency does not recover its capital and operating costs through farebox and ancillary revenues alone, so its financial returns will be negative. However, should a proposed project create net social benefits and fall in the upper-left quadrant, government capital and operating funding can be justified on the basis that it supports positive social benefits. By contrast, projects in the lower left quadrant should not proceed because neither the net social benefits nor financial returns of the project are positive.

In this chapter, we discuss the *financial* implications of a commuter rail system on Halifax Transit considering several metrics, including:

- Revenue, which specifically refers to the farebox revenue
- Cash requirements, which is the difference between the cost (capital or operating) and revenue in a given year
- Farebox recovery ratio, which is the ratio of revenue to operating cost
- Financial net present value (FNPV), which is the present (discounted) value of the revenues minus the capital and operating costs

As expected, a commuter rail system in Halifax would have negative financial returns, and would fall in one of the left two quadrants. As a result, in this chapter, we (1) quantify the metrics above to assess the degree to which additional financial support would be required and (2) describe other alternatives for increasing revenue through other sources.

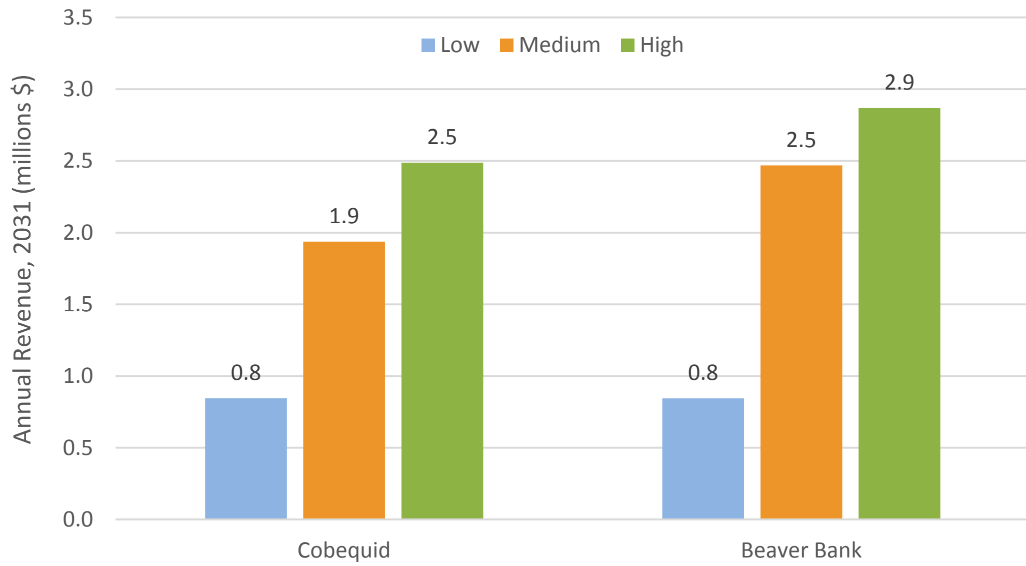
12.1 Revenue Forecast

We estimate annual revenue for the six scenarios assuming the zone-fare discussed in Chapter 11 (Figure 12-2). The results presented here are expected revenues in 2031; revenues would increase proportionally to traffic growth over the analysis period.

The revenue forecast is the incremental revenue that Halifax Transit would expect to receive after the implementation of the commuter rail system (and any changes to the bus network). The methodology for the revenue analysis is elaborated in Appendix G. It accounts revenue lost by Halifax Transit from transit users switching from bus to rail as well as the fare integration between commuter rail service and bus service proposed in Chapter 10.

Revenue forecasts vary between $0.8 million per year (both low-demand scenarios) to $2.9 million per year (Beaver Bank High Scenarios). In the medium and high scenario, the addition of a station at Beaver Bank provides $0.4 to $0.5 million in additional annual revenue beyond the Cobequid service.

Figure 12-2: Revenue Forecast



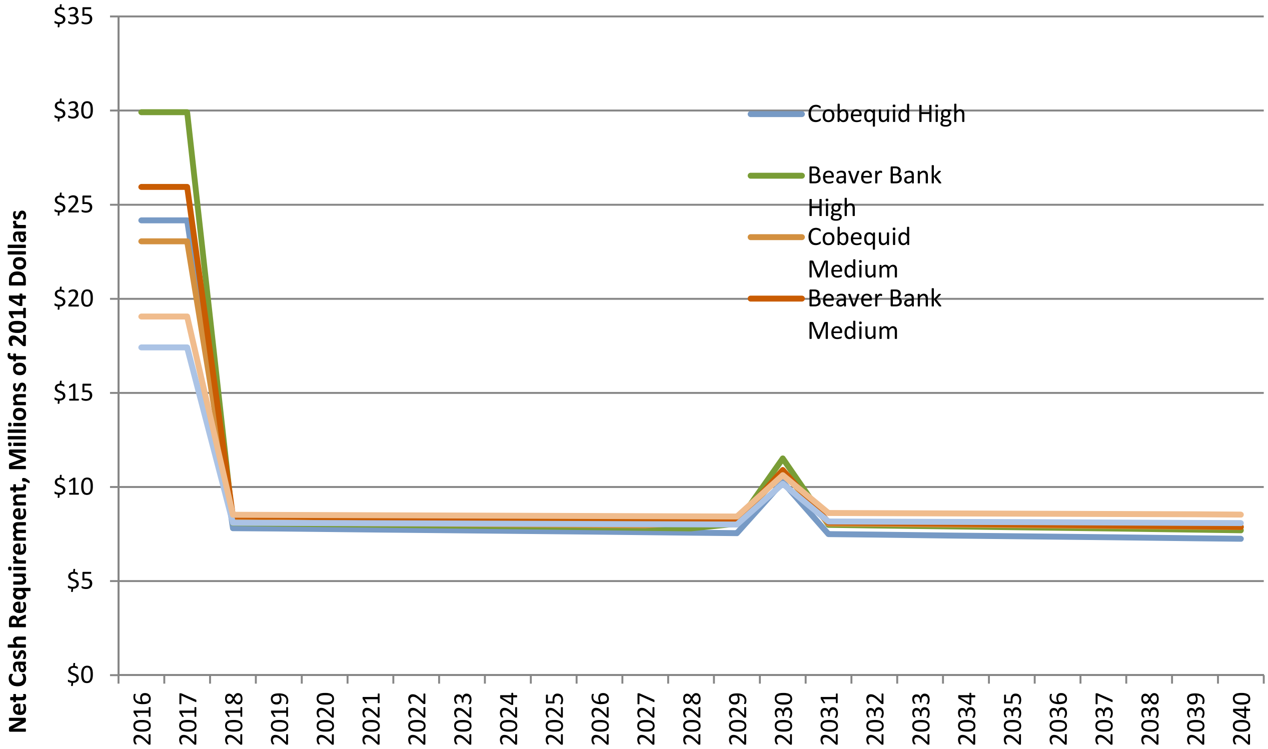
Source: CPCS Team

12.2 Operating Support Requirements

Figure 12-3 shows the net cash requirement associated with the two-year construction (2016-2017)[60] and 23-year operating phases of the proposed Halifax Commuter Rail System. Net cash requirements are calculated as the difference between costs and revenues, and can be viewed as the funding gap that needs to be filled to operate the system. Initially, the Beaver Bank Scenarios have a somewhat higher cash requirement due to the higher capital cost of these scenarios; afterwards, the cash requirements of all six scenarios vary between $7.3 million to $8.5 million per year, except approximately 10 years after service entry, when an additional maintenance overhaul would be required on the rolling stock.

[60] We have assumed that the total capital costs estimated in Chapter 9 (except for the RDC maintenance overhaul in year 10) would be approximately evenly distributed over two years; hence, during each of the first two years of the project, the net cash requirements are approximately one-half of the total capital cost.

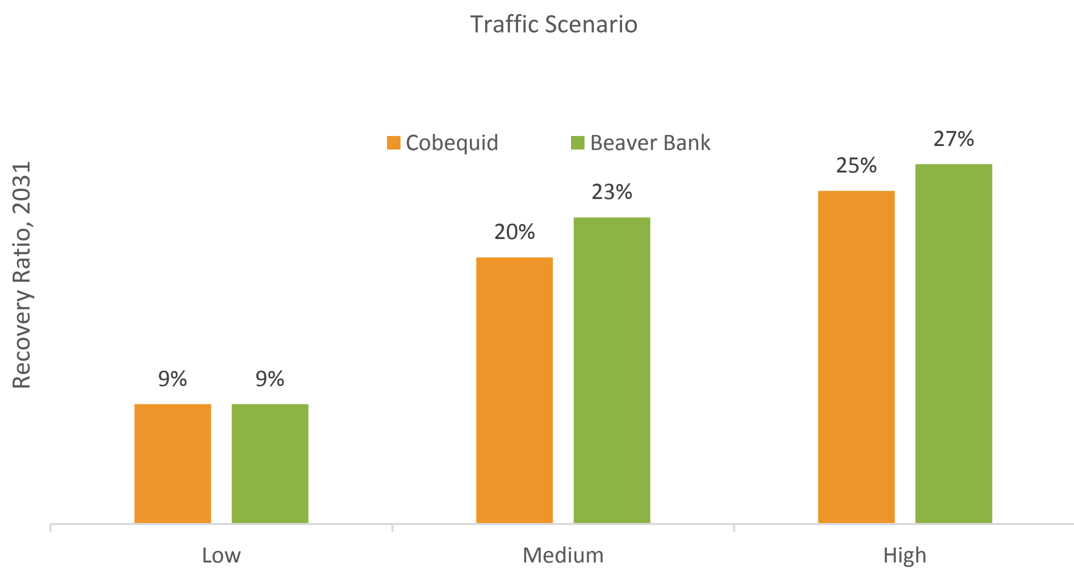
Figure 12-3: Cash Requirements for Commuter Rail Development and Operations, 2016-2040



Source: CPCS.

Figure 12-4 shows the farebox recovery ratio, i.e. the fraction of operating costs (including costs associated with shuttle buses and bus route changes) that is recovered through fare revenues. Should a commuter rail system be operating in 2031, we anticipate that it would have a recovery ratio between 9% and 27%. The recovery ratio would increase by approximately five percentage points in each scenario between 2018 and 2040 as a result of ridership growth. The Beaver Bank Medium and High Scenarios would perform better along this metric than the Cobequid Medium and High Scenarios; the additional ridership boarding at Beaver Bank Station would allow the commuter rail system to recover a greater proportion of its operating costs through fares.

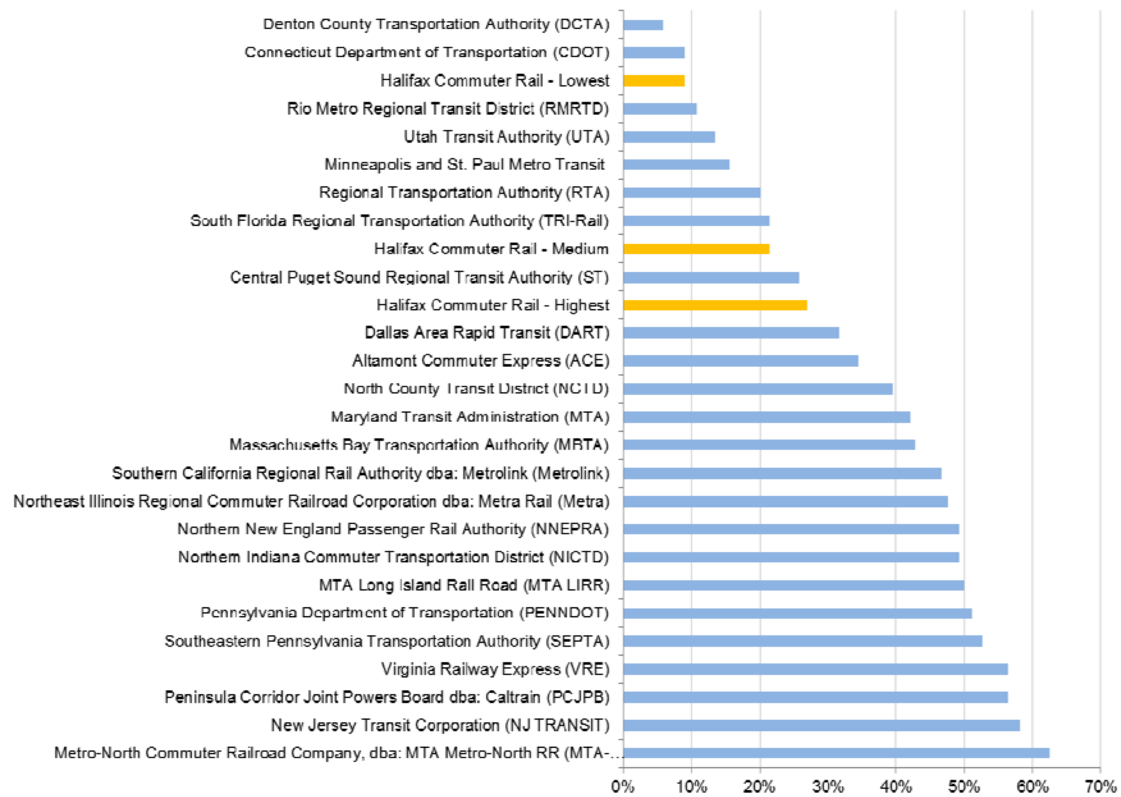
Figure 12-4: Farebox Recovery Ratio, 2031



Source: CPCS

Comparison: US Commuter Rail Systems Recovery Ratio

The figure below shows the recovery ratio of all existing commuter rail systems in the US. None of the 24 publicly owned commuter rail systems in the US currently cover their operating expenses from passenger revenues. As can be seen from the figure below, passenger cost recovery from operations varies from 3% to 63%. Most achieve less than 50%. The recovery ratio in the Cobequid and Beaver Bank Medium Scenarios (in 2031) would result in a higher recovery ratio than seven of the 24 existing commuter rail operations (29%) in the US.



Source: CPCS analysis of Federal Transit Administration's 2012, National Transit Database (NTD), 2012 NTD Data Tables, "Fare Per passenger and Recovery Ratio". Downloaded from: http://www.apta.com/resources/statistics/Pages/NTDDataTables.aspx (accessed August 13, 2014). The recovery ratio is the percentage of operating expenses covered by passenger revenues.

12.3 Financial Analysis

12.3.1 Cost of Capital

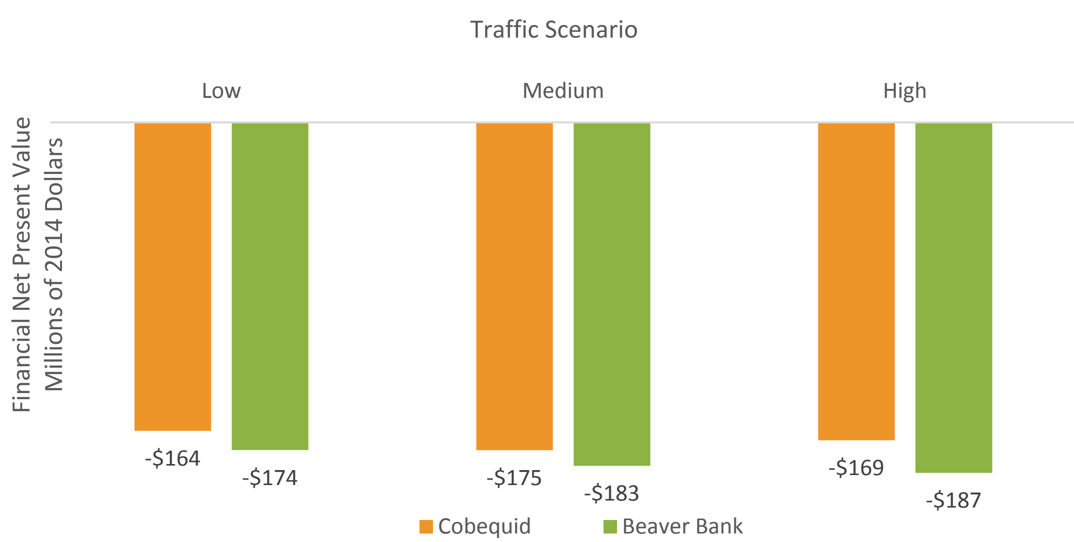
In order to discount future cash flows to estimate a financial net present value (FNPV) for the project, an appropriate discount rate is required. The financial discount rate can be viewed as the cost to Halifax of cash used in the project. Halifax raises cash through both debt and taxes.

The cost of debt is relatively straightforward and is generally calculated as the interest paid divided by the market value of debt. The cost of taxes is much more complex, and relates to the cost to the economy of the economic distortions generated by the various taxes levied by Halifax and the senior governments that may provide funding to Halifax. Given the conceptual nature of this study, we have chosen to use only the cost of debt as the financial discount rate for the project. In 2013 Halifax was borrowing at a nominal rate of 5%,[61] which is equivalent to a real rate of 3% assuming annual inflation of 2%.

12.3.2 Financial Net Present Value

The FNPV is the discounted sum of all net cash flows associated with the project, which includes changes to bus routes. In all six scenarios the FNPV would be negative, given the 3% real financial discount rate adopted. This result reflects relatively high upfront capital costs, high operating costs and relatively modest revenues during the operating phase of the project. The Cobequid Scenarios would have a slightly less negative FNPV than the Beaver Bank Scenarios (except in the high demand level scenarios), which suggests that the incremental revenue from the Beaver Bank Scenarios would not quite offset the additional costs of running longer service. However, in the Beaver Bank High Demand Scenario, the fact that shuttle buses would not be provided from Fall River and Beaver Bank results in a similar FNPV as the Cobequid High Scenario.

Figure 12-5: Financial Net Present Value



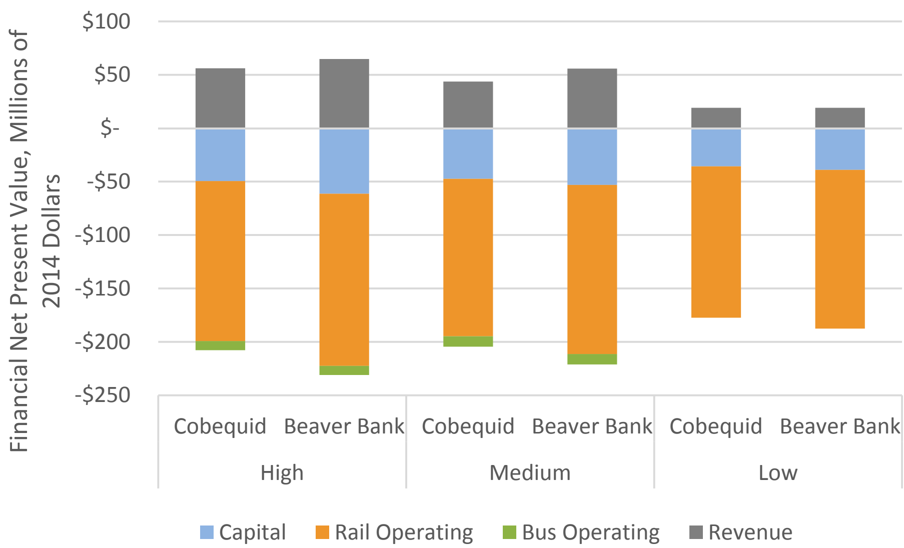
Source: CPCS

61 http://www.halifax.ca/council/agendasc/documents/130409ca1113.pdf

The FNPV analysis provides guidance on a preferred alternative from a financial point of view only. From this point of view, none of the six scenarios should be adopted, because all would result in significant financial cost to Halifax Transit, i.e. returns are much lower than the 3% cost of the funds used to make the investment. However, this analysis does not include the potential social and economic benefits of a commuter rail system, which are addressed in Chapter 12.

Figure 12-6 shows how the FNPV figures presented in Figure 12-5 are composed in terms of revenue, capital costs, rail operating costs and net bus operating costs. Rail operating costs are the largest cost in all scenarios, and bus service changes add to, rather than reduce, overall costs. However, the change bus operating costs are relatively modest as compared to the rail operating costs of the system, and are lower in the high scenarios than in the medium scenarios as a result of the removal of bus routes that compete with commuter rail service (as per the modelling assumptions).

Figure 12-6: Financial Net Present Value by Major Revenue and Expenditure



Source: CPCS

12.4 Risk Assessment

This section provides a complete list of potential hazards and risks that could occur during implementation of the commuter rail line, and proposes mitigation measures for each. In this section, the proponent of the commuter rail line refers to Halifax or any entity created or assigned to develop the commuter rail project.

12.4.1 Construction Risk

Figure 12-7 sets out the most important construction risks associated with the commuter rail project.

Figure 12-7: Construction Phase Risks

Risk	Description	Primary Responsibility
Planning	Construction is not correctly planned	Construction contractor
Technology	Technology is not fully functioning and it is discovered post-construction that the project is not performing as expected as a result	
Delay	Construction phase is completed later than planned	
Low performance	The project is not performing to agreed specifications.	
Cost	Costs are higher than budgeted.	
Other performance failure	The project is delayed or underperforms for reasons outside of the control of the construction contractor	Proponent

Mitigation

Our proposed mitigation strategy is based on the principle of transferring risks to the party that is best placed to manage and control the type of risk in question.

The construction contract should include the following three provisions:

- Specific provision for a maximum cost ceiling
    - Any extra costs above this ceiling, within the responsibility of the contractor, would be covered by the construction contractor.
- Specific provision for the payment of delay in construction damages
- Specific provision for the construction contractor to pay damages if the project fails to meet minimum performance standards, as tested by an independent engineer once construction is complete.

Moreover the construction contract should be backed with a bank warranty, such that in the event the contractor is unable to pay damages, the bank would pay those damages on the contractor's behalf.

In practice, it may be difficult to put these provisions into place for the track work construction, which must be undertaken by CN or a CN-hired contractor.

12.4.2 Operating Risk

Figure 12-8 sets out the three most important operating risks associated with the commuter rail project.

Figure 12-8: Operating Phase Risks

Risk	Description	Primary Responsibility
Demand/market	Traffic on the line is lower than projected.	Proponent
Operational	Malfunctioning, bad procedures, inadequate maintenance, natural disaster	Operations and maintenance contractor(s)
Supply	Risk that the project runs short of raw materials to function as planned.	Suppliers

Mitigation

Demand risk would be the most important risk facing this project, and also the most difficult to mitigate. The most important approach to mitigating demand risk would be to develop a commuter rail line that has the highest FNPV, per Section 12.3.1. As well there are a wide range of land use planning tools that could be employed to strengthen the transit orientation of development around stations, thereby increasing ridership. Some of these tools will be discussed in Section 12.5.1. Finally, there are larger policy tools such as road pricing that could be employed to further strengthen the attractiveness of commuter rail to riders (see Section 12.6).

Operating risk should be mitigated through the use of an operating and maintenance (O&M) service level agreement (SLA). This contract provides for payment to the proponent for damages resulting from the underperformance of operations relative to the agreed-upon service levels. Use of an O&M agreement allows the proponent to shift operating risk to the O&M contractor(s).

Supply risk could be mitigated by implementing put-or-pay agreements with a small number of suppliers. Such agreements should specify the quantity, delivery date, quality and price of the supplies required. In the event that the supplier is unable to deliver as promised, it would be required to procure supplies from alternative sources and to bear any additional costs of doing so. Use of a put-or-pay supply contract transfers the risk of supply disruptions from the proponent to the supplier.

In this project the train service agreement to be negotiated with CN would represent a notable supply risk, as it is difficult to know in advance the terms of conditions of such an agreement. Moreover, CN is the only possible supplier, and therefore the proponent would have no alternative supplier to turn to if it encountered difficulties in negotiating an agreement with CN. However, there would be the possibility of recourse to the Canadian Transportation Agency, as described in Chapter 5.

12.4.3 Risks Common to Both Phases of the Project

Figure 12-9 sets out risks that would exist throughout the project lifecycle and associated mitigations.

Figure 12-9: Risks Common to Both Phases of the Project

Risk	Description	Primary Responsibility	Mitigation
Counterparty	Counterparty risk is the risk that one of the counterparties is unable to perform in accordance with the terms of the relevant agreement. For example, the construction contractor is unable to pay damages associated with a delay in completion of the project or a supplier is unable to pay damages in lieu of finding alternative sources of supply.	Proponent	The most important way of mitigating counterparty risk is to ensure that the counter parties are financially stable and sound. In addition, provision should be put in place to substitute new counterparties in the event that a counterparty loses the ability to perform.
Natural disaster	Like counterparty risk, natural disaster risks can occur at any time in the project lifecycle and include the risks associated with natural disasters and political uncertainty.	Insurance company	It is possible to insure against natural disasters.
Legal and regulatory	Legal and regulatory risk reflects the potential that laws and regulations may change during a project lifecycle and would affect the performance of the project. For example, governments can change rail safety or air emissions regulations at any time, potentially affecting the ability of the commuter rail line to be operated with particular type of rolling stock. The legal/regulatory risk related to rolling stock is discussed more extensively in Section 7.3.1.	Proponent	It is not possible to purchase insurance against legal and regulatory risk; therefore, the proponent must bear this risk. Prior to implementation of the proposed commuter rail system, an engineering study of possible rolling stock options, considering the Budd RDCs, should be undertaken to ensure compliance with applicable regulations.
Public opposition	The risk that the public might oppose the project for one reason or another.	Proponent	Public opposition can be mitigated through a project development process that is sensitive to this risk.
Inflation	Risk that inflation differs from expectations.	Per contract	Inflation risks can be mitigated by including provision for inflation in contracts.
Interest rate risk	If project is debt financed, the risk that interest rates are higher than anticipated.	Proponent	Interest rate hedging.

12.5 Structure, Partnering and Financing

12.5.1 Potential for Private Sector Financing or Funding

Private sector partners generally seek to deploy their capital in such a way as to earn the greatest possible return, taking into account the risk to which they would be exposed. The introduction of commuter rail may potentially create a business opportunity for private sector partners by virtue of changes in travel patterns and the relative accessibility of various locations. In both cases, it may be possible to leverage these two sources of value creation to generate revenue.

Changes in Travel Patterns

The most significant change in travel patterns would be a significant increase in passenger volumes at the VIA Station. It may be possible to attract new retail or service tenants to the station on the basis of increased traffic volumes. The incremental lease revenue from locating such services would flow to VIA as the owner and operator of the Halifax Station. It would likely be possible to factor this incremental revenue into negotiations for use of the station, to obtain a reduced rent. Given the limited ridership at other stations, we anticipate there would be little opportunity for lease revenue.

Land Value Uplift and Land Value Capture

There has been a great deal of interest in recent years in the potential to capture some of the land value uplift associated with investments in transit. Commuter rail can have positive impacts on land values. Previous studies of land value uplift around commuter rail stations suggest ranges from 4% to 120% are possible. The magnitude of the uplift depends on a variety of factors. Generally higher speed and frequency of service; better comfort, safety and reliability; and lower cost to riders result in greater uplift. Land use planning can also help to drive land value uplift. Generally, station areas that exhibit transit-oriented development would experience greater uplift. Important aspects of transit-oriented development that can drive land value uplift include higher density, greater development mix (not uniform industrial or residential development), and the quality of the design.

When land value uplift is generated by a transportation investment that is publicly financed, it is increasingly accepted that the public should share in the uplift through land value capture. A wide variety of tools exist to capture land value uplift, including development charges, special assessment districts, tax increment financing, joint development (between public and private sectors), property taxes, land value taxes and transportation utility fees. Fares and parking charges can also capture land value uplift.

The land value capture strategy associated with a project must be in place at the time that a project is approved. Land value uplift occurs in anticipation of a new rapid transit line. As uncertainty over whether a line will be constructed declines, land value uplift will rise. While not investigated in detail here, the point at which developers are almost certain a project will be implemented is probably some point following the start of construction. Providing as much certainty as possible around intended land value capture strategy would allow developers to optimize their investment plans. If plans have to be revised once projects have been developed, or even after construction has started, developers can suffer losses and the project proponents can lose credibility on future projects.

In the course of our research we have identified four specific land value uplift/capture opportunities.

- The location near Mill Cove is on land that is being developed by the Waterfront Development Corporation Limited (WDCL) as Bedford Waterfront Phase 2.[62] WDCL plans to develop an area near Mill Cove station into a multi-modal passenger terminal amongst mixed residential and commercial development. WDCL would retain ownership of the land but would grant 99-year leases to developers.

- Sunnyside Station would offer potential for connection to Sunnyside Mall and commercial opportunities. The owners of the mall would likely absorb costs of the connection.

- The location around the potential West End station already has some office buildings, two large shopping centres and several apartment buildings, but is interrupted by large tracts of surface parking. Some of this parking could go into a podium to enable towers to be built above.

- The area around Bedford Common could become attractive for higher-density residential development if convenient access by commuter rail were feasible. Allowing for development would, however, require regional and community plan and zoning amendments, and care would have to be taken to ensure a continued supply of rail-serviced industrial land.

Mobility Hubs – A Key Tool to Generate Land Value Uplift

Mobility Hubs or Transit Nodes around rail stations are a potent tool to encourage transit-oriented development. Mobility Hubs are key regional locations where transportation modes come together seamlessly to support and attract intensified development. They have the potential to transform municipalities and reinforce land use intensification policies, providing opportunities for people to live, work and play close to a sustainable transportation anchor with links to other regions through reliable rapid transit. Commuter rail can become an anchor for this type of development, linked with Halifax Transit services, active transportation facilities and other transportation demand management tools such as carpooling lots and auto sharing vehicle spots.

[62] http://www.halifax.ca/visionhrm/BedfordWaterfront/documents/BedfordWaterfrontDesignStudy.pdf

One of the first steps would be to identify the proposed rail corridor and stations as a schedule in the Regional Plan. A number of areas where there are already proposed stations are already identified as growth centres. Mill Cove Station is within the Bedford Mill Cove Urban Local Growth Centre and Sunnyside Station is within the Sunnyside Mall Urban District Growth Centre.

Transit supportive development can be encouraged through a series of policies and practices that influence urban structure, mix of land uses, density of development, distances to transit facilities/services, corridors/right-of-way and pedestrian amenities. This reflects the notion that encouraging transit-supportive development is not a matter that can be dealt with by focusing on one subject alone (e.g. density). Rather, it requires a system of policies working together to encourage high-quality, transit-supportive communities.

The Regional Plan addresses many components of transit-supportive development. With the implementation of rail service, there should be a special focus on each of the rail corridors. This starts with designating each of the rail stations in the Regional Plan and identifying special policies around a one-km radius of each station. Each station should be assessed in more detail with regards to development potential and transit-oriented development policies should be identified to guide future growth management and development.

12.5.2 Potential for Federal Funding

In its 2013 budget, the Government of Canada announced the New Building Canada Plan,[63] a 10-year plan to provide $53 billion in funding for infrastructure across Canada. The Plan has a number of components that might offer sources of funds for Halifax Commuter Rail.

Provincial-Territorial Infrastructure Component National and Regional Projects

Because Halifax is a municipality and the proposed commuter rail line is a public transit investment, the Halifax Commuter Rail Project could be eligible for the Provincial-Territorial Infrastructure Component National and Regional Projects. Nova Scotia's share of this fund is $426 million over 10 years.

All projects with eligible costs[64] above $100 million are required to undergo a P3 screen, which assesses the viability of a project for procurement using a public-private partnership (P3). If it is determined that a project would generate better value for money if procured using a P3, then federal funding would be contingent on the use of a P3 procurement. In this case, all of the Cobequid and Beaver Bank Scenarios' capital costs are less than $100 million and therefore a P3 screening would not be required.

[63] http://www.infrastructure.gc.ca/plan/nbcp-npcc-eng.html

[64] Eligible costs are defined here: http://www.infrastructure.gc.ca/plan/ptic-vipt/ir-ei05-eng.html. Eligible costs are generally those associated with capital costs and not with operating costs.

While projects are generally cost-shared on an equal (one-third) basis between the municipal, provincial and federal governments, public transit projects may receive up to 50% of their funding from the federal government.

For public transit infrastructure, the project must demonstrate benefits to Canadians in support of one or more of the following outcomes:

- Supporting efforts to reduce urban congestion
- Increasing transit ridership
- Improving safety
- Improving mobility (e.g., improved access, reduced travel times)

Based on the information developed thus far in this project, the Halifax commuter rail line would support all four outcomes.

In addition the project must meet the following minimum requirements:[65]

- Proponents must demonstrate the economic advantages and the broader public benefits of the project
- Projects must be part of an official, integrated land-use and transportation development plan or strategy. Where applicable, projects must be consistent with the approved plans of regional transportation bodies
- Proponents must demonstrate that their proposal is based on current or projected demand and the intended results must be substantiated
- If the project includes an ITS component or system, the ITS component or system must be compliant with the ITS Architecture for Canada

P3 Canada Fund

The P3 Canada Fund is a separate federal fund administered by P3 Canada Inc, a federal Crown Corporation. Because Halifax is a municipality and the proposed commuter rail line is a public transit investment, the Halifax Commuter Rail Project could be eligible for the P3 Canada Fund, if the commuter rail project is structured as P3 procurement that meets P3 Canada requirements. The P3 Canada Fund would provide up to 25% of the project's eligible costs.

[65] http://www.infrastructure.gc.ca/plan/ptic-vipt/bc-pa04-eng.html

12.6 Options for Reducing Required Operating Support

Outside of limited land value capture opportunities or obtaining greater funding from the Governments of Nova Scotia or Canada, a number of options exist for reducing required subsidies/raising greater revenue. These options are not reflected in the financial analysis but should be considered during the evaluation of the project.

12.6.1 Road and Auto-Use Pricing Options

Toll Competing Road Infrastructure

The geography of Halifax road and highway network makes it possible to implement tolls. The key routes that would compete with commuter rail are Highway 102, the Bedford Highway (Highway 2), Highway 7 and the planned Sackville Expressway. Two existing bridges between Dartmouth and Halifax are currently tolled, including the MacKay Bridge, which is a competing route to Halifax via Burnside.

Area Toll of Halifax Peninsula

Another option, given the geography of Halifax, would be to implement a toll on cars entering the Halifax Peninsula. Doing so is facilitated by the limited number of roads entering the peninsula, in part because of the barrier created by the rail-cut. This is the type of area-based toll is often referred to as a cordon charge or congestion charge. Schemes have been operating in cities such as London and Stockholm for many years. Since such a toll would affect all inbound vehicles, regardless of origin, for reasons of equity it may be necessary to upgrade transit to areas not served by commuter rail.

Time- and Distance-Based Vehicle Use Fees

A more sophisticated approach to pricing the use of roads is time- and distance-based vehicle use charging. Such schemes rely on technology (e.g. GPS) to track the time and location of vehicle movements in order to charge users based on the distance travelled or even potentially the time of days at which a trip occurs.

12.6.2 Branding, Sponsorship and Naming Rights

Transport operators may brand their product, facility or service with the name of a commercial enterprise in exchange for regular payments from the enterprise. Examples include naming a train station after a corporate enterprise. The extent of funding potential is limited, and depends on the location and number of anticipated viewers of the branding (e.g. number of passengers who would pass through the station platform). In very approximate terms, based on data from large metropolitan areas (e.g. New York), funding can range from

$200,000 to $2 million per year per rail station.[66] There are marketing and legal costs associated with arranging for branding of stations, though these would be relatively small – in the order of 5% of the proceeds. We understand that there are several large enterprises around some of the proposed stations that might be potentially interested in branding.

Assuming that four to eight stations have branding potential, and that the revenue per station would be approximately $50,000/year, the total increase in present value would be approximately $2.7 to $5.4 million.

12.6.3 Farebox Revenue Maximization

A major source of revenue for transit is ticket sales. Farebox revenue is a function of ridership level and fare structure. Revenue maximization is often constrained by political acceptability; even without this, it depends on a transit agency's ability to accurately predict elasticity of demand from passengers. Raise prices too high and passengers would use other modes, leading to reduced social and economic benefits from the system; keep ticket prices low and operators may be missing an opportunity for higher revenues.

In Chapter 11, we proposed a zone fare structure to increase revenues to account for the higher cost of longer-distance commuter rail service. As discussed, in Section 11.2.2, we set the fare levels in Halifax at the lower end of the range of existing comparable commuter rail fares in Canada. For example, commuter rail fares for comparable distances to Cobequid or Beaver Bank from the VIA Station (Zone 2) (a $4.50 fare) can be as high as $7.25 in Vancouver, though most commuter rail fares covering the same area to an urban transit system are closer to $5.30 to $5.60. Should Halifax Transit wish to increase farebox revenues, it could consider setting a higher fare level.

12.6.4 Station Parking Charges

Station parking charges can be set at different levels to reflect market demand, and to encourage off-peak transit use.

Parking rates can be varied not just by duration of use, but also by other factors to encourage public transit use and generate additional revenue. For example:

- Higher charges can be levied for spaces closer to the station, or under cover
- Lower charges or even free parking can be offered for mid-day use, of say less than four hours. This encourages off-peak use, when trains are empty. It also can reduce enforcement costs, as cars only need to be checked in the peaks

[66] CPCS et al. 2015. NCRRP Report 1: Alternative Funding and Financing Mechanisms for Passenger and Freight Rail Projects.

- Free parking on weekends and holidays
- Higher rates for use by non-transit riders
- Offer multi-day rates, which can be useful for people who may need to travel during the week or are using rail for access to an airport

Some operators offer reduced rates for monthly users. While there are lower collection and enforcement costs for these customers, a monthly discount can be counter-productive as it means, in effect, that occasional users, who more often travel off peak when there is capacity, pay more and are therefore discouraged from using transit.

Some operations offer reduced rates for car pools.

Car parking charges can actually be designed to increase demand for public transit use, where parking is constrained, because some early birds who currently take scarce spaces may be encouraged by high charges to switch to bus or car pool for station access, leaving spaces open for additional users.

12.6.5 Other Tax Mechanisms

A wide variety of other taxation and user fee mechanism options exist in Halifax and at the provincial level that could be employed to generate revenue for commuter rail (or transit more generally) including:

- Gas tax
- Car registration plate auction
- Motor vehicle registration fees
- Payroll taxes used for transport
- Sales tax
- Carbon tax or credits (cap-and-trade)

These mechanisms are not as directly related to trip costs as some of those discussed above and are not considered further here.

12.1 Closing

Should a funding gap remain after other sources of funding are exhausted, Halifax would need to cover the funding gap through a property tax increase. However, Halifax's ability to raise taxes is constrained by overall wealth in the region as well as how much the other levels of government are taxing individuals. For example, even if real wages were growing in the region, if the tax burden imposed by the higher levels of government was growing faster than the real wage growth, then Halifax's ability to raise property or other taxes would be constrained to something below the percentage increase in real wages.

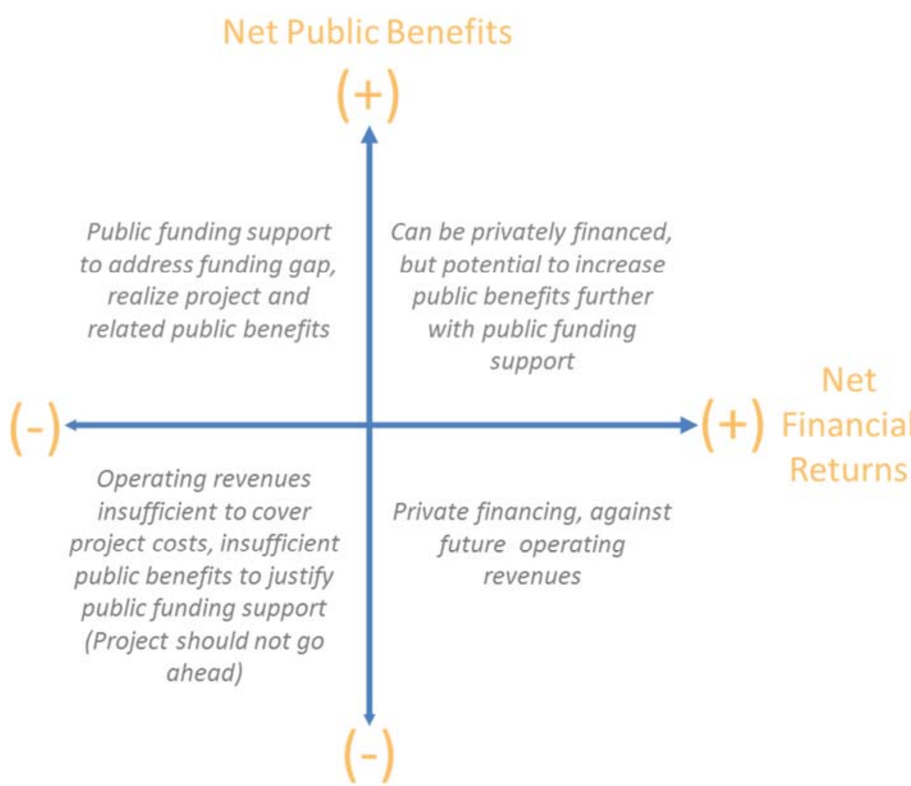
13 Economic Analysis

Key Messages

- All six scenarios are analyzed in terms of economic costs and benefits they generate. Key benefits estimated are travel time savings, automobile operating cost savings and CO2 emissions reductions.
- Two metrics are used to assess the scenario: economic net present value (ENPV) and the benefit-cost ratio (BCR). The ENPV is the discounted sum of all benefits less the discounted sum of all costs for each scenario. The BCR is the ratio of the present value of the benefits of each scenario to the present value of its costs.
- No scenario studied exhibited benefits that exceed costs. For all three demand levels, the Beaver Bank Scenarios outperform the Cobequid Scenarios.
- The Cobequid and Beaver Bank Low and Medium Scenarios are the most promising economically.
- These conclusions are not sensitive to the choice of real social discount rate (5%) on the basis of a standard range of rate (3%-7%).

As discussed in Chapter 12, the implications of a transportation infrastructure project can be thought of along two key dimensions, as shown in Figure 13-1. In this matrix, the vertical axis represents the social benefits of a project; projects falling in the upper two quadrants have social benefits (e.g. travel time savings, automobile cost savings, and environmental benefits) that exceed the cost of the project. The horizontal axis represents the financial returns of the project; that is, the benefits that accrue solely to the entity that implements the project (i.e. the commuter rail agency). Projects in the two right quadrants have financial returns that exceed the cost of the project. Projects in the left quadrants have negative financial returns.

Figure 13-1: Matrix of Public and Financial Benefits



Source: CPCS and others

The purpose of the economic analysis is to allow decision makers to evaluate the scenarios in terms of their economic benefits, i.e. from the societal perspective of Halifax. It is therefore different than financial impacts (as presented in Chapter 12), which consider a project from the particular perspective of the project entity (Halifax Transit) and can be affected by the financial structure of the project (e.g. debt versus equity, PPP versus entirely private, etc.).

We use two metrics to evaluate the economic impact of different scenarios:

- The economic net present value (ENPV) of the investment, which measures the sum of the present value of all the benefits (positive) and costs (negative); a positive ENPV indicates the project creates net social benefits
- The benefit-cost ratio (BCR), which measures the ratio of project benefits to costs; a BCR greater than one suggests the project creates net social benefits

Though the ranking of scenarios can differ based on the metric used since each metric reflects a slightly different concept, should the ENPV be positive and/or the BCR greater than one, the project would fall in the upper two quadrants. Should these results not materialize, the project generally should not proceed.

As with the financial evaluation, it is also important to consider the robustness of the results, i.e. their ability to stand up in sensitivity analysis to reasonable changes in the assumptions.

13.1 Key Concepts

13.1.1 Internal and External Costs and Benefits

Two types of costs and benefits exist: (1) internal costs/benefits, those that are borne/captured by the project's entity and (2) external costs/benefits (also called externalities), those that are not borne/captured by the project's entity. In general, internal costs/benefits are already included in the financial analysis of a project. While these must be adjusted to reflect their real economic value, data requirements generally remain limited.

Externalities, on the other hand, impose greater data requirements on the analyst. Indeed, not only must they be identified and measured (e.g. pollution avoided), but also they must then be monetized, that is, transformed into a monetary value based on their economic value.

13.1.2 Monetizing Externalities

A significant amount of research exists on the appropriate values to monetize different types of externalities. This research, however, is generally not specific to Halifax. The main difference across geographies lies in the different capacity to pay (and thus the willingness to pay) to avoid negative externalities (e.g. pollution) and benefit from positive externalities (e.g. lower transit time). In turn, the capacity to pay is closely related to gross domestic product (GDP) per capita.

It is important to note that a number of methodologies exist to monetize the different externalities associated with a commuter rail project. In this project, and given the significant literature available on the subject, we do not spend a significant amount of time discussing the valuation methodologies and rationale.[67]

13.1.3 Scope and Length

Given data limitations, the scope of the economic analysis is restricted to the impacts within Nova Scotia. The only exception to this scope is for CO_2 emissions, which are taken into account even though they have a global rather than purely local effect.

13.1.4 Social Discount Rate (SDR)

The choice of the SDR (or economic discount rate) can be quite controversial, and rightly so since it can have a significant impact on results. Unlike the financial discount rate, which reflects the opportunity cost of capital, the SDR should reflect how society values costs and benefits now relative to future periods.[68]

Metrolinx applies a real SDR of 5% to its projects.[69] While the authors noted the apparent absence of a standard SDR policy in Ontario or Québec, a real SDR of 5% was also used on the recent "Updated Feasibility Study of a High Speed Rail Service in the Quebec City-Windsor Corridor."[70] Since the appropriate discount rate is arguable, we have conducted sensitivity analysis using real SDRs of 3%, 5% and 7% to illustrate the impact of this choice.

13.1.5 Time Horizon

Consistent with the financial analysis, the economic analysis is conducted over a 25-year period, a two-year construction period in 2016 and 2017 and a 23-year operations period from 2018 to 2040. Because of discounting, benefits and costs occurring after 2040 have little impact on the results of this analysis.

As with the financial analysis all dollar figures are in constant 2014 dollars. Implicitly, we are assuming that all future increases in cost would be at the rate of inflation. This assumption is made to simplify the analysis by avoiding the need for inflation forecasting, and it means that

[67] For example, non-economists often debate whether it is appropriate to attribute a monetary value to a human life. These ethical issues, along with more arcane methodological issues on valuation, are the subject of ample literature and will not be discussed in the context of this report.

[68] A consensus is growing around the social time preference rate (STPR) approach. This approach relies on income growth, relative risk aversion and the pure rate of time preference. In general, income growth drives differences across countries.

[69] Metrolinx (2010) "GO Rail Options Benefits Case Assessment," Final Report, June. http://www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/Benefits_Case-GO_Rail.pdf

[70] EcoTrain (2011) "Updated Feasibility Study of a High Speed Rail Service in the Quebec City-Windsor Corridor," February, p. 173, available on request from Transport Canada: https://www.tc.gc.ca/eng/policy/acg-acgb-high-speed-rail-2956.htm

the SDR we are using should be viewed as a real (i.e. inflation-adjusted) SDR and not a nominal SDR.

13.1.6 Study Area

The study area is Halifax. Given that we anticipate that many users would drive or travel by bus to commuter rail stations, there is a wide geographical dispersion of benefits and costs.

13.1.7 Analytical Scenarios

It is useful to remind the reader that, six operational (Cobequid and Beaver Bank) and demand (low, medium, high) scenarios have been developed in previous chapters. In this analysis, we consider each scenario in relation to a no-rail Base Case.

13.1.8 Fares

Fares are the other major perceived cost of using transit. As discussed above, we have used a zonal fare for the financial analysis (Chapter 10) and have accounted for this structure in the economic analysis. The fare revenues paid (and the revenues received by Halifax Transit) do not enter into the economic analysis directly, as they are economic transfers; however, they impact the benefit-potential of the system through ridership.

Notably, there is a trade-off between increasing fares and improving the financial performance of the system (as discussed in Chapters 11 and 12) and keeping fares low and providing ongoing funding to support public benefits (as discussed in this chapter). The selection of a zonal fares structure for analysis reduces person-kilometres travelled on the commuter rail system by approximately 10% to 30% as compared to a flat fare structure based on the existing $2.50 Halifax base bus fare. By extension, the potential benefits of the system (discussed in Section 13.2 and 13.3) would also be reduced by similar percentages should a zonal fare system be implemented.

We have accounted for the reduction in benefits by estimating the ratio of person-kilometres travelled on the commuter rail system assuming a zonal fare to the person-kilometres travelled on the commuter rail system assuming a flat fare, and factored the potential travel time savings and automobile operating cost savings using the same factor.

13.1.9 Land-Use Changes

As noted in Section 6.3.2, forecast population and employment growth in the 2031 horizon year in the Halifax Travel Demand Model were based on the 2014 Halifax Regional Plan (RP+5) figures and applied by Halifax in its model.

While these official population and figures were used in the development of the rail corridor ridership forecasts and, by extension, the economic and financial analyses, they do not explicitly consider potential intensification and/or growth over and above the RP+5 figures. For example, the area around the proposed Mill Cove Station has the potential for higher density, transit-oriented developments (TODs). However, this additional growth is not currently represented in the model, as the developments are currently not approved. Therefore, forecasted commuter rail transit ridership in the Mill Cove area is likely underestimated (for example). By extension, the forecasted benefits accruing from a commuter rail system do not account for this potential growth.

13.1.10 Summary Measures

We use two metrics to evaluate the different scenarios:

- The economic net present value (ENPV) of the investment
- The benefit-cost ratio (BCR)

The ENPV is simply the discounted value of a cost or a benefit. The ENPV of the project is the difference between the discounted total benefits and costs. Projects with larger ENPV are more valuable to society. It is hard to compare options since ENPV generally grows with the size of the initial investment, i.e. there is no denominator in the calculation that reflects the scale of the necessary investments. The ENPV is also sensitive to the SDR.

The BCR resolves the issue of scalability. The BCR is the ratio of discounted total social benefits to discounted total social costs. Projects with higher BCRs indicate that for each unit of social cost, more benefits are generated. Options of differing scale can be meaningfully compared, as the BCR appropriately reflects the social return per social cost. The key issue with the BCR is that the exact definition of benefits and costs, and how they are allocated, can affect results. Moreover, the BCR is also sensitive to the SDR.

13.2 Internal Benefits: Travel Time and Cost Savings

Most transportation improvements generate the largest proportion of their benefits through travel time and cost savings for users of the transportation system. In the case of the proposed Halifax commuter rail project these savings accrue to

- Existing transit riders who switch from bus to rail, or a combination of rail and bus.
- Existing automobile users who switch to transit.
- Existing automobile users who do not switch to transit but experience reduced travel times because of reduced road congestion.[71]

[71] While it is also desirable to estimate travel time savings for goods movement (e.g. trucks), Halifax does not separately model trucks. As a result travel time savings for road users should be interpreted as including travel

As noted above, we have not forecast any induced ridership, i.e. we do not anticipate that anyone not currently travelling by either bus or car is likely to travel because of the changes we have proposed.

13.2.1 Travel Time Savings Calculations: Transit

For transit users, travel time can be segmented into time spent walking to transit, waiting, riding and transferring between routes. Generally, time spent walking to and waiting for transit is perceived to cost two to three times the cost of time spent travelling.[72] Qualitative factors such as ride comfort are included in the value of travel time.

We estimate the perceived cost of travel (PCT) for transit trips as follows:

PCT = PJT (VTT)

where

PCT - Perceived cost of travel

PJT - Perceived journey time

VTT - Value of travel time (i.e., hourly wage)

We take the change in PCT as the benefit to transit users of the proposed commuter rail and associated changes to bus routes.

Perceived Journey Time Calculations

People value time differently. Time spent inside a warm and dry commuter rail car is less unpleasant for a commuter than time spent waiting at an open-air bus stop. Adjusting actual travel time to reflect these differences in perceived cost (or unpleasantness) is important to obtain a more accurate estimate of the value of time.

In the Halifax model, different trip segments are valued as follows:

*Perceived Journey Time = (1.00 * In-Vehicle Time) + (1.00 * Put-Aux Time) + (2.00 * Access Time) + (2.00 * Egress Time) + (2.00 * Walk Time) + (2.0* Origin Wait Time) + (2.00 * Transfer Wait Time) + (5 minutes * Number of transfers) + (0 minutes * Number of operator changes) + (0 * Extended Impedance)*

---

time savings for both users of cars and trucks. It is not possible to assess the likely impact of this situation on the results of this economic analysis.

[72] Transportation Research Board, "Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners," Transit Cooperative Research Program Report 78, 2002: p. II-3.

Put-Aux Time - Time on shuttles or other auxiliary service that brings transit riders to the main service

Access Time - Walk time to access the stop (i.e., within a station)

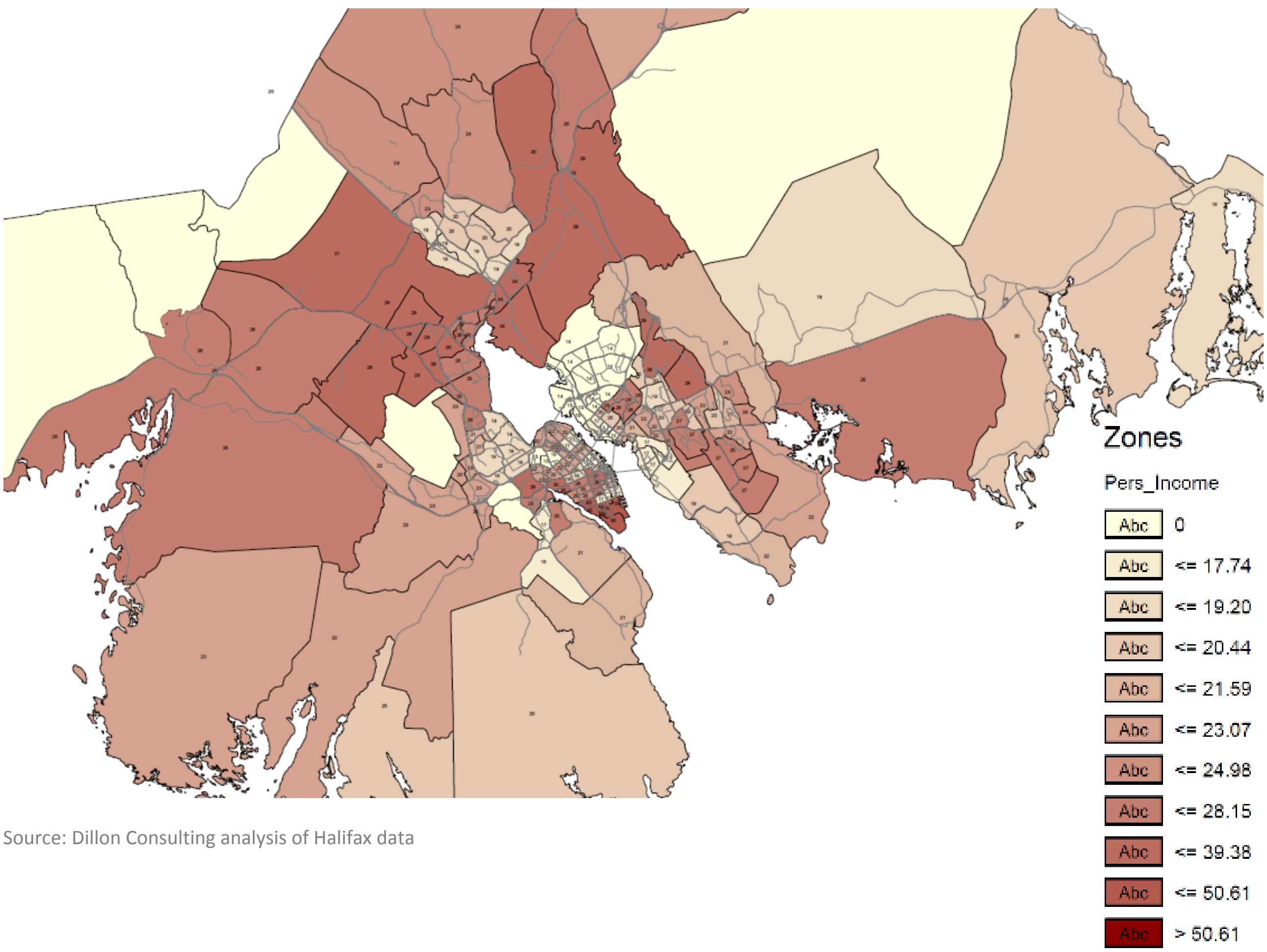
Egress Time - Walk time to leave a stop (i.e., within a station)

Walk Time - Walk time along roads/sidewalks to the station

Value of Travel Time

The Halifax model has a very fine-grained approach to travel time. Each traffic analysis zone (TAZ) is assigned a different value of time based on wage rates from the 2011 National Household Survey, conducted by Statistics Canada every five years. The hourly value of travel time varies from $12.70 to $49.94; the weighted average for Halifax, based on population, is $22.38 per hour. The model does not distinguish between work, school, shopping or other trip types, which is very likely to overstate the value of time on non-work trips.

Figure 13-2: Halifax Traffic Analysis Zones by Level of Personal Income



Source: Dillon Consulting analysis of Halifax data

Accident and Crime Cost

Accident and crime costs are generally not included since they are generally considered to be incorporated by riders into the cost of travel, and so are ignored.[73]

13.2.2 Travel Time Savings Calculations: Automobile

We estimate a perceived cost of travel (PCT) for autos as follows:

PCT = PTT (VTT)

where

PCT - Perceived cost of travel

PTT - Perceived travel time *(travel time plus toll penalty)*[74]

VTT - Value of travel time *(i.e. hourly wage)*

Perceived Travel Time

This is the actual travel time between two TAZs, plus the toll penalty as described above.

Value of Travel Time

Is the same as VTT for transit and was described above.

13.2.3 Present Value of Total Travel Time Savings

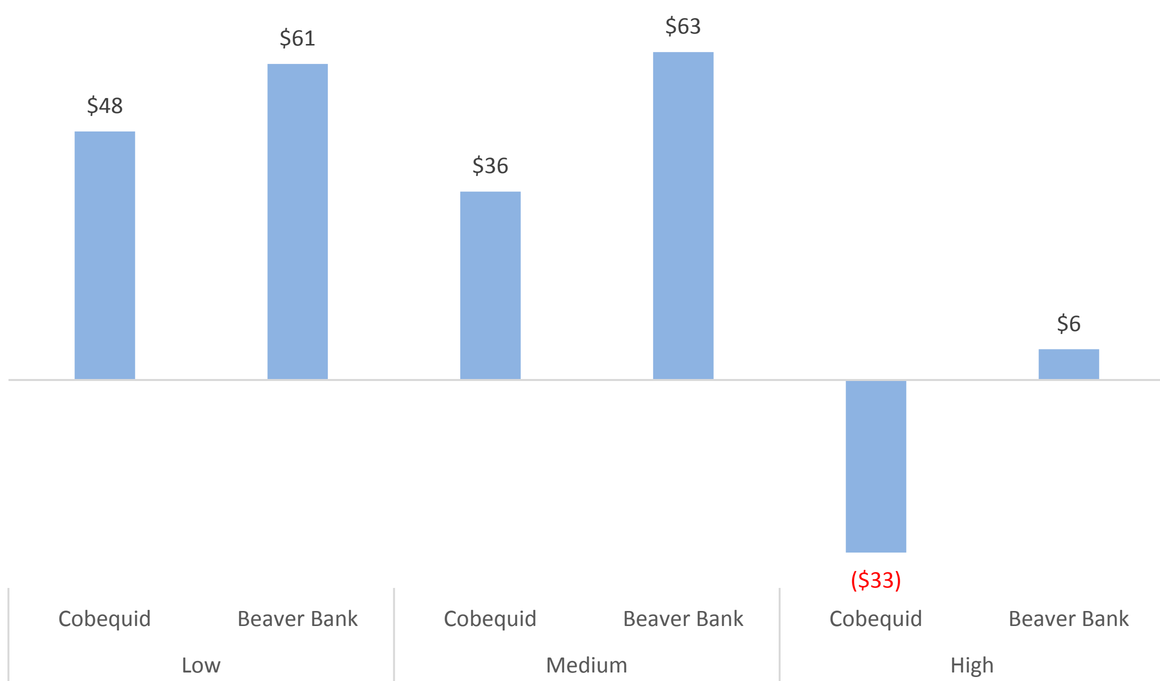
The total value of travel time savings for all road and transit users ranges from a high of $63 million (present value, 2014 dollars) in the Beaver Bank Medium Scenario to a low of -$33 million in the Cobequid High Scenario (Figure 13-3). The negative number indicates that a scenario results in an overall increase in travel time relative to the Base Case (i.e. no commuter rail case). This increase in travel times in the High Scenario is probably the result of additional transfers required between car/bus and rail relative to the more direct routing (one bus or one car trip) in the Base Case.

---

[73] Transportation Research Board, "Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners," Transit Cooperative Research Program Report 78, 2002: p. II-3.

[74] The Halifax model applies a toll penalty of $1 toll x 180 seconds to auto trips crossing the bridges.

Figure 13-3: Present Value of Travel Time Savings (millions)



Source: CPCS

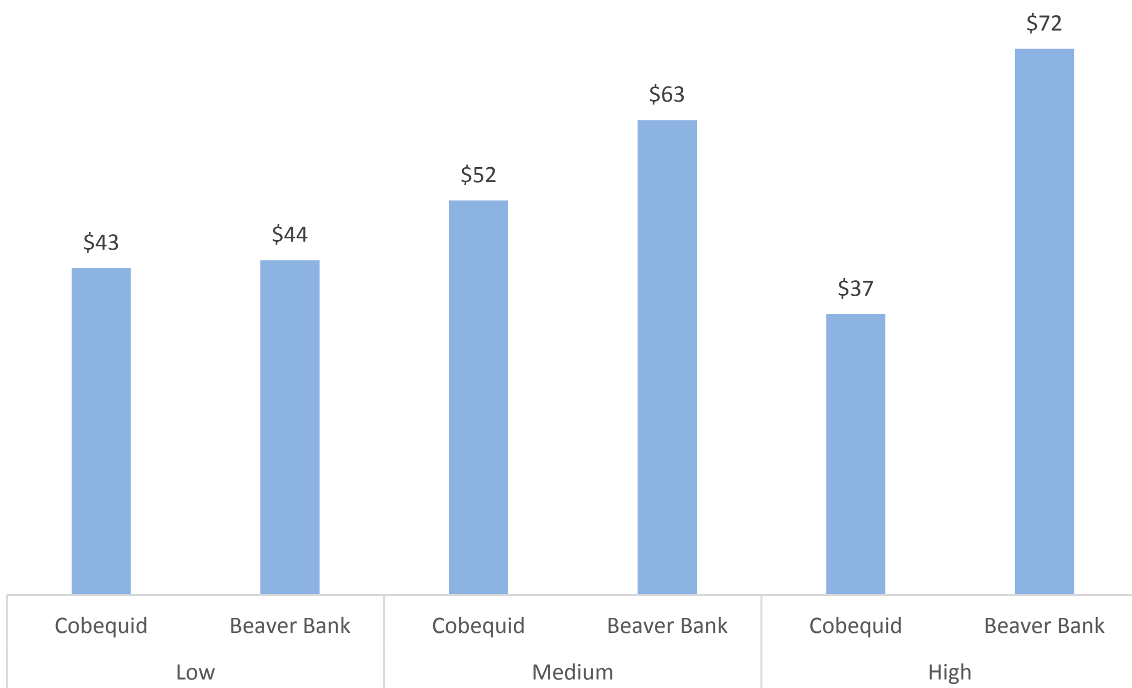
13.2.4 Automobile Operating Cost Savings

Savings to transportation system users through reduced automobile use (e.g. maintenance, fuel, insurance, real depreciation) are also an important part of most transportation infrastructure projects. In the case of the project under study, transportation system users could realize automobile operating cost savings by switching to transit. The Halifax model assumes a cost of $0.55/km. This rate is multiplied by the overall change in vehicle-km travelled between each scenario and the Base Case to estimate automobile operating cost savings.

Figure 13-4 shows the present value of automobile operating cost savings for each of the six scenarios. Highest savings are achieved in the Beaver Bank High Scenario, and the lowest in the Cobequid High Scenario. Notably, the automobile operating cost savings achieved in the High Demand Scenarios are sufficient to offset the cost of higher travel times discussed in Section 13.2.3.

Accident and crime cost would largely be covered by the cost of insurance.

Figure 13-4: Present Value of Automobile Operating Cost Savings (millions)



Source: CPCS

13.3 Externalities

In general, any economic analysis should strive to encompass the complete range of externalities associated with the project. These should include both positive and negative externalities. In the case of a commuter rail project such as this one, potential externalities include:

- Changes in emissions of air pollutants
- Impacts on the flora and fauna (ambiguous depending on the road/rail trade-off and routing)
- Impact on noise and vibration levels (ambiguous depending on the road/rail trade-off and routing)

In this project we focus only on the value of CO2 emissions, the approach taken by Metrolinx in its benefits cases.[75] We also use the Metrolinx benefit estimate of $40/tonne of CO2 reduced. Figure 13-5 summarizes the assumptions we used to estimate the emissions.

Figure 13-5: Emission Factors by Mode of Transporation

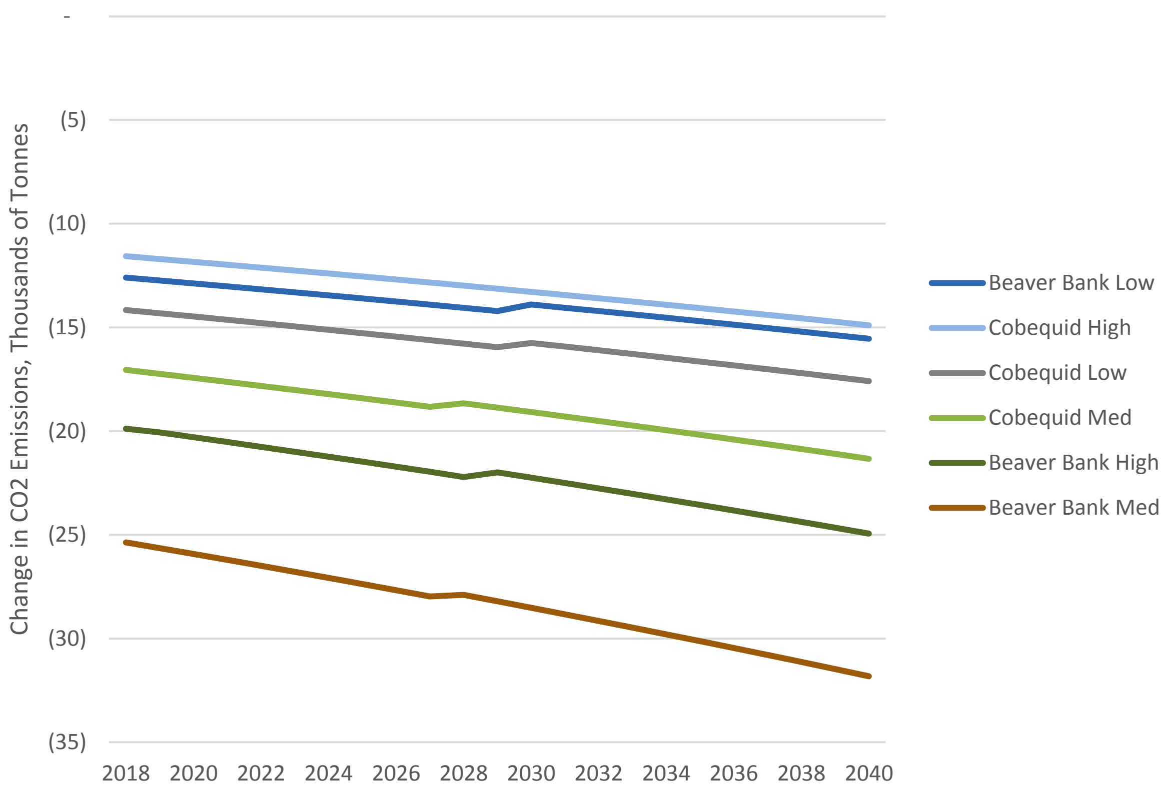
Metric	DMU (per car)	Buses	Cars
Fuel type	Diesel	Diesel	Gasoline
Consumption	119 L/100 km	56 L/100 km	9.6 L/100 km
CO2	2,650 g/L	2,650 g/L	2,289 g/L

Sources: DMU: Los Angeles County Metropolitan Transportation Authority (2009) "DMU Technical Feasibility Analysis, Propulsion Technology Investigation," p. 25; Bus: http://www.translink.ca/~/media/documents/plans_and_projects/bus_tech_evaluation/bus%20technology%20phase%201%20final%20test%20program%20report.ashx; Car: http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=AC2B7641-1 and http://oee.nrcan.gc.ca/publications/statistics/cvs09/chapter2.cfm?attr=0.

We estimate that the Beaver Bank Medium and High Scenarios as well as the Cobequid Medium Scenario would offer the most substantial reductions in CO2 (Figure 13-6). The economic benefit of these emissions reduction would be included in the overall economic results presented in the next section.

[75] http://www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/benefits_case_analyses.aspx

Figure 13-6: Change in CO2 Emission, by Scenario

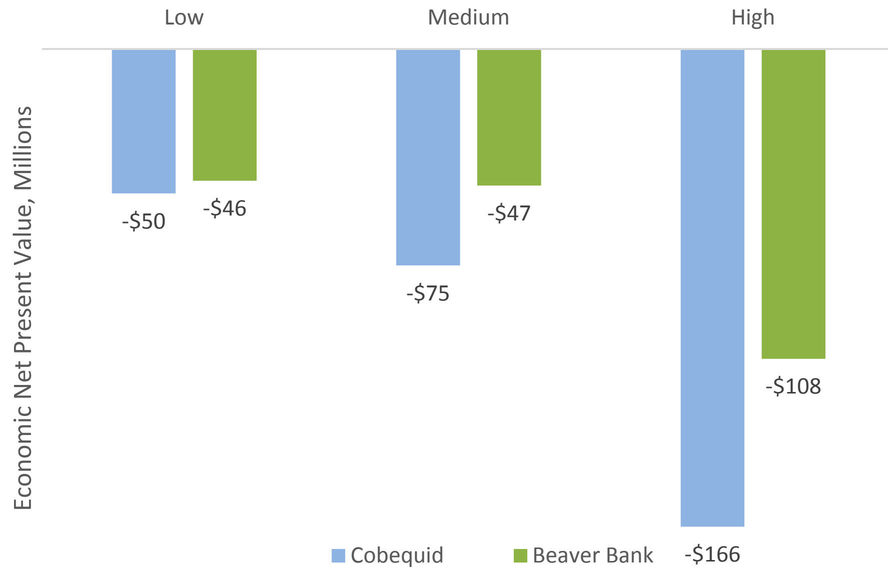


Source: CPCS analysis of various sources (see text)

13.4 Key Results

The economic net present value (ENPV) for all six scenarios is negative, indicating that undertaking any of the six scenarios would result in net economic costs (Figure 13-7). The Beaver Bank Low Demand Scenario has the least negative ENPV (-$46 million) and the Cobequid High Scenario has the most negative (-$166 million). For all three demand scenarios the Beaver Bank concept outperforms the Cobequid concept, which indicates that additional economic benefits would be possible from continuing service to Beaver Bank.

Figure 13-7: Economic Net Present Value

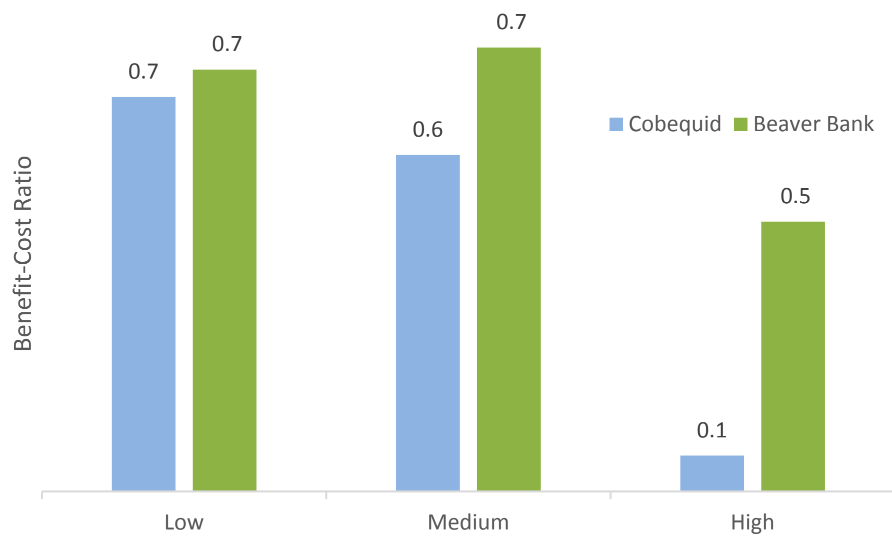


Source: CPCS

Figure 13-8 shows the benefit cost ratio (BCR) for all six scenarios. A BCR of 1.0 is a neutral result and indicates that estimated benefits are equal to estimated costs, meaning that society is likely to be no better or no worse off if the project is undertaken. A BCR above one indicates that estimated benefits exceed estimated costs, and that the project should be undertaken, unless funds are unavailable or projects with higher BCRs can be undertaken. A BCR between 0 and 1.0 indicates that the estimated economic costs or a project exceed its estimated economic benefits. In these cases, it is generally considered not economically justifiable to undertake a project.

The highest BCR, 0.7, is achieved in the Beaver Bank Low and Medium Demand Scenarios and Cobequid Low Demand Scenario. Since this BCR is less than 1.0, consistent with the negative ENPV estimates, no scenario appears economically justified. The lowest BCRs occur in the High Demand Scenarios, indicating that the proposed bus route changes result in costs that exceed benefits. In the Low and Medium Demand Scenarios, the Beaver Bank Scenario exhibits slightly higher BCRs than the Cobequid Scenarios.

Figure 13-8: Benefit-Cost Ratio



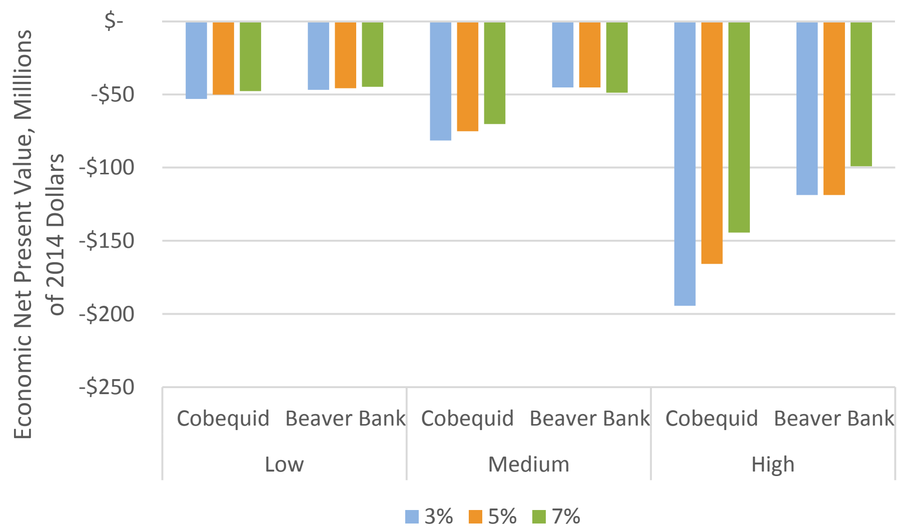
Source: CPCS

In summary, on the basis of both ENPVs and BCRs none of the six scenarios investigated generates sufficient economic benefits to justify the resources that would be required to undertake the projects. However, on the basis of the scenarios considered, the most promising are the Beaver Bank and Cobequid Low and Medium Demand Scenarios. Some further optimization of these scenarios are considered in Chapter 14.

13.5 Economic Sensitivity

In order to show the sensitivity of our results to variations in the SDR assumption, we compute the NPVs (Figure 13-9) and BCRs (Figure 13-10) for real SDRs of 3% and 7% in addition to our base case scenario of 5%. In all three demand scenarios the preferred scenario based on ENPV is not affected by varying the SDR: Beaver Bank is preferred to Cobequid. Furthermore, none of the ENPVs becomes positive, which suggests that the economic viability of the project is not affected by the selection of a reasonable range of discount rates.

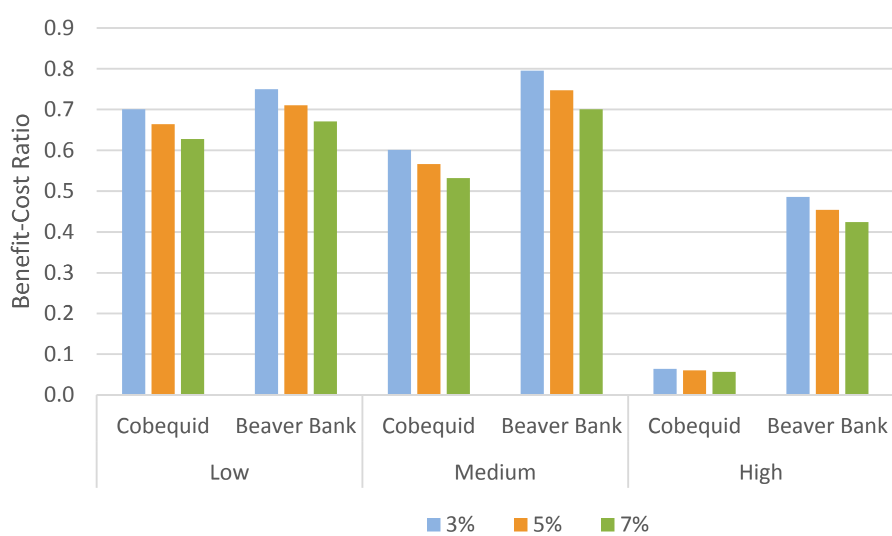
Figure 13-9: Economic Net Present Value Sensitivity



Source: CPCS

In all three demand scenarios the preferred scenario based on BCR is not affected by varying the SDR: Beaver Bank is preferred to Cobequid. Furthermore, none of the BCRs becomes greater than one, which suggests that the economic viability of the project is not affected by the selection of a reasonable range of discount rates.

Figure 13-10: Benefit-Cost Ratio Sensitivity



Source: CPCS

This sensitivity analysis shows that the conclusions of the economic analysis, as presented in Section 13.4, are not sensitive to our choice of 5% as the real SDR, at least within a range of real SDRs that can be considered to reflect conventional assumptions about social time preference in Canada.

13.6 Limitations of Economic Analysis

Because of the primary purpose of the travel demand modelling (described in Chapter 6) was to develop credible estimates of commuter rail ridership, the project team adjusted the travel demand forecast to account for intricacies in the Halifax Travel Demand Model's behaviour, including:

- Increasing the perceived journey time for trips through park and ride lots at rail stations to account for lot capacity constraints and the counterintuitive modelled-travel behaviour in the suburban regions furthest from Halifax, where the travel analysis zones are very large
- Making post-model run traffic adjustments as discussed in Appendix B to account for counterintuitive traveller behaviour

These adjustments introduced approximations into economic analysis. Notably, the team capped the maximum perceived journey time (for all scenarios) at 100 minutes to account for the manual increase in perceived journey time introduced by the modelling team. The value of 100 minutes was chosen as it was the shortest trip time that minimized the change in the value of the perceived journey time to approximately 1% in the base (no rail) scenario. (Capping the maximum trip time any shorter clearly affected legitimate trips within the region.) Nonetheless, we anticipate that the value of perceived journey time savings may still be modestly underestimated in scenarios that include rail park and ride facilities (e.g. medium and high).

14 Further Optimization Potential

This chapter studies some potential optimization opportunities, including the potential for in-street running into downtown Halifax.

14.1 In-Street Extension

Currently, the existing CN Bedford Subdivision terminates at the VIA Station, which is approximately a 10-minute walk from downtown Halifax. This section discusses the possibility of providing an in-street extension into downtown Halifax based on a review of literature and publicly available imagery, and a consultation with an agency running commuter rail in-street.

14.1.1 Existing Street Running in North America

There are several jurisdictions with existing in-street running that can be consulted for information regarding in-street running. Notably, we are aware of several instances of street-running commuter rail services in the US, including:

- Capital MetroRail, in Austin, Texas, operates a commuter rail service with a Stadler (European-designed) DMU over a dedicated street lane
- Northern Indiana Commuter Transportation District (NICTD) operates the South Shore Line in Michigan City, Indiana, along the centre of a street using electric multiple units

In Canada, there is at least one instance in which a federally regulated railway runs in street, in Brantford, Ontario. Based on Google Earth imagery and videos posted online[76], when the rail line is in use, car traffic is prevented from proceeding on the section of road that has railway track using traffic signals. There are also several instances in the United States where a freight or intercity passenger railway runs on shared right-of-way with automobiles (e.g. Augusta, Georgia; Oakland, California). Several of these operate in mixed traffic, e.g. Jack London Square in Oakland.[77]

We consulted with Austin Capital Metro to understand the characteristics of its operations. Its commuter rail service operates over a former freight line. The existing infrastructure is timber tie construction paved over with asphalt. The commuter rail service operates in "Yard Limits", that is, at a maximum speed of 25 miles per hour and prepared to stop in half the range of vision. (The Canadian equivalent, in the *Canadian Rail Operating Rules*, specifies a maximum speed of 15 miles per hour [24 km/h] when operating on non-main track.) Capital Metro has one at-grade crossing where train operations pre-empt the road traffic signals; however, train

[76] See e.g. https://www.youtube.com/watch?v=sLTr1TnvhN8
[77] See e.g. https://www.youtube.com/watch?v=TSJUp_VDFjY

movements over the intersection are governed by signal indication (i.e. the train must be prepared to stop at the signal).

14.1.2 Regulatory Considerations

Unlike with other segments of the system, which would be owned by CN or the WHCR, we anticipate that Halifax Transit would need to own and operate this section of the line. As a result, Halifax Transit would likely need to apply for its own railway licence under the Nova Scotia *Railways Act* (and pursuant to the *Railway Notification and Licence Regulations*). The *Railways Act* defines a "railway" as "a railway, or any part thereof, and includes all railway lines, stations, depots, wharves, rolling stock, equipment, stores, real and personal property and works connected with a railway and any bridge, tunnel or other structure and any crossings used by a railway." The requirements of such a licence would require the operation of the street-running segment in keeping with federal railway safety regulations incorporated by reference into the Nova Scotia *Railway Safety Regulations*. Further research would be required to understand any regulatory constraints associated with street-running, notably pertaining to clearances, separation from auto traffic and grade crossings.

14.1.3 Potential Routes

Conceptually, there are two potential routes – with potential variations – for an in-street extension. In either case, the extension would be approximately 1.1 km from the existing CN Bedford Subdivision to Duke Street. (The exact terminus would need to be confirmed in a more detailed study). We emphasize that the discussion regarding routes is for the purposes of assessing the *feasibility* of a potential in-street extension, and not to recommend specific routings should Halifax decide to proceed with such a concept.

One possible route is to use Hollis Street, which is a one-way (southbound) street. Hollis has on-street parking on both sides of the street over much of the distance into Halifax and would likely have sufficient room to maintain both a rail lane and vehicle lane. The alignment would first need to pass through a parking lot – which is generally at the same grade as the Bedford Subdivision – and a parking lot access road. The remainder of Hollis Street is straight, so we would anticipate no operating constraints caused by the curvature in the rail alignment. However, there are additional constraints to the construction of a station platform along Hollis Street (as compared to the route along Water Street) given the close proximity of large buildings.

Another possible route is to use Water Street, which is a one-way (northbound) street with one lane of parking. In this case, a new alignment would come off the Bedford Subdivision and continue into a parking lot, before continuing north along Water Street. There is an S-curve on Water Street that may preclude the use of this street depending on the rolling stock selected, either due to rolling stock minimum curve radius constraints, or the fact that a curve in the rail alignment may impinge on a driving lane. Additionally, the parking lot adjacent to the Bedford Subdivision is about two metres lower than both the Bedford Subdivision and Water Street, which would necessitate additional grade construction. This street also provides access to a nearby container terminal; there is significant truck traffic visible on Google imagery. However, the key advantage of using Water Street is that there are several parking lots along the east side of the street that could be used to develop an appropriately large rail terminus (i.e. end-of-line station).

One variation of the Water Street route at the north end of this route would be to cut across a parking lot adjacent to Sackville Street onto Bedford Row. This route variation would avoid some of the S-curve on Water Street, though the rail alignment might still necessitate an at-grade crossing of Water Street. Bedford Row would generally be a suitable location for a station, as auto traffic is minimal and there are large sidewalks that could be integrated with a station platform.

Though we have not performed any detailed operational analysis, one track would be sufficient to maintain the 30-minute headways outlined in the travel demand study. Assuming an average speed of approximate 25 km/h, the total round trip travel time between the Bedford Subdivision and the downtown terminus would be approximately six minutes. Allowing another 10 minutes for station dwell (total 16 minutes), the train would be able to return to the Bedford Subdivision approximately 10 minutes before the next train would arrive at the dedicated right-of-way.

The trains would operate in their own dedicated lane, though they would need to cross several cross streets (approximately six to seven depending on the terminus). The design of at-grade crossings would be a key consideration. At minimum, specific rail traffic signals, ideally with some form of priority, would need to be installed and/or integrated into existing road traffic signals. Consideration would also need to be given to installing gates at intersections with cross-street. Though the operation of this service would be unique in Canada, the design would need to incorporate guidance from federal *Grade Crossing Standards*. Finally, another challenge with in-street running would be maintaining safe access to properties along the side of the street that the trains would run.

A key consideration in the route selection and alignment design would be (1) verifying that underground utilities can support the weight of the selected rail vehicle and (2) verifying that access can be maintained to utilities that would be under the rail alignment. Typically, any utilities that are underneath and parallel to the rail corridor would need to be considered for relocation as there is a likelihood that utility repairs would disrupt service.

14.1.4 Stations

All else equal, a terminus closer to the downtown core would be preferable. However, given that the in-street station would see significant passenger traffic (as the terminus), a key consideration would be finding an area that is large enough in width to accommodate a platform four to five metres wide. Additionally, in order to allow level-boarding, which would be preferable given the high ridership to/from this station, a platform should be at least 600 mm high above top of rail (see e.g. Figure 14-1), which is based on a European-designed low floor DMU.[78] (The Budd RDCs and Nippon Sharyo DMUs have a floor height of approximately 1200 mm [48 inches]). A platform at either of these heights could interfere with building entrances, notably along Hollis Street, though at some buildings it may reduce or remove the step in. There are potential station locations along Hollis Street, though in general the area is more constrained by adjacent buildings. There appears to be ample room along Water Street to allow such a platform given the presence of parking lots on the east side of the street. A station along Bedford Row is also a possibility, which has wide sidewalks.

Figure 14-1: Austin Capital MetroRail Infrastructure

Source: paulkimo90 on flickr

Along Hollis and Water Street, intersections of cross streets are approximately 100 metres apart (e.g. Prince Street to George Street.) This distance would accommodate three traditional car lengths. Based on our analysis of the travel demand previously (which indicated three-car RDCs would be required to accommodate medium demand levels at 30-minute headways and an average of 100% seated load factor), we anticipate that there would be sufficient room for a station between cross-streets.

However, access to adjacent properties remains a concern that would need to be addressed in a conceptual design phase. For example, if there were a terminus along Lower Water Street between Prince and George Street, there is only approximately 75 metres between roadway

[78] This height corresponds to the height of a low-floor DMU. A high-floor DMU has a height approximately 1200mm (48 inches) above top of rail.

curb cuts for a parking lot on the east side of the street. Should a station be located here, it may be necessary to close and relocate an access point.

14.1.5 Rolling Stock

Should an in-street extension be considered, rolling stock would be operating in a much different environment than on a freight rail line. Additional factors in selecting rolling stock should be considered, including notably:

- **Minimum turning radius:** Depending on the route selected, the DMU may need to navigate sharper corners than on the existing Bedford Subdivision
- **Maximum grade:** While traditional freight lines have only 1% to 2% grades, there are locations in downtown Halifax with steeper slopes. The maximum grade performance of the rolling stock could affect the route selection in the case of street running.
- **Acceleration/braking:** As the trains would be operating in mixed traffic, having quick acceleration and more importantly, responsive braking, would be an important factor in its selection.
- **Floor height:** Because the station platform needs to be integrated into the surrounding streetscape, a lower-floor DMU would likely be preferable to facilitate level-boarding and station access.
- **Operator visibility:** Many DMUs are designed to operate on traditional freight tracks and do not provide operators with significant peripheral visibility.[79] Given that the vehicle would be operating in mixed traffic with pedestrian traffic, this characteristic of the rolling stock would be an important design consideration to ensure the safety of other right-of-way users.
- **Aesthetics:** Given that this vehicle would be running along narrow downtown streets (as opposed to a freight corridor) aesthetics would be a larger consideration in the selection.

It may be possible to use the RDCs for street running, but based on these additional criteria, additional consideration should be given to using a low-floor European-designed DMU. These

[79] Hatch Mott MacDonald. 2005. North-South Corridor LRT Project: Overview Assessment of Rail and Bus Technologies. http://ottawa.ca/calendar/ottawa/citycouncil/trc/2005/07-06/Document%202%20-%20Bus%20vs%20Rail.pdf

vehicles have a floor height of about 600mm (24 inches) above top of rail,[80] which would facilitate installing level-boarding while being integrated with the surrounding streetscape, and are generally more aesthetically pleasing for running along narrow streets.

Without indicating any preference, one such DMU, a Stadler GTW, is currently being used in operations in commuter rail operations in Austin, Texas, which includes a segment running in-street (Figure 14-2). Stadler DMUs are approximately 2.95 metres wide. The basic variant, the 2/6 being used in Austin, is 40.9 metres long and can accommodate 92 people seated and an additional 96 people standing. There are several other variants, including a 6/12 that is 77 metres long and can seat 231 people. We understand that these vehicles are equipped with electromagnetic track brakes, which allow them to stop very quickly in emergency situations (around six miles per hour per second).

Figure 14-2: Stadler DMU Running On-Street as Austin Capital MetroRail

Source: Wikipedia.org

While using European-designed DMUs would be desirable from an urban design perspective, they would require the Canadian equivalent of an alternative-compliance design waiver from Transport Canada to operate on the Bedford Subdivision, as discussed in Chapters 5 and 7.

[80] Nelson, D. O. 2012. Rebalancing Commuter Rail Level Boarding with Freight Clearance Requirements. http://www.apta.com/mc/rail/previous/2012/presentations/Presentations/Nelson-D-Rebalancing-Commuter-Rail-Level-Boarding.pdf

Receiving such a waiver may be feasible in the longer term after further discussions with Transport Canada about developing a suitable evaluation process, but it is not a realistic option in the short term, as highlighted in Section 5.1.3.

Consideration could still be given to utilizing rebuilt rolling stock. OC Transpo has recently replaced its European-designed DMUs on its O-Train service, which could be one alternative considered. At the time of drafting this report, we do not know the status of these units. However, given that these units are not compliant for mixed-use operation with freight, they would need to be assessed for their suitability for receiving an alternative-compliance waiver. Achieving such a waiver would certainly require vehicle modifications, which may not be feasible. Alternatively, the Budd RDCs could be assessed for in-street operations, though would be less suitable for this type of operation due to their high floors.

14.1.6 Costs

Construction

In order to approximate the costs of an in-street extension, we have considered the construction costs of other in-street rail construction projects.

One recent example in Toronto was the reconstruction of the St. Clair streetcar line. In this case, an existing 6.8 km double-track streetcar corridor was completely reconstructed with a new dedicated right-of-way and curb-height platforms. This project also included some waterline and utility upgrades. The total cost of the project was $129 million, or approximately $19 million per corridor km and $10 million per track km. While the St. Clair construction was noted for not being well managed, it is indicative of costs associated with construction of in-street line in a densely populated area. [81]

The in-street alignment in Halifax would have a single track. Given that many of the costs associated with a rail corridor would be incurred regardless of whether one or two tracks are installed (e.g. station construction, utility relocations, etc.), we have assumed an estimated cost of $15 million per km of single track. Over the 1.1 km corridor, the construction cost is estimated to be in the order of the magnitude of $17 million, excluding land acquisition and engineering costs. Allowing $5 million for land acquisition around the VIA Station for the new rail extension and $3 million for engineering costs (15%), provides a total estimated cost of

---

[81] During the project, a report titled *"Getting It Right" Lessons from the Implementation of the St. Clair Streetcar for the Implementation of Transit City* was commissioned to study some of the issues that came up during construction.
https://www.ttc.ca/About_the_TTC/Commission_reports_and_information/Commission_meetings/2010/Jan_20_2010/Reports/Transit_City_Impleme.pdf;
http://www.thestar.com/news/city_hall/2012/03/20/st_clair_rightofway_a_rite_of_passage_for_a_gentrifying_avenue.html

$25 million. These costs should be considered order-of-magnitude estimates only, as they are based on information from comparable projects and not the specific construction requirements in the potential corridor.

Rolling Stock

In the Cobequid Medium Scenario, three three-RDC trainsets are required (plus two spares) to accommodate demand, at a total capital cost of approximately $22 million. Each trainset has a total of 192 seated spaces.

Should a new European-designed DMU be used instead of the Budd RDCs, there would be additional rolling stock costs over and above the estimates provided in scenarios. The cost of a Stadler GTW 2/6 trainset is approximately US$7.25 million each based on a recent order.[82] A single 2/6 unit would not be sufficient to accommodate demand with 92 seated places. We anticipate that a larger unit, such as the Stadler GTW 2/12, which can seat 231 people, would be required and cost around US$14.5 million. Given that three trainsets would be required (plus one spare), the total cost of rolling stock acquisition would be approximately US$58 million (approximately $73 million Canadian). The total incremental cost would thus be on the order of $50 million.

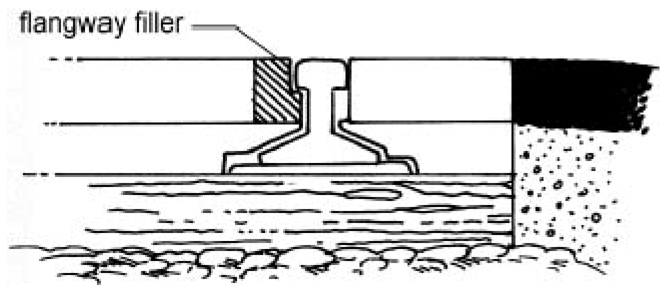
14.1.7 Impacts

There would be several impacts of in-street running:

- Reduced parking: Though traffic lanes may not need to be removed, parking lanes would need to be removed along the corridor to allow rail access.
- Increased roadway congestion: there may also be increased congestion due to rail signal priority of the in-street rail segment, the impacts of which would need to be considered in a more detailed study.
- Potentially reduced cycling infrastructure: There are currently plans for a bike lane along Hollis Street, which may not fit if a driving lane and rail lane are prioritized.
- Increased pedestrian and cycling safety concerns: Cyclists (and pedestrians) would be concerned about the gap between on the inside of the rail known as the flangeway; however, there are products that can minimize this gap (Figure 14-3). Infrastructure would also have to be designed to warn pedestrians of train traffic, particularly as trains would travel in both directions on a one-way street.

[82] http://www.railjournal.com/index.php/rolling-stock/bart-orders-stadler-dmus.html?channel=529

Figure 14-3: Flangeway Filler Diagram



Source: US Federal Highway Administration

- Reduced truck access to container terminal: The impacts on truck traffic from the container terminal would need to be considered, as the presence of the rail line could constrain vehicular traffic.
- Increased noise potential: Canadian Rail Operating Rules require a train engine bell to be rung approaching stations and the whistle to sound when crossing roadways. Halifax Transit could potentially discuss other techniques to improve pedestrian, cyclist and road user safety with Transport Canada as alternatives to these requirements.[83]

14.1.8 Benefits

There would be several benefits to in-street running (as compared to the current approach to terminate service at the VIA Station). Existing riders arriving at the VIA Station, most of whom are likely going downtown, would no longer need to transfer to a shuttle bus. The Halifax Travel Demand Model assumes that a transfer results in at least 5 minutes of disutility. Assuming that approximately 1,200 daily riders using the VIA Station daily would board downtown and no longer need to take a shuttle bus (corresponding to the Cobequid Medium Scenario), there would be approximately 200 hours in perceived travel time savings per day. At approximately $22.98 per hour, the average value of time in Halifax, users would save approximately $1.1 million per year in perceived travel time. Having the service continue to downtown would also obviate the need for a shuttle bus service from the VIA Station to downtown, at an approximate annual cost of $459,000 per year.

Assuming a real social discount rate of 5%, the present value of these annual benefits (over 23 years of operations) would be approximately $21 million.

The direct connection to downtown would also likely result in new riders to the system. These new riders would experience travel time savings, vehicle operating cost savings and provide

[83] There is a Transport Canada process for requesting whistling cessation, but the unique characteristics of the in-street running would require a tailored approach to ensure that the crossings are appropriately designed. See i.e. https://www.tc.gc.ca/eng/railsafety/railsafety-976.html.

carbon emission savings (as discussed in Chapter 13), which would enhance the benefits of the commuter rail system. However, there would also be increases in train operating costs that would offset some of the savings. The potential for additional traffic congestion in Halifax, as discussed in Section 14.1.8, would also offset some of the savings.

14.1.9 Summary

Overall, while the construction cost of an in-street extension would be significant, there are also notable benefits from having a one-seat commute into downtown (as opposed to transferring at the VIA Station). At an order of magnitude level, the analysis suggests that the incremental benefits ($21 million) could come close to offsetting construction costs ($25 million); however, they would not outweigh the incremental cost of acquiring new (as opposed to used) rolling stock. Furthermore, there are likely to be economic costs in terms of the disruption of traffic along Halifax streets, which we have not quantified.

Ultimately, we believe that an in-street extension could be feasible; however, several issues need to be studied in more depth (preliminary design), including, in particular:

- Utility relocations
- Access to properties along the rail alignment
- At-grade crossings

Finally, the fact that Halifax Transit would need to construct and operate the segment itself would add significantly to the complexity of the project.

14.2 Other Optimization Opportunities

In this section, we discuss optimization opportunities to improve the economic and financial performance of the scenarios considered and to facilitate the implementation of the system.

14.2.1 Cost Optimization

Halifax to Bedford Common Concept

We developed an approach to reduce the number of trainsets required in the Halifax-Cobequid Scenarios from three to two by operating only as far as Bedford Common (instead of Cobequid) and removing stops in the off-peak direction. This alternative would reduce the capital cost and operating cost of the Cobequid Medium Scenario by approximately $9.3 million (approximately 20%) and $1.0 million per year (approximately 10%), respectively. The latter corresponds to a present value of approximately $13.5 million using similar assumptions to the economic analysis. We anticipate that careful service planning would suggest that ridership would be only modestly reduced, as headways could be maintained at around 30 minutes, so the potential economic benefit of the system would only slightly decrease.

Ultimately, this potential optimization would not change the overall conclusions of the financial and economic analysis. Providing service as far as Bedford Common could slightly increase the operating ratio of the system by one to two percentage points at most (to approximately 22%). Given that the ENPV of the Cobequid Medium Scenario is -$75 million, the cost savings that could be achieved by terminating service at Bedford Common would not result in a positive ENPV.

Reduction in Track Access Charges

We also assessed the impact of a reduction in track access charges by 50% given the uncertainty that surrounds their estimation. In the case of the Beaver Bank Low Scenario, which has the least negative ENPV, the savings would be approximately $1.8 million per year, or approximately $25 million in present value terms. Since a reduction in track access charges would not influence the benefits resulting from the project, the ENPV would increase to approximately -$21 million, but still remain negative. A similar conclusion would be reached using the Cobequid Medium Scenario.

Crew Size Reduction

As discussed in Section 8.4, we have based our analysis on three-person crews (two operating personnel and one on-board service member), but there is an instance in Canada (the GO Transit Milton Line) where commuter rail service operates using only two qualified crew members. Should it be determined to be feasible to operate as a two-person crew (i.e. with the conductor operating doors and wheelchair lifts), approximately $350,000 per year in savings is possible, equivalent to approximately $4.7 million in present value terms. Again, even after considering all the potential savings discussed above, changing this assumption would not result in a positive ENPV.

Multiple Cost Reductions

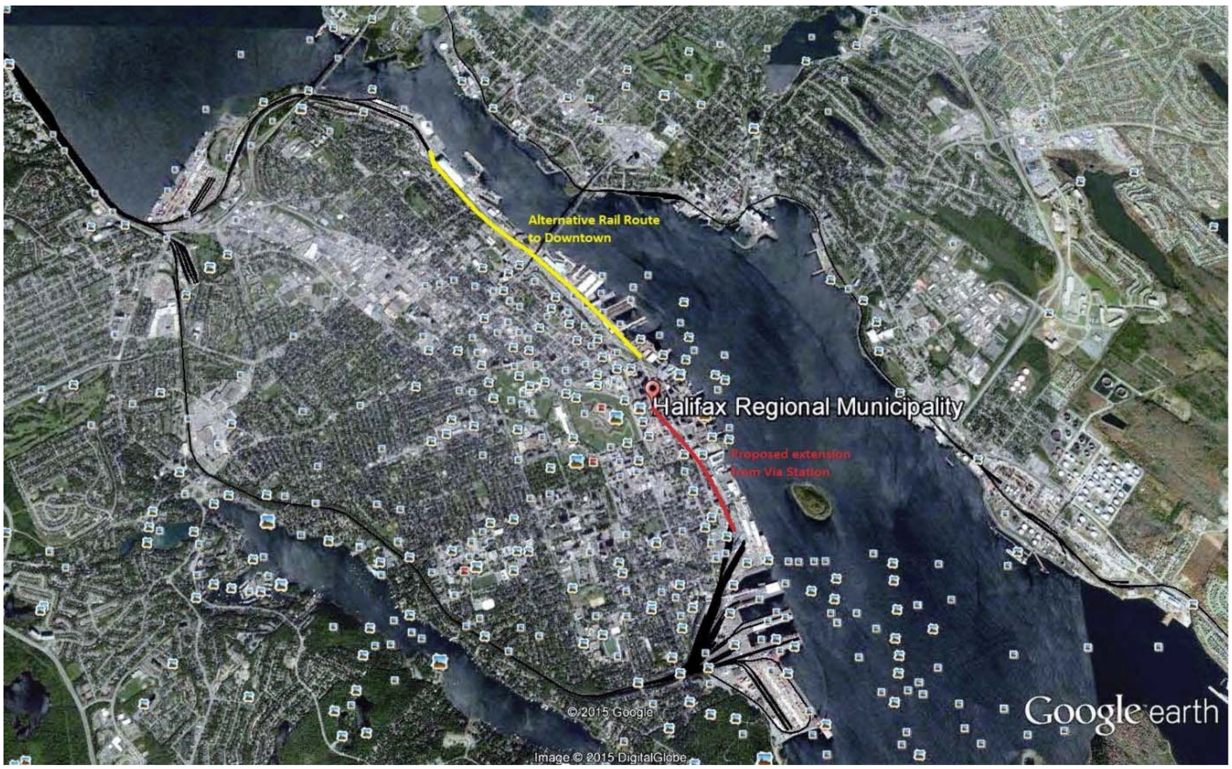
The potential cost savings resulting from lower track access charges and crew size reductions can be summed directly. In the case of the Beaver Bank Low scenario, which has the least negative ENPV, the ENPV would increase to approximately -$16 million, but still remain negative, if there were a 50% reduction in track access charges and a crew size reduction from three persons to two.

If service were to continue only as far as Bedford Common, track access charges were 50% less than estimated, the crew sized were reduced through the elimination of a service personnel, then the total operating cost saving would be approximately $2.7 million per year less than the Cobequid Medium Scenario, with an equivalent present value of approximately $37 million. Combined with the capital cost savings of $9.3 million, the ENPV would fall to approximately -$29 million. As such, even after accounting for all of the potential changes combined, the ENPV would still be negative.

14.2.2 Alternative Route to Downtown Core

Instead of street running, there is alternative route for a rail line into downtown Halifax from the north end of Halifax, as per the Figure 14-4, that may require less infrastructure. As such, capital costs of construction could also be reduced.

Figure 14-4: Alternative Route into Halifax



Source: Google Earth

Currently, CN has a rail line into its Halifax Intermodal terminal in the north end. Up until about 10 years ago, there was a rail line (some with rail installed) beyond the intermodal terminal to close to the MacDonald Bridge. Since then, it appears that the right-of-way has been largely sold or leased, and some development has occurred on the land. However, in general terms, the land is less densely developed than from the VIA Station to the downtown core and, as such, the development of a link from CN's intermodal terminal to downtown (near the Casino Nova Scotia) may provide a less costly, albeit longer route. The length of track to be constructed would be in the range of 1.8 miles. As part of our analysis, we have not inspected this alternative corridor.

It is important to note that the route would likely need to be in addition to the planned route from VIA Station to Cobequid and Beaver Bank. The distance from the currently considered alignment to the downtown terminus (near Casino Nova Scotia) would be approximately 4 miles. The 2.2 miles of existing track that is used by CN into and in the Halifax Intermodal terminal is non-main-track and movements are governed by Rule 105. Moving from a purely linear operation to one with a diverging route would add operating complexity and costs quite likely without any significant increase in revenue. Clearly, more analysis would be required.

14.3 Opportunities and Risks

From an economic net benefit standpoint, all of the scenarios that we tested suggested commuter rail service in Halifax is not economically viable. However, while the analysis is based on the best available information and reasonable assumptions, there are several uncertainties and limitations in the analysis that could result in the project being less or more economically viable than our findings indicate.

As discussed in Section 14.2, there may be several opportunities to reduce operating charges; however, none of them on their own would be sufficient to result in a positive ENPV. (We do not anticipate that significant reductions in capital costs would be possible.) Equally likely, there are risks that operating costs (notably track access fees, etc.) and/or capital costs would be higher than expected (e.g. higher construction or rolling stock costs); the latter is common with infrastructure projects in general.

There is also the risk that the anticipated benefits do not materialize due to lower than expected ridership. Notably, there is a modal bias included in the model that favours commuter rail. This adjustment is in line with expectations that, assuming rail and bus service were to have similar service qualities that are explicitly modelled (i.e. travel time, cost, and frequency), more riders would prefer rail due to its perceived higher reliability, comfort or other factors. However, the actual magnitude of the modal bias effect in reality may be lower than the factor built into the model, as there is no empirical evidence from Halifax to test this assumption.

There is the potential a commuter rail system could create more benefits if ridership is higher than expected, which could occur if more auto users than expected shift from to commuter rail. As discussed in Section 6.7, existing auto users, which represent over 90% of the motorized modal share[84] in Halifax based on the model outputs, are the largest source of potential commuter rail users. The analysis suggests that, depending on the scenario,

[84] This modal share does not factor in trips that only use active transportation modes, such as walking all the way or biking.

between four and seven out of 1,000 auto commuters would switch to rail (Section 6.7). If the switch rate is greater than or equal to 10 in 1000, then there is the potential that the economic benefits could exceed costs. Such an increase is unlikely though not implausible.

Additionally, and more concretely, while official population and figures were used in the development of the rail corridor ridership forecasts and, by extension, the economic and financial analyses, these figures do not explicitly consider potential population intensification around stations and, by extension, the forecasted benefits accruing from a commuter rail system are likely also underestimated.

In sum, while our base analysis suggests that commuter rail in Halifax is not economically viable, there is upside potential for higher benefits. If strategies are employed to encourage transit-oriented development and discourage auto use, there is the potential for an economically viable project. However, particularly at this early feasibility stage of analysis, there is also the potential for downside risks, such as lower than expected ridership and higher than expected costs. The strategies noted have the potential to mitigate some of the downside demand risk, and careful discussions with CN, considering all available opportunities, have the potential to mitigate some of the cost risks pertaining to track access and infrastructure requirements; however, both risks remain present.

Appendix A Inventory of Bridges on Bedford Subdivision (Halifax-Elmsdale)

Mileage	Name	Number of Spans	Over Head (O/H) Structure	Total Bridge Length	Numbers of Tracks	Built Year	Notes
0.33	Pedestrian Tunnel	1		172’	9	1935	Concrete Box
0.80	Young Avenue	2	Yes	192’	6	1917	Reinforced concrete arch
0.88	Harbour Solution O/H pipe	1	Yes		3		Thru Truss
0.90	Tower Road	1	Yes	145'	2	1917	Reinforced concrete arch
1.40	Marlborough Woods	1	Yes	132'	1	1917	Reinforced concrete arch
1.60	Belmont on the Arm	1	Yes	122'	1	1917	Reinforced concrete arch
1.80	Oakland Road	1	Yes	146'	1	1917	Reinforced concrete arch
2.00	South Street	1	Yes	113'	1	1917	Reinforced concrete arch
2.30	Coburg Road	1	Yes	124'	1	1917	Reinforced concrete arch
2.60	Jubilee Road	1	Yes	125'	1	1917	Reinforced concrete arch
2.80	Prince Arthur Street	1	Yes	118'	1	1916	Reinforced concrete arch
3.00	Quinpool Road	1	Yes	108'	1	1916	Reinforced concrete arch
3.40	Chebucto Road	3		78'-6"	1	1917	Thru Plate Girder
3.90	Mumford Road	1	Yes	180'	1	1916	Reinforced concrete arch
4.12	Bicentennial Drive	3	Yes	368'	1	1962	Beam span
4.20	Bayers Road	1	Yes	120'	1	1917	Reinforced concrete arch
4.77	Kempt Rd. by pass Ramp	4	Yes	263'	3	1981	Continuous Reinforced Concrete Slab
4.83	Kempt Road	3	Yes	272'	3	2010	Pre-stressed Concrete Girders
4.83	Kempt Road	3	Yes	185'	3	1981	Pre-stressed Concrete Girders
6.90	Rockingham Yacht Club	1		15'	2	1966	Reinforced Concrete Frame
9.67	Convoy Run	1	Yes	???	1	1990	Pre-stressed Concrete Girders
10.70 # 1	Sackville River	3		282'	1	1905	Deck Plate Girder
10.70 # 2	Out of service	3		280'	1	1906	Deck Plate Girder
11.00 # 1	Subway	1		52'	1	1951	Deck Plate Girder
11.00 # 2	Out of service	1		52'	1	1951	Deck Plate Girder

Appendix B Passenger Operations on Freight Lines in Canada

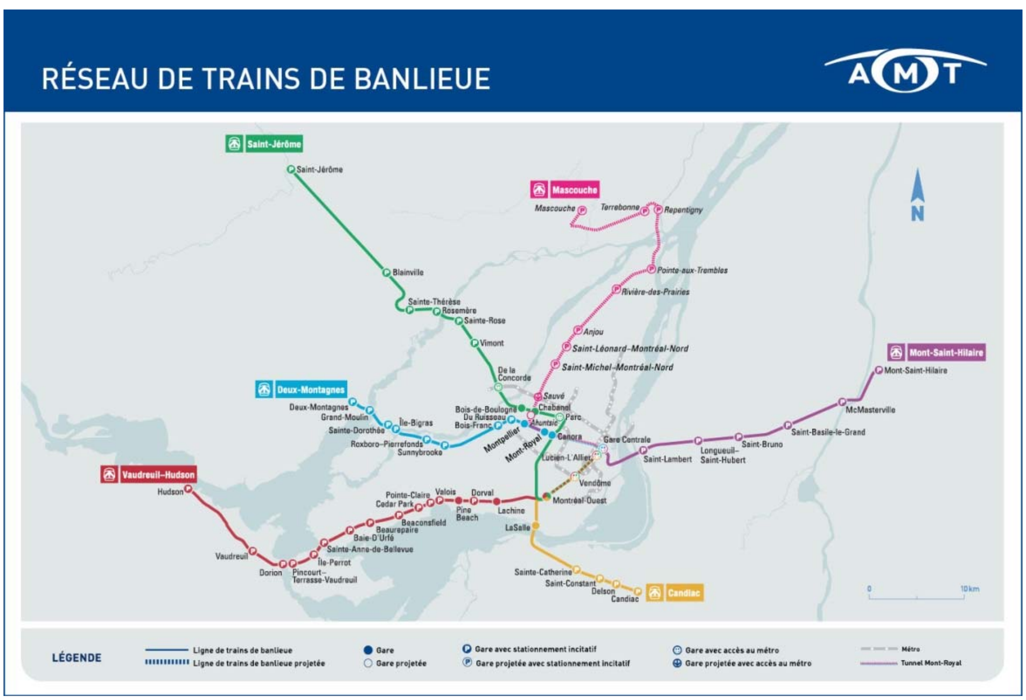
Agence métropolitaine de transport (Montreal)

The Agence métropolitaine de transport (AMT) is the regional transit agency responsible for interregional transit within the Greater Montreal Area. The AMT is an agency of the Government of Quebec.

Service Offered

The AMT currently has six commuter rail lines (Figure B-1). The Mascouche Line, the newest line, opened in December 2014.

Figure B-1: AMT Commuter Rail Lines



Source: AMT : www.amt.qc.ca

Services offered are as per the following figure (Figure B-2).

Figure B-2: AMT Commuter Rail Summary 2013

Line	Deux-Montagnes	Vaudreuil-Hudson	Blainville-Saint-Jérôme	Mont-Saint-Hilaire	Candiac	Mascouche (opened 2014)
Operator	CN	CP	CP	CN	CP	CN
Line Ownership	AMT (acquired from CN in 2014)	CP to Dorion AMT Dorion-Hudson	CP	CN	CP	AMT to Ahuntsic, CN, AMT in the median of Highway A-640.
Rolling stock	Electric – EMU	Diesel – Hauled	Diesel – Hauled	Diesel – Hauled	Diesel – Hauled	Dual-mode (electric/diesel) locomotive
Rolling Stock Maintenance		Bombardier	Bombardier		Bombardier	
Length (km)	29.9	51.2	62.8	34.9	25.6	50.1
Daily Trips Inbound	25	13	13	7	9	8
Daily Trips Outbound	24	14	13	7	9	8
Stations	12	18	13	7	8	11
Parking Facilities	8	14	7	6	4	7
Parking Spots	5,958	3,189	3,349	3,520	1,449	2,521
Ridership (Annual Millions)	7.7	3.8	2.9	2.3	1.1	0.1
Operating costs ($ millions)	39.3	34.8	31.0	23.3	11.2	5.1
Operating cost per passenger ($)	5.10	9.16	10.68	10.13	10.18	49.0

Source: AMT Rapport Annuel 2014 : https://www.amt.qc.ca/Media/Default/pdf/section8/publications/amt-rapport-annuel-2014.pdf and Plan Triennal d'Immobilisations : www.amt.qc.ca/pti-2014-15-16.pdf

Track Access

The AMT contracts with CN and CP for train operations, including the train operations, track access, and station and track maintenance. Contractual agreements extend until 2025. At December 31, 2013, the balance of the commitment of the AMT with respect to these contracts amounted to $579 million. Expected payments are $66.4 million in 2014, $67.0 million in 2015, $54.4 million in 2016 and $41.2 million in 2017.[85]

[85] AMT Rapport Annuel 2013 :

GO Transit (Greater Toronto Area)

GO Transit is a division of Metrolinx (MX), a crown corporation of the Government of Ontario.

Services Offered

GO Transit has seven commuter rail lines (Figure B-3).

Figure B-3: GO Transit Commuter Rail Lines

Source: GO Transit: www.gotransit.com

A summary of its operations is provided in Figure B-4.

Figure B-4: GO Transit Commuter Rail Summary 2013

Line	Lakeshore West	Lakeshore East	Milton	Kitchener	Barrie	Richmond Hill	Lincolnville
Operator	Bombardier	Bombardier	CP	Bombardier	Bombardier	Bombardier	Bombardier
Line Ownership	MX Union Burlington CN Burlington to past Aldershot, CP past Aldershot to Hamilton	MX	MX Union to Bloor, CP Bloor to Milton	MX Union to Bramalea, CN Bramalea to Georgetown. MX Georgetown to Kitchener	MX	MX Union to south of Langstaff, and CN	MX
Rolling stock	Diesel-Hauled Train						
Rolling Stock Maintenance	Bombardier						
Length (km)	63.2	50.5	50.2	102.7	101.4	33.8	49.6
Daily Trips Inbound (weekday)	44	46	8	9	7	5	7
Daily Trips Outbound (weekday)	46	42	8	7	7	6	8
Stations*	12	10	9	12	11	5	10
Parking Spots (2014)	19,013	16,656	9,968	6,761	7,078	3,881	5,853

Source: GO Transit: www.gotransit.com.
http://www.metrolinx.com/en/docs/pdf/board_agenda/20130627/20130627_BoardMtg_GO_Transit_Update_EN.pdf
http://www.gotransit.com/public/en/docs/publications/GO_Annual_Report_2011-12_EN.pdf
http://news.ontario.ca/mto/en/2014/09/metrolinx-rail-purchase-means-better-service-for-riders.html
Parking: http://www.metrolinx.com/en/regionalplanning/projectevaluation/studies/GO_Transit_Rail_Parking_and_Station_Access_Plan_EN.pdf
*Not all trains stop at all stations.

Track Access

In 2013, Metrolinx owned 68% of its corridors. CP and CN owned the remaining 11% and 21%, respectively. CN's ownership includes track leased to the Goderich and Exeter Railway, a shortline.[86]

86 http://www.metrolinx.com/en/docs/pdf/board_agenda/20130627/20130627_BoardMtg_GO_Transit_Update_EN.pdf

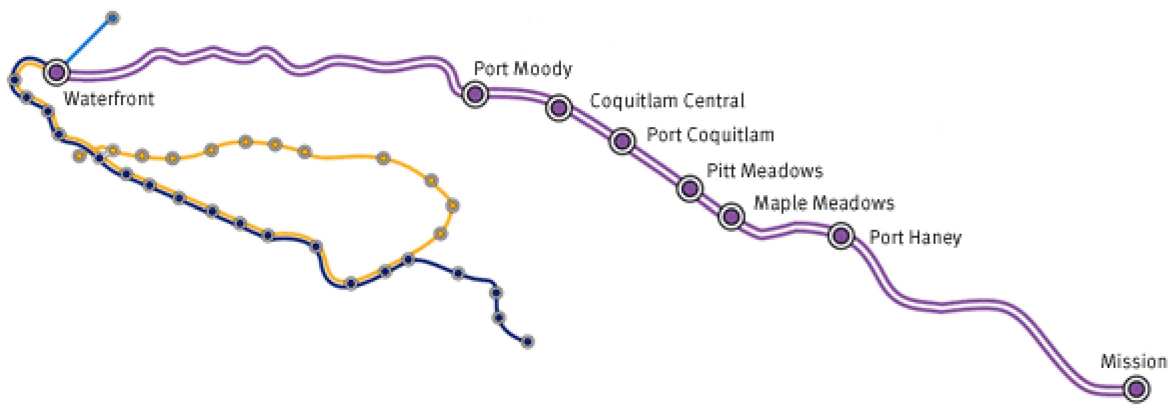
West Coast Express (Vancouver Area)

West Coast Express is a subsidiary of TransLink.

Services Offered

The West Coast Express is a single commuter rail line (Figure B-5). A summary of its operations is provided in Figure B-6.

Figure B-5: West Coast Express Commuter Rail Line



Source: http://tripplanning.translink.ca/hiwire?.a=iScheduleLookupSearch&LineName=997&LineAbbr=997

Figure B-6: West Coast Express Commuter Rail Summary

Line	West Coast Express
Operator	Bombardier
Line Ownership	CP
Rolling Stock	Diesel-Hauled Train
Rolling Stock Maintenance	Bombardier
Length (km)	69
Daily Trips Inbound (weekdays only)	5
Daily Trips Outbound (weekdays only)	5
Stations	8
Parking Facilities	
Parking Spots	
Ridership (Annual)	2,800,000

Source: http://www.translink.ca/en/About-Us/Corporate-Overview/Operating-Companies/WCE.aspx

Appendix C Modifications to VISUM Models and Modelling Assumptions

Introduction

To update the VISUM models in accordance with the Halifax Commuter Rail Feasibility Study, modifications were applied to the VISUM models provided by the Halifax Regional Municipality (Halifax). This appendix documents the modifications/updates applied to the models.

Model Files Provided

Halifax provided Dillon Consulting Limited (Dillon) with various VISUM files used in the running of the existing regional model. While many of the files provided were of use for graphical display and reference, the following files were required for VISUM model runs and their modifications covered in this document:

- 2013 Existing Model
  - "2013 Baseline PM Peak Final Sept 15 2014.ver" VISUM Version file, which includes the primary model network and associated attributes.
  - "2013 PM Peak.par" VISUM Procedure file, which is used to specify the procedural steps used in a model run.
- 2031 Horizon Model
  - "2031 Baseline PM Peak.ver" VISUM Version file, which includes the primary model network and associated attributes.
  - "2031 PM Peak.par" VISUM Procedure file, which is used to specify the procedural steps used in a model run.
- Common Files
  - "PR_Skim Sept 10 2014.py" Python script file used to calculate park and ride skim matrices.
  - "PR_Mode Split Sept 3 2014.py" Python script file used to reallocate mode split trips in the home bound work (HBW) park and ride trip matrix.

Outline of Commuter Rail Scenarios

- Scenario combinations of: Ridership Levels - Low, Medium, High; and, Rail Line Length - VIA to Elmsdale Station, VIA to Cobequid Station
  - Total of 6 scenarios run
- Description of Ridership Level scenarios
  - Low Scenario
    - Status quo, non commuter rail model as base
    - Allow transit bus access to stations (pass-by routes only or minor extensions/modifications)
    - No rail-specific park and ride lots, except Mumford (de facto)
    - No downtown shuttle service
  - Medium Scenario
    - Low Scenario +
    - Add rail-specific park and ride lots - Mumford (de facto), Sunnyside, Bedford Common, Cobequid, Wellington, Elmsdale
    - Add downtown shuttle routes - City Centre to VIA, University Shuttle
  - High Scenario
    - Medium Scenario +
    - Suburban transit modifications - feeder routes at Cobequid and Elmsdale
    - Eliminate parallel routes to commuter rail, competing for mode share

Explanation of Model Modifications

Network Modifications - Changes made to network objects from within the network editor.

Procedure Sequence - Documents changes to procedure sequences. Due to complicated nature of procedural sequence references, changes are denoted as follows:

- Procedure Group Reference as "Steps - old 9, new 10"
- Procedure Line Reference as "Step 10 of 10, New Line 116"

Matrix Modifications - Addition, modification, and/or deletion of model matrices.

User-Defined Variable Additions - Defining additional object variables.

Python Modifications - Changes made to Python script files.

<u>Existing 2013 Model</u>

Model File: 2013 CommuterRail PM Peak 2014-10-06.ver

Model Genesis: 2013 Baseline PM Peak Final Sept 15 2014.ver (Provided by Halifax)

Base Existing model provided by Halifax.

1) Procedure Sequence
    a) Modified "Trip Distribution" Group (Steps - old 9, new 10)
        i) Step 10 of 10, New Line 116 - Copy original HBW Matrix 21 to Matrix 603. Change requested by Halifax staff due to known bug issue.

<u>Future 2031 Horizon Model - Base Scenario (No Rail)</u>

Model File: 2031 CommuterRail PM Peak - Base 2014-10-08.ver

Model Genesis: 2031 Baseline PM Peak.ver (Provided by Halifax)

Base Future model provided by Halifax.

1) Procedure Sequence Changes
    a) Modified "Transit and Pedestrian Skim Matrices" Group (Steps - old 16, new 18)
        i) Step 4 of 18, New Line 88 - Schedule Adherence, transpose Matrix 71 on Perceived Journey Time
        ii) Step 12 of 18, New Line 96 - Transit Utility, save transposed Matrix 107 to Matrix 999 for PuT Travel Times
    b) Modified "Park and Ride Skim" Group (Steps - old 1, new 2)
        i) Step 1 of 2, New Line 104 - Transit cost transposed calculation.
        ii) Step 2 of 2, Modified Line 105 - Change park and ride skim Python script reference to latest version.
    c) Modified "Trip Distribution" Group (Steps - old 9, new 10)
        i) Step 2 of 10, Modify Line 108 - PrT Skim Calculation, Add Direct Distance calculation
        ii) Step 10 of 10, New Line 116 - Copy original HBW Matrix 21 to Matrix 603. Change requested by Halifax staff due to known bug issue.
    d) Modified "Transit and Auto Captivity" Group (Steps - old 19, new 8)
        i) Removed Steps 9 to 19 from group.
        ii) Moved 8 steps to "Mode Choice 1" group as denoted below.
    e) Modified and Renamed "Park and Ride Mode Choice" to "Mode Choice 1" Group (Steps - old 18, new 29)
        i) Steps 1 to 8, Lines 130 to 137, Moved from "Transit and Auto Captivity" Group
        ii) Step 9 to 11, Lines 138 to 140 - Relocated from within current group

iii) Step 12 of 29, Moved/Modified Line 141 - Relocated from within current group; Modified mode choice procedure, HBW Transit to reference Matrix 999 as utility function
iv) Steps 13 to 15, Lines 142 to 144 - Relocated from within current group
v) Steps 16 to 20, New Lines 145 to 149 - Add calculation and combination of park and ride / transit exponential utility functions
vi) Steps 21 to 22, New Lines 150 to 151 - Add matrix calculations for park and ride mode split and trips
vii) Step 23 of 29, Moved/Modified Line 152 - Modified Matrix 35 to remove park and ride trips
viii) Step 24 of 29, Modified Line 153 - Change park and ride mode split Python script reference to latest version.
ix) Step 25 of 29, Moved/Modified Line 154 - Modified Matrix 35 to add modified park and ride trips
x) Removed other extraneous procedures (5 steps)
xi) Steps 26 to 29, Lines 155 to 158 - Move add captive trips for Matrices 21, 22, 23, 25

f) Copy “Mode Choice 1” group, rename copy to “Mode Choice 2” group, and move copy after “Matrix Adjustment” group (Steps - new 26)
   i) Step 1 of 26, New Line 175 - Calculate PrT skim matrices for tCur and Impedance
   ii) Steps 2 to 4, Lines 176 to 178 - Car cost and impedance relocated from within current group
   iii) Steps 5 to 6, Lines 179 to 180 - Mode choice steps relocated from within current group
   iv) Removed check negative value steps (4 steps)
g) Delete “Park and Ride Mode Choice” Group
h) Modified “Transit Assignment” Group (Steps 3)
   i) Step 1 of 3, Modified Line 202 - Removed Matrix 400 from combination calculation.
i) Modified “Post Assignment Analysis” Group (Steps - old 18, new 21)
   i) Step 10 of 21, New Line 218 - Calculate All Trips Matrix 820
   ii) Step 14 of 21, New Line 233 - Calculate park and ride trip attribute
   iii) Step 21 of 21, New Line 229 - Calculate public transportation operating indicators

2) Matrix Modifications

   a) Add Skim Matrix 643 - Park and Ride Utility
   b) Add Skim Matrix 644 - Transit Utility
   c) Add Skim Matrix 645 - Sum Utility
   d) Add Skim Matrix 646 - Park and Ride Modal Split
   e) Add Skim Matrix 647 - Transit Modal Split
   f) Add Demand Matrix 820 - All Trips
3) User-Defined Variable Addition
   a) Zones List
      i) Add "PR_Time" variable

<u>Future 2031 Horizon Model - Elmsdale Medium Scenario</u>

Model File: 2031 CommuterRail PM Peak - ElmMED 2014-10-28.ver

Model Genesis: 2031 CommuterRail PM Peak - Base 2014-10-08.ver

Initial commuter rail scenario significantly modified from the Future Base model (no rail) conditions. Represents modest shuttle service and park and ride enhancements to attract commuter rail ridership.

1) Network Modifications
   a) Defined new "R Commuter Rail" Transportation System affiliated with the "T Transit" Mode and Demand Segment.
   b) Created dedicated commuter rail line corridor along prescribed route from VIA Station (Halifax City Centre) to Elmsdale.
      i) Continuous Links between station locations.
      ii) Station nodes tied into adjacent road network and given transit access.
   c) Created Stop Points representing each commuter rail stop location.
   d) Transit Route Additions/Modifications
      i) Added Line / Line Routes / Timetables for "5001 Commuter Rail Line" - VIA to Elmsdale and Elmsdale to VIA. Truncated Elmsdale to VIA back to South End for calibration due to extreme model demand from South End to VIA.
      ii) Added Line / Line Routes / Timetables for "5102 Downtown Halifax" - Shuttle service for commuters from city centre area.
      iii) Added Line / Line Routes / Timetables for "5103 University Circle" - Shuttle service for commuters from university area.
      iv) Modified Line Routes adjacent to stations to modestly extend or include pass-by routes to station Stop Points.

e) Added Transit Access Connectors - Created additional connectors through calibration that provided direct transit access to Mumford, Mill Cove, and Wellington stations
f) Modified Transit Access Links - Added transit access demand segment to adjacent network Links to ensure connectivity to nearby TAZs.
g) Added TAZs representing PR lots for following locations:
   i) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
   ii) 1503 Sunnyside PR - Zone available, PR currently disconnected
   iii) 1504 Bedford Common PR - Proposed PR lot location, in use
   iv) 1505 Cobequid PR - Proposed PR lot location, in use
   v) 1506 Wellington PR - Proposed PR lot location, in use
   vi) 1505 Elmsdale PR - Proposed PR lot location, in use
h) Connected Highway 102 / Glooscap Trail interchange and Glooscap Trail to Elmsdale PR area
i) Modified General Procedure Settings
   i) PuT Settings > Assignment > Maximum walk time set to "20min"

2) Procedure Sequence Changes
   a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_ElmMED.py"
   b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_ElmMED.py"
   c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_ElmMED.py"
3) Matrix Modifications
   a) Modified Skim Matrix 997 - Park and Ride Temporary
      i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
      ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zones 1501, 1504, 1505, 1506, and 1507 flagged
4) Python Modifications
   a) Changes to "PR_Skim_2031H_ElmMED.py" script from original Halifax provided.
      i) Added Commuter Rail PR lots 1501, 1504, 1505, 1506, and 1507 references to shortest PR travel time algorithm.
      ii) Added Commuter Rail PR lots 1501, 1504, 1505, 1506, and 1507 references to catchment area algorithm and calibrated values.

        iii) Added Commuter Rail PR lots 1501, 1504, 1505, 1506, and 1507 references to perceived journey time / cost algorithm and calibrated values.
    b) Changes to "PR_ModeSplit_2031H_ElmMED.py" script from original Halifax provided.
        i) Added Commuter Rail PR lots 1501, 1504, 1505, 1506, and 1507 references to mode choice algorithm.

<u>Future 2031 Horizon Model - Elmsdale Low Scenario</u>

Model File: 2031 CommuterRail PM Peak - ElmLOW 2014-10-28.ver

Model Genesis: 2031 CommuterRail PM Peak - ElmMED 2014-10-28.ver

Bare bones commuter rail scenario without additional infrastructure support (i.e. park and ride, downtown shuttles, etc.).

1) Network Modifications
    a) Transit Route Modifications
        i) Removed Line / Line Routes / Timetables for "5102 Downtown Halifax" - Shuttle service for commuters from city centre area.
        ii) Removed Line / Line Routes / Timetables for "5103 University Circle" - Shuttle service for commuters from university area.
    b) Modified TAZs representing PR lots for following locations:
        i) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
        ii) 1503 Sunnyside PR - Zone available, PR currently disconnected
        iii) 1504 Bedford Common PR - Zone available, PR currently disconnected
        iv) 1505 Cobequid PR - Zone available, PR currently disconnected
        v) 1506 Wellington PR - Zone available, PR currently disconnected
        vi) 1505 Elmsdale PR - Zone available, PR currently disconnected
2) Procedure Sequence Changes
    a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_ElmLOW.py"
    b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_ElmLOW.py"
    c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_ElmLOW.py"
3) Matrix Modifications
    a) Modified Skim Matrix 997 - Park and Ride Temporary
        i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2

ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zone 1501 flagged

4) Python Modifications
    a) Changes to "PR_Skim_2031H_ElmLOW.py" script from "PR_Skim_2031H_ElmMED.py".
        i) Removed Commuter Rail PR lots 1504, 1505, 1506, and 1507 references from shortest PR travel time algorithm.
        ii) Removed Commuter Rail PR lots 1504, 1505, 1506, and 1507 references from catchment area algorithm.
        iii) Removed Commuter Rail PR lots 1504, 1505, 1506, and 1507 references from perceived journey time / cost algorithm.
    b) Changes to "PR_ModeSplit_2031H_ElmLOW.py" script from "PR_ModeSplit_2031H_ElmMED.py".
        i) Removed Commuter Rail PR lots 1504, 1505, 1506, and 1507 references from mode choice algorithm.

<u>Future 2031 Horizon Model - Elmsdale High Scenario</u>

Model File: 2031 CommuterRail PM Peak - ElmHIGH 2014-10-28.ver

Model Genesis: 2031 CommuterRail PM Peak - ElmMED 2014-10-28.ver

Enhanced commuter rail scenario with additional infrastructure support (i.e. removal of competing bus park and ride, addition of suburban shuttles, supportive transit bus route modifications, etc.).

1) Network Modifications
    a) Transit Route Additions/Modifications
        i) Added Line / Line Routes / Timetables for "5211 Cobequid R1" - Shuttle service for suburban commuters near Cobequid Station.
        ii) Added Line / Line Routes / Timetables for "5212 Cobequid R2" - Shuttle service for suburban commuters near Cobequid Station.
        iii) Added Line / Line Routes / Timetables for "5221 Mill Cove Shuttle" - Shuttle service for suburban commuters near Mill Cove Station.
        iv) Modified Line / Line Routes for "66 Penhorn" - Terminated north of Sunnyside Station.
        v) Modified Line / Line Routes for "82 Millwood" - Terminated south of Sunnyside Station, all trips ending at Cobequid Terminal extended to Sunnyside Station.

vi) Modified Line / Line Routes for "87 Downsview" - Rerouted between Cobequid Terminal and Sunnyside Station (connection) via Bedford Highway, uses Dartmouth Road to access Bedford By-Pass and continue route south.
vii) Modified Line / Line Routes for "88 Duke" - Removed Cobequid Road portion of route.
viii) Modified Line / Line Routes for "89 Bedford" - Terminated north of Sunnyside Station.
ix) Removed Line / Line Routes / Timetables for "84 Glendale" - Competing route to commuter rail.
x) Removed Line / Line Routes / Timetables for "85 Downsview" - Competing route to commuter rail.

b) Modified TAZs representing PR lots for following locations:
   i) 1002 Sackville PR - Zone available, PR currently disconnected
   ii) 1004 Fall River PR - Zone available, PR currently disconnected
   iii) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
   iv) 1503 Sunnyside PR - Zone available, PR currently disconnected
   v) 1504 Bedford Common PR - Proposed PR lot location, in use
   vi) 1505 Cobequid PR - Proposed PR lot location, in use
   vii) 1506 Wellington PR - Proposed PR lot location, in use
   viii) 1505 Elmsdale PR - Proposed PR lot location, in use

2) Procedure Sequence Changes
   a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_ElmHIGH.py"
   b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_ElmHIGH.py"
   c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_ElmHIGH.py"
3) Matrix Modifications
   a) Modified Skim Matrix 997 - Park and Ride Temporary
      i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
      ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zones 1501, 1504, 1505, 1506, and 1507 flagged; Assigned "999999" to zones 1002 and 1004
4) Python Modifications

a) Changes to "PR_Skim_2031H_ElmHIGH.py" script from "PR_Skim_2031H_ElmMED.py".
    i) Removed Transit Bus PR lots 1002 and 1004 references from shortest PR travel time algorithm.
    ii) Removed Transit Bus PR lots 1002 and 1004 references from catchment area algorithm.
    iii) Removed Transit Bus PR lots 1002 and 1004 references from perceived journey time / cost algorithm.
b) Changes to "PR_ModeSplit_2031H_ElmHIGH.py" script from "PR_ModeSplit_2031H_ElmMED.py".
    i) Removed Transit Bus PR lots 1002 and 1004 references from mode choice algorithm.

Future 2031 Horizon Model - Cobequid Medium Scenario

Model File: 2031 CommuterRail PM Peak - CobMED 2014-10-28.ver

Model Genesis: 2031 CommuterRail PM Peak - ElmMED 2014-10-28.ver

Represents modest shuttle service and park and ride enhancements to attract commuter rail ridership. Outbound route terminates at Cobequid Station - route portion to Elmsdale Station removed.

1) Network Modifications
    a) Transit Route Additions/Modifications
        i) Modified Line / Line Routes / Timetables for "5001 Commuter Rail Line" - Removed Cobequid to/from Elmsdale portion of commuter rail route.
    b) Modified TAZs representing PR lots for following locations:
        i) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
        ii) 1503 Sunnyside PR - Zone available, PR currently disconnected
        iii) 1504 Bedford Common PR - Proposed PR lot location, in use
        iv) 1505 Cobequid PR - Proposed PR lot location, in use
        v) 1506 Wellington PR - Zone available, PR currently disconnected
        vi) 1505 Elmsdale PR - Zone available, PR currently disconnected

2) Procedure Sequence Changes
    a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_CobMED.py"

   b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_CobMED.py"
   c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_CobMED.py"
3) Matrix Modifications
   a) Modified Skim Matrix 997 - Park and Ride Temporary
      i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
      ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zones 1501, 1504, and 1505 flagged
4) Python Modifications
   a) Changes to "PR_Skim_2031H_CobMED.py" script from "PR_Skim_2031H_ElmMED.py".
      i) Removed Commuter Rail PR lots 1506 and 1507 references from shortest PR travel time algorithm.
      ii) Removed Commuter Rail PR lots 1506 and 1507 references from catchment area algorithm and calibrated values.
      iii) Removed Commuter Rail PR lots 1506 and 1507 references from perceived journey time / cost algorithm and calibrated values.
   b) Changes to "PR_ModeSplit_2031H_CobMED.py" script from "PR_ModeSplit_2031H_ElmMED.py".
      i) Removed Commuter Rail PR lots 1506 and 1507 references from mode choice algorithm.

<u>Future 2031 Horizon Model - Cobequid Low Scenario</u>

Model File: 2031 CommuterRail PM Peak - CobLOW 2014-10-28.ver

Model Genesis: 2031 CommuterRail PM Peak - ElmLOW 2014-10-28.ver

Bare bones commuter rail scenario without additional infrastructure support (i.e. park and ride, downtown shuttles, etc.). Outbound route terminates at Cobequid Station - route portion to Elmsdale Station removed.

1) Network Modifications
   a) Transit Route Additions/Modifications
      i) Modified Line / Line Routes / Timetables for "5001 Commuter Rail Line" - Removed Cobequid to/from Elmsdale portion of commuter rail route.

b) Modified TAZs representing PR lots for following locations:
   i) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
   ii) 1503 Sunnyside PR - Zone available, PR currently disconnected
   iii) 1504 Bedford Common PR - Zone available, PR currently disconnected
   iv) 1505 Cobequid PR - Zone available, PR currently disconnected
   v) 1506 Wellington PR - Zone available, PR currently disconnected
   vi) 1505 Elmsdale PR - Zone available, PR currently disconnected

2) Procedure Sequence Changes
   a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_CobLOW.py"
   b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_CobLOW.py"
   c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_CobLOW.py"

3) Matrix Modifications
   a) Modified Skim Matrix 997 - Park and Ride Temporary
      i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
      ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zone 1501 flagged

4) Python Modifications
   a) Changes to "PR_Skim_2031H_CobLOW.py" script from "PR_Skim_2031H_ElmLOW.py".
      i) Same as ElmLOW scenario.
   b) Changes to "PR_ModeSplit_2031H_ElmLOW.py" script from "PR_ModeSplit_2031H_ElmMED.py".
      i) Same as ElmLOW scenario.

Future 2031 Horizon Model - Cobequid High Scenario

Model File: 2031 CommuterRail PM Peak - CobHIGHwo1004 2014-10-28.ver

Model Genesis: 2031 CommuterRail PM Peak - ElmHIGH 2014-10-28.ver

Enhanced commuter rail scenario with additional infrastructure support (i.e. removal of competing bus park and ride, addition of suburban shuttles, supportive transit bus route modifications, etc.). Outbound route terminates at Cobequid Station - route portion to Elmsdale Station removed.

1) Network Modifications
   a) Transit Route Additions/Modifications
      i) Modified Line / Line Routes / Timetables for "5001 Commuter Rail Line" - Removed Cobequid to/from Elmsdale portion of commuter rail route.
   b) Modified TAZs representing PR lots for following locations:
      i) 1002 Sackville PR - Zone available, PR currently disconnected
      ii) 1004 Fall River PR - Zone available, PR currently disconnected
      iii) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
      iv) 1503 Sunnyside PR - Zone available, PR currently disconnected
      v) 1504 Bedford Common PR - Proposed PR lot location, in use
      vi) 1505 Cobequid PR - Proposed PR lot location, in use
      vii) 1506 Wellington PR - Zone available, PR currently disconnected
      viii) 1505 Elmsdale PR - Zone available, PR currently disconnected

2) Procedure Sequence Changes
   a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_CobHIGH.py"
   b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_CobHIGH.py"
   c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_CobHIGH.py"
3) Matrix Modifications
   a) Modified Skim Matrix 997 - Park and Ride Temporary
      i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
      ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zones 1501, 1504, and 1505 flagged; Assigned "999999" to zones 1002 and 1004
4) Python Modifications

a) Changes to "PR_Skim_2031H_CobHIGH.py" script from "PR_Skim_2031H_ElmHIGH.py".
   i) Removed Commuter Rail PR lots 1506 and 1507 references from shortest PR travel time algorithm.
   ii) Removed Commuter Rail PR lots 1506 and 1507 references from catchment area algorithm and calibrated values.
   iii) Removed Commuter Rail PR lots 1506 and 1507 references from perceived journey time / cost algorithm and calibrated values.

b) Changes to "PR_ModeSplit_2031H_CobHIGH.py" script from "PR_ModeSplit_2031H_ElmHIGH.py".
   i) Removed Commuter Rail PR lots 1506 and 1507 references from mode choice algorithm.

Future 2031 Horizon Model - Beaver Bank Medium Scenario

Model File: 2031 CommuterRail PM Peak - BeaMED 2015-02-18.ver

Model Genesis: 2031 CommuterRail PM Peak - CobMED 2014-10-28.ver

Represents modest shuttle service and park-and-ride enhancements to attract commuter rail ridership. Outbound route terminates at Beaver Bank Station - route portion from Cobequid Station extended.

1) Network Modifications
   a) Transit Route Additions/Modifications
      i) Modified Line / Line Routes / Timetables for "5001 Commuter Rail Line" - Extended Cobequid to/from new Beaver Bank portion of commuter rail route.
      ii) Modified Line / Line Routes / Timetables for "82 Millwood" - Extended route from Millwood Drive up to Beaver Bank Station and return.
      iii) Modified Line / Line Routes / Timetables for "Beaver Bank" (Route 400) - Included Beaver Bank Station stop along existing route.
   b) Added TAZs representing PR lots for following locations:
      i) 1508 Beaver Bank PR - Proposed PR lot location, in use

2) Procedure Sequence Changes
    a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_BeaMED.py"
    b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_BeaMED.py"
    c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_BeaMED.py"

3) Matrix Modifications
    a) Modified Skim Matrix 997 - Park and Ride Temporary
        i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
        ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zones 1501, 1504, 1505, and 1508 flagged

4) Python Modifications
    a) Changes to "PR_Skim_2031H_BeaMED.py" script from "PR_Skim_2031H_CobMED.py".
        i) Added Commuter Rail PR lot 1508 reference to shortest PR travel time algorithm.
        ii) Added Commuter Rail PR lots 1508 reference to catchment area algorithm and calibrated values.
        iii) Added Commuter Rail PR lots 1508 reference to perceived journey time / cost algorithm and calibrated values.
    b) Changes to "PR_ModeSplit_2031H_BeaMED.py" script from "PR_Skim_2031H_CobMED.py".
        i) Added Commuter Rail PR lots 1508 references to mode choice algorithm.

Future 2031 Horizon Model - Beaver Bank Low Scenario

Model File: 2031 CommuterRail PM Peak - BeaLOW 2015-02-23.ver

Model Genesis: 2031 CommuterRail PM Peak - CobLOW 2014-10-28.ver

Bare bones commuter rail scenario without additional infrastructure support (i.e. park and ride, downtown shuttles, etc.). Outbound route terminates at Beaver Bank Station.

1) Network Modifications
    a) Transit Route Additions/Modifications
        i) Modified Line / Line Routes / Timetables for “5001 Commuter Rail Line” - Extended Cobequid to/from new Beaver Bank portion of commuter rail route.
        ii) Modified Line / Line Routes / Timetables for “Beaver Bank” (Route 400) - Included Beaver Bank Station stop along existing route.
    b) Modified TAZs representing PR lots for following locations:
        i) 1501 Mumford PR - De facto (not formal) PR location due to site characteristics.
        ii) 1508 Beaver Bank PR - Zone available, PR currently disconnected
2) Procedure Sequence Changes
    a) Modified Step 105 - Python skim matrix calculation reference to “PR_Skim_2031H_BeaLOW.py”
    b) Modified Step 153 - Python mode split calculation reference to “PR_ModeSplit_2031H_BeaLOW.py”
    c) Modified Step 195 - Python mode split calculation reference to “PR_ModeSplit_2031H_BeaLOW.py”
3) Matrix Modifications
    a) Modified Skim Matrix 997 - Park and Ride Temporary
        i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
        ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of “999999” - Commuter Rail PR zone 1501 flagged
4) Python Modifications
    a) Changes to “PR_Skim_2031H_BeaLOW.py” script from “PR_Skim_2031H_CobLOW.py”.
        i) Same as CobLOW scenario.
    b) Changes to “PR_ModeSplit_2031H_BeaLOW.py” script from “PR_ModeSplit_2031H_CobMED.py”.
        i) Same as CobLOW scenario.

Future 2031 Horizon Model - Beaver Bank High Scenario

Model File: 2031 CommuterRail PM Peak - BeaHIGH 2015-02-23.ver

Model Genesis: 2031 CommuterRail PM Peak - CobHIGHwo1004 2014-10-30.ver

Enhanced commuter rail scenario with additional infrastructure support (i.e. removal of competing bus park and ride, addition of suburban shuttles, supportive transit bus route modifications, etc.). Outbound route terminates at Beaver Bank Station.

1) Network Modifications
    a) Transit Route Additions/Modifications
        i) Modified Line / Line Routes / Timetables for "5001 Commuter Rail Line" - Extended Cobequid to/from new Beaver Bank portion of commuter rail route.
        ii) Modified Line / Line Routes / Timetables for "82 Millwood" - Extended route from Millwood Drive up to Beaver Bank Station and return.
        iii) Modified Line / Line Routes / Timetables for "Beaver Bank" (Route 400) - Included Beaver Bank Station stop along existing route.
    b) Modified TAZs representing PR lots for following locations:
        i) 1002 Sackville PR - Zone available, PR currently disconnected
        ii) 1004 Fall River PR - Zone available, PR currently disconnected
        iii) 1508 Beaver Bank PR - Proposed PR lot location, in use
2) Procedure Sequence Changes
    a) Modified Step 105 - Python skim matrix calculation reference to "PR_Skim_2031H_BeaHIGH.py"
    b) Modified Step 153 - Python mode split calculation reference to "PR_ModeSplit_2031H_BeaHIGH.py"
    c) Modified Step 195 - Python mode split calculation reference to "PR_ModeSplit_2031H_BeaHIGH.py"
3) Matrix Modifications
    a) Modified Skim Matrix 997 - Park and Ride Temporary
        i) As per instruction from Halifax, copied in free flow time (t0) Skim Matrix 2
        ii) Column (destination) TAZs not affiliated with an active park and ride (PR) lot zone are set to a value of "999999" - Commuter Rail PR zone 1508 flagged; Assigned "999999" to zones 1002 and 1004
4) Python Modifications
    a) Changes to "PR_Skim_2031H_BeaHIGH.py" script from "PR_Skim_2031H_CobHIGH.py".
        i) Added Commuter Rail PR lot 1508 reference to shortest PR travel time algorithm.
        ii) Added Commuter Rail PR lots 1508 reference to catchment area algorithm and calibrated values.

iii) Added Commuter Rail PR lots 1508 reference to perceived journey time / cost algorithm and calibrated values.

b) Changes to "PR_ModeSplit_2031H_CobHIGH.py" script from "PR_ModeSplit_2031H_ElmHIGH.py".

i) Added Commuter Rail PR lots 1508 references to mode choice algorithm.

Model Inputs

This section briefly discusses model inputs implemented in the testing of the various commuter rail scenarios.

Commuter Rail Route and Total Trip Time

The commuter rail route was assumed to operate between VIA and three possible termini:

- VIA Rail to Elmsdale Station (48.4 km length)
- VIA Rail to Cobequid Station (25.6 km length)
- VIA Rail to Beaver Bank Station (29.8 km length)

Free flow travel speed (v0) on rail corridor links was assumed to be 70 km/h, which does not include acceleration and deceleration. A 1.5 minute dwell time was assumed at each stop with a total accumulated run time of approximately 58 minutes from VIA to Elmsdale (average speed 50 km/h), approximately 32 minutes from VIA to Cobequid (average speed 48 km/h), and approximately 41 minutes from VIA to Beaver Bank (average speed 48 km/h).

Travel Time by Automobile

Travel time for passenger automobiles is estimated from skim matrices calculated by the VISUM model for congested travel times and travel distance. For the two route extents, the compared travel time and average speed by automobile is taken from Scotia Square (Zone 19) to the associated Elmsdale and Cobequid park and ride lots:

- VIA Rail to Elmsdale Station
    - Travel Time - 44 minutes
    - Travel Distance - 37 km
    - Average Speed - 50 km/h
- VIA Rail to Cobequid Station
    - Travel Time - 39 minutes
    - Travel Distance - 22 km
    - Average Speed - 34 km/h
- VIA Rail to Beaver Bank Station
    - Travel Time - 39 minutes

- Travel Distance - 22 km
- Average Speed - 34 km/h

Access and Egress Times

Access and egress times for passenger automobile travel are included in the travel time determined by the VISUM model. For commuter rail, access and egress times represent the travel time by transit shuttle or walking. Considering the commuter rail skim matrices taken from Scotia Square (Zone 19), the average access time would be approx. 6 minutes and the average egress time approx. 5 minutes.

Wait Time

Wait time is not included for passenger automobile travel. For commuter rail, wait time represents the time waiting for the rail car to arrive. This was assumed to be 5 minutes.

Transfers

Since the commuter rail route would end at the VIA Rail and Scotia Centre is assumed to be the final destination, a transfer to a transit shuttle would be required and is provided in the medium and high scenarios. Similar shuttles would exist at the South End Station accessing the universities in the medium and high scenarios. Suburban shuttles are provided at Elmsdale, Cobequid and Mill Cove in the high scenarios.

Value of Travel Time

The value of travel time is variable in the range of $12.70 to $49.94 per hour, and constant regardless of the trip length. These figures were derived from annual household income based on the 2006 Census Tract profile data. These assumptions are listed in Demand Matrix 110.

Travel Distance

For passenger automobiles, travel distance was calculated by the VISUM model, and was based on the shortest route (based on travel time) for the PM peak hour. For commuter rail, travel distance was determined by the VISUM software based on the dedicated rail right-of-way (ROW) corridor via the Line Route calculation.

Vehicle Operating Costs

Vehicle operating costs are assumed to be $0.55 per km by Halifax in the VISUM model.

Walk Links

A maximum walking time of 20 minutes was set in the general procedure settings.

Parking Costs

Parking costs in the VISUM model were set by Halifax in Skim Matrix 105 to a value of up to $4 in the PM peak hour.

Transit Fare

Transit fares (including commuter rail) between zone OD pairs were set by Halifax in Skim Matrix 104 to a value of $1.64. This value represents an average fare figure provided by Halifax Transit, aggregating ridership and fare variances due to single use fare, monthly passes, U-passes, child rates, adult rates, senior rates, etc.

Appendix D Travel Demand Detail

The demand forecast was conducted for each of the scenarios using the Halifax Travel Demand Model. This was completed for the PM peak hour.

Adjustments to Model Outputs

The Halifax Model, as with all models, is created on a number of assumptions and processes in an attempt to represent reality. When properly applied, model results would give a good indication of the demand or performance expected for some future or alternate scenario. However, as with any automated process, the results should be critiqued based on professional experience, local knowledge and general logic. As such, a number of post-modelling adjustments were applied to the model outputs, as described below:

- **Reduce Ridership Between VIA Station and South End Station by 75%**
  - The model assigned a significant number of rail trips between these two closely located stations in Halifax's south end. This is likely due to the very short rail travel time between these two stations (4 minutes). In reality, the location of the two stations would likely not be conducive to taking the train as the major destinations are between a 5 to 10 minute walk from both stations (downtown Halifax employment and St. Mary's and Dalhousie University). Based on the distance, ease of walking and biking, and frequency and directness of existing bus service, it is more likely that travellers would find more convenient alternative modes between these stations. Therefore, the demand between these stations produced by the model was reduced by 75% for all scenarios.

- **Increase Ridership to the Cobequid Station on the High and Medium Demand Scenarios for the Cobequid to VIA Corridor Concept**
  - Service is very similar to the Cobequid Station between Scenario A (Elmsdale to VIA) and Scenario B (Cobequid to VIA) and should therefore attract a similar ridership to the Cobequid Station. The model was originally producing an improperly low number of riders to this station. Therefore, the same adjustments made from Wellington Station in the High and Medium Demand Elmsdale to VIA Corridor Scenario were made to this scenario.

Mill Cove Park and Ride: In addition to these changes, the team increased ridership to the proposed Mill Cove Station to account for a potential park and ride, which was included in the Cobequid and Beaver Bank Medium and High Scenarios after the substantive modelling work was completed. Unlike at the other stations, the size of the Mill Cove park and ride was estimated based on the GO Transit catchment rate for suburban areas of eight riders for 1,000 population, as opposed to the approach described in Chapter 6.[87] We converted this expected ridership into an appropriate number of park-and-ride locations, and then constrained the size of the park and ride based availability of land suitable for a park and ride adjacent to the station. The additional ridership expected to result from the addition of this park and ride was assigned to Mill Cove Station and assumed to travel to the VIA Station.

Final Adjusted Commuter Rail Demand

The projected ridership (boardings) for each of the proposed scenarios is illustrated in the tables below. Using various factors, travel demand was estimated for the following periods:

1. Weekday daily travel;
2. AM Peak period (6:00 to 9:00 AM);
3. Midday trip (12:00 to 1:00 PM); and
4. PM Peak period (3:00 to 6:00 PM);

These tables do *not* account for the zonal fare structure, though it was accounted for in the modelling process.

[87] This approach was utilized as the decision to include a park and ride at Mill Cove was made after the travel demand modelling work had been completed.

Figure D-1: Projected Ridership, Cobequid Low Demand Scenario

	Daily Trips		Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	66	248	257	86	2	0	0	659
	South End Station	2.6	74	0	65	80	9	9	0	0	237
	West End Station	3.8	277	74	0	9	0	2	0	0	362
	Rockingham Station	6.0	286	89	10	0	6	0	0	0	391
	Mill Cove Station	9.0	97	10	0	7	0	0	0	0	114
	Sunnyside Station	10.5	2	10	2	0	0	0	0	0	14
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	0
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	0
	Total		736	249	325	353	101	13	0	0	1777

	Morning Peak (0600-0900)		Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	7	24	25	8	0	0	0	64
	South End Station	2.6	59	0	6	8	1	1	0	0	75
	West End Station	3.8	220	59	0	1	0	0	0	0	280
	Rockingham Station	6.0	228	71	8	0	1	0	0	0	308
	Mill Cove Station	9.0	77	8	0	6	0	0	0	0	91
	Sunnyside Station	10.5	2	8	2	0	0	0	0	0	12
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	0
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	0
	Total		586	153	40	40	10	1	0	0	830

Figure D-1 Cont'd: Projected Ridership, Cobequid Low Demand Scenario

Afternoon Peak (1500-1800)			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
			Destination								
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	55	204	211	71	2	0	0	**543**
	South End Station	2.6	10	0	54	66	7	7	0	0	**144**
	West End Station	3.8	39	10	0	7	0	2	0	0	**58**
	Rockingham Station	6.0	40	12	1	0	5	0	0	0	**58**
	Mill Cove Station	9.0	14	1	0	1	0	0	0	0	**16**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	0	**1**
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	**0**
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	**0**
	Total		**103**	**79**	**259**	**285**	**83**	**11**	**0**	**0**	**820**

Mid-Day Non-Peak (1200-1300)			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
			Destination								
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	5	20	21	7	0	0	0	**53**
	South End Station	2.6	5	0	5	6	1	1	0	0	**18**
	West End Station	3.8	18	5	0	1	0	0	0	0	**24**
	Rockingham Station	6.0	18	6	1	0	0	0	0	0	**25**
	Mill Cove Station	9.0	6	1	0	0	0	0	0	0	**7**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	0	**1**
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	**0**
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	**0**
	Total		**47**	**18**	**26**	**28**	**8**	**1**	**0**	**0**	**128**

Figure D-2: Projected Ridership, Beaver Bank Low Demand Scenario

DAILY TRIPS			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	66	245	260	86	2	0	0	0	**659**
	South End Station	2.6	74	0	65	80	9	9	0	0	0	**237**
	West End Station	3.8	273	74	0	9	0	2	0	0	0	**358**
	Rockingham Station	6.0	288	89	10	0	6	0	0	0	0	**393**
	Mill Cove Station	9.0	97	10	0	7	0	0	0	0	0	**114**
	Sunnyside Station	10.5	2	10	2	0	0	0	0	0	0	**14**
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	0	**0**
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	0	**0**
	Beaver Bank Station	18.6	0	0	0	0	0	0	0	0	0	**0**
	Total		**734**	**249**	**322**	**356**	**101**	**13**	**0**	**0**	**0**	**1775**

Morning Peak (0600-0900)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	7	24	25	8	0	0	0	0	**64**
	South End Station	2.6	59	0	6	8	1	1	0	0	0	**75**
	West End Station	3.8	217	59	0	1	0	0	0	0	0	**277**
	Rockingham Station	6.0	229	71	8	0	1	0	0	0	0	**309**
	Mill Cove Station	9.0	77	8	0	6	0	0	0	0	0	**91**
	Sunnyside Station	10.5	2	8	2	0	0	0	0	0	0	**12**
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	0	**0**
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	0	**0**
	Beaver Bank Station	18.6	0	0	0	0	0	0	0	0	0	**0**
	Total		**584**	**153**	**40**	**40**	**10**	**1**	**0**	**0**	**0**	**828**

Figure D-2 Cont'd: Projected Ridership, Beaver Bank Low Demand Scenario

Afternoon Peak (1500-1800)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	55	201	214	71	2	0	0	0	**543**
	South End Station	2.6	10	0	54	66	7	7	0	0	0	**144**
	West End Station	3.8	38	10	0	7	0	2	0	0	0	**57**
	Rockingham Station	6.0	40	12	1	0	5	0	0	0	0	**58**
	Mill Cove Station	9.0	14	1	0	1	0	0	0	0	0	**16**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	0	0	**1**
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	0	**0**
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	0	**0**
	Beaver Bank Station	18.6	0	0	0	0	0	0	0	0	0	**0**
	Total		**102**	**79**	**256**	**288**	**83**	**11**	**0**	**0**	**0**	**819**

Mid-Day Non-Peak (1200-1300)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	5	20	21	7	0	0	0	0	**53**
	South End Station	2.6	5	0	5	6	1	1	0	0	0	**18**
	West End Station	3.8	18	5	0	1	0	0	0	0	0	**24**
	Rockingham Station	6.0	19	6	1	0	0	0	0	0	0	**26**
	Mill Cove Station	9.0	6	1	0	0	0	0	0	0	0	**7**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	0	0	**1**
	Bedford Common Station	12.7	0	0	0	0	0	0	0	0	0	**0**
	Cobequid Station	15.0	0	0	0	0	0	0	0	0	0	**0**
	Beaver Bank Station	18.6	0	0	0	0	0	0	0	0	0	**0**
	Total		**48**	**18**	**26**	**28**	**8**	**1**	**0**	**0**	**0**	**129**

Figure D-3: Projected Ridership, Cobequid Medium Demand Scenario

Daily Trips			Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	69	250	260	234	0	176	373	**1362**
	South End Station	2.6	76	0	65	80	9	9	9	72	**320**
	West End Station	3.8	278	74	0	9	0	2	9	87	**459**
	Rockingham Station	6.0	288	89	10	0	6	0	0	12	**405**
	Mill Cove Station	9.0	242	10	0	7	0	0	0	0	**259**
	Sunnyside Station	10.5	0	10	2	0	0	0	0	9	**21**
	Bedford Common Station	12.7	197	10	10	0	0	0	0	0	**217**
	Cobequid Station	15.0	421	81	100	13	0	10	0	0	**625**
	Total		**1502**	**343**	**437**	**369**	**249**	**21**	**194**	**553**	**3668**

Morning Peak (0600-0900)			Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	7	24	25	8	0	17	36	**117**
	South End Station	2.6	60	0	6	8	1	1	1	7	**84**
	West End Station	3.8	221	59	0	1	0	0	1	8	**290**
	Rockingham Station	6.0	229	71	8	0	1	0	0	1	**310**
	Mill Cove Station	9.0	223	8	0	6	0	0	0	0	**237**
	Sunnyside Station	10.5	0	8	2	0	0	0	0	1	**11**
	Bedford Common Station	12.7	157	8	8	0	0	0	0	0	**173**
	Cobequid Station	15.0	331	63	78	10	0	8	0	0	**490**
	Total		**1221**	**224**	**126**	**50**	**10**	**9**	**19**	**53**	**1712**

Figure D-3 Cont'd: Projected Ridership, Cobequid Medium Demand Scenario

Afternoon Peak (1500-1800)			Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	56	206	214	219	0	145	307	**1147**
	South End Station	2.6	11	0	54	66	7	7	7	59	**211**
	West End Station	3.8	39	10	0	7	0	2	7	72	**137**
	Rockingham Station	6.0	40	12	1	0	5	0	0	10	**68**
	Mill Cove Station	9.0	13	1	0	1	0	0	0	0	**15**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	7	**8**
	Bedford Common Station	12.7	27	1	1	0	0	0	0	0	**29**
	Cobequid Station	15.0	63	13	16	2	0	1	0	0	**95**
	Total		**193**	**94**	**278**	**290**	**231**	**10**	**159**	**455**	**1710**

Mid-Day Non-Peak (1200-1300)			Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	6	20	21	7	0	14	30	**98**
	South End Station	2.6	5	0	5	6	1	1	1	6	**25**
	West End Station	3.8	18	5	0	1	0	0	1	7	**32**
	Rockingham Station	6.0	19	6	1	0	0	0	0	1	**27**
	Mill Cove Station	9.0	6	1	0	0	0	0	0	0	**7**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	1	**2**
	Bedford Common Station	12.7	13	1	1	0	0	0	0	0	**15**
	Cobequid Station	15.0	27	5	6	1	0	1	0	0	**40**
	Total		**88**	**25**	**33**	**29**	**8**	**2**	**16**	**45**	**246**

Figure D-4: Projected Ridership, Beaver Bank Medium Demand Scenario

DAILY TRIPS			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	69	248	254	228	0	174	352	361	**1686**
	South End Station	2.6	76	0	65	80	9	9	9	68	96	**412**
	West End Station	3.8	277	74	0	9	0	0	9	86	14	**469**
	Rockingham Station	6.0	284	89	10	0	6	0	0	9	0	**398**
	Mill Cove Station	9.0	237	10	0	7	0	0	0	0	0	**254**
	Sunnyside Station	10.5	0	10	0	0	0	0	0	6	0	**16**
	Bedford Common Station	12.7	194	10	10	0	0	0	0	0	0	**214**
	Cobequid Station	15.0	393	77	97	10	0	7	0	0	0	**584**
	Beaver Bank Station	18.6	403	108	17	0	0	0	0	0	0	**528**
	Total		**1864**	**447**	**447**	**360**	**243**	**16**	**192**	**521**	**471**	**4561**

Morning Peak (0600-0900)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	7	24	25	8	0	17	34	35	**150**
	South End Station	2.6	60	0	6	8	1	1	1	7	9	**93**
	West End Station	3.8	220	59	0	1	0	0	1	8	1	**290**
	Rockingham Station	6.0	226	71	8	0	1	0	0	1	0	**307**
	Mill Cove Station	9.0	219	8	0	6	0	0	0	0	0	**233**
	Sunnyside Station	10.5	0	8	0	0	0	0	0	1	0	**9**
	Bedford Common Station	12.7	154	8	8	0	0	0	0	0	0	**170**
	Cobequid Station	15.0	313	61	77	8	0	6	0	0	0	**465**
	Beaver Bank Station	18.6	321	86	14	0	0	0	0	0	0	**421**
	Total		**1513**	**308**	**137**	**48**	**10**	**7**	**19**	**51**	**45**	**2138**

Figure D-4 Cont'd: Projected Ridership, Beaver Bank Medium Demand Scenario

	Afternoon Peak (1500-1800)		Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	56	204	209	214	0	143	290	297	**1413**
	South End Station	2.6	11	0	54	66	7	7	7	56	79	**287**
	West End Station	3.8	39	10	0	7	0	0	7	71	12	**146**
	Rockingham Station	6.0	40	12	1	0	5	0	0	7	0	**65**
	Mill Cove Station	9.0	12	1	0	1	0	0	0	0	0	**14**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	5	0	**6**
	Bedford Common Station	12.7	27	1	1	0	0	0	0	0	0	**29**
	Cobequid Station	15.0	55	11	14	1	0	1	0	0	0	**82**
	Beaver Bank Station	18.6	56	15	2	0	0	0	0	0	0	**73**
	Total		**240**	**107**	**276**	**284**	**226**	**8**	**157**	**429**	**388**	**2115**

	Mid-Day Non-Peak (1200-1300)		Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	6	20	20	6	0	14	28	29	**123**
	South End Station	2.6	5	0	5	6	1	1	1	5	8	**32**
	West End Station	3.8	18	5	0	1	0	0	1	7	1	**33**
	Rockingham Station	6.0	18	6	1	0	0	0	0	1	0	**26**
	Mill Cove Station	9.0	6	1	0	0	0	0	0	0	0	**7**
	Sunnyside Station	10.5	0	1	0	0	0	0	0	0	0	**1**
	Bedford Common Station	12.7	13	1	1	0	0	0	0	0	0	**15**
	Cobequid Station	15.0	25	5	6	1	0	0	0	0	0	**37**
	Beaver Bank Station	18.6	26	7	1	0	0	0	0	0	0	**34**
	Total		**111**	**32**	**34**	**28**	**7**	**1**	**16**	**41**	**38**	**308**

Figure D-5: Projected Ridership, Cobequid High Demand Scenario

Daily Trips			Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	67	248	260	249	39	442	462	1767
	South End Station	2.6	74	0	65	80	9	2	56	75	361
	West End Station	3.8	277	74	0	9	0	0	14	89	463
	Rockingham Station	6.0	288	89	10	0	6	0	6	12	411
	Mill Cove Station	9.0	259	10	0	7	0	0	0	0	276
	Sunnyside Station	10.5	44	2	0	0	0	0	2	11	59
	Bedford Common Station	12.7	493	64	17	7	0	2	0	0	583
	Cobequid Station	15.0	516	86	101	13	0	12	0	0	728
	Total		1951	392	441	376	264	55	520	649	4648

Morning Peak (0600-0900)			Destination								
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	7	24	25	10	4	43	45	158
	South End Station	2.6	59	0	6	8	1	0	5	7	86
	West End Station	3.8	220	59	0	1	0	0	1	8	289
	Rockingham Station	6.0	229	71	8	0	1	0	1	1	311
	Mill Cove Station	9.0	237	8	0	6	0	0	0	0	251
	Sunnyside Station	10.5	35	2	0	0	0	0	0	1	38
	Bedford Common Station	12.7	392	51	14	6	0	2	0	0	465
	Cobequid Station	15.0	410	69	80	10	0	10	0	0	579
	Total		1582	267	132	56	12	16	50	62	2177

Figure D-5 Cont'd: Projected Ridership, Cobequid High Demand Scenario

Afternoon Peak (1500-1800)			Destination: VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	55	204	214	231	32	364	380	1480
	South End Station	2.6	10	0	54	66	7	2	46	62	247
	West End Station	3.8	39	10	0	7	0	0	12	74	142
	Rockingham Station	6.0	40	12	1	0	5	0	5	10	73
	Mill Cove Station	9.0	15	1	0	1	0	0	0	0	17
	Sunnyside Station	10.5	6	0	0	0	0	0	2	9	17
	Bedford Common Station	12.7	69	9	2	1	0	0	0	0	81
	Cobequid Station	15.0	72	12	15	2	0	1	0	0	102
	Total		251	99	276	291	243	35	429	535	2159

Mid-Day Non-Peak (1200-1300)			Destination: VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	
Origin	VIA Station	0.0	0	5	20	21	8	3	35	37	129
	South End Station	2.6	5	0	5	6	1	0	5	6	28
	West End Station	3.8	18	5	0	1	0	0	1	7	32
	Rockingham Station	6.0	19	6	1	0	0	0	0	1	27
	Mill Cove Station	9.0	7	1	0	0	0	0	0	0	8
	Sunnyside Station	10.5	3	0	0	0	0	0	0	1	4
	Bedford Common Station	12.7	32	4	1	0	0	0	0	0	37
	Cobequid Station	15.0	34	5	6	1	0	1	0	0	47
	Total		118	26	33	29	9	4	41	52	312

Figure D-6: Projected Ridership, Beaver Bank High Demand Scenario

DAILY TRIPS			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	67	245	257	242	39	292	371	484	**1997**
	South End Station	2.6	76	0	65	80	9	2	29	74	101	**436**
	West End Station	3.8	273	74	0	9	0	0	9	86	14	**465**
	Rockingham Station	6.0	286	89	10	0	6	0	6	9	0	**406**
	Mill Cove Station	9.0	252	10	0	7	0	0	0	0	0	**269**
	Sunnyside Station	10.5	44	2	0	0	0	0	2	6	0	**54**
	Bedford Common Station	12.7	327	34	10	7	0	2	0	0	0	**380**
	Cobequid Station	15.0	411	84	97	10	0	7	0	0	0	**609**
	Beaver Bank Station	18.6	539	112	17	0	0	0	0	0	0	**668**
	Total		**2208**	**472**	**444**	**370**	**257**	**50**	**338**	**546**	**599**	**5284**

Morning Peak (0600-0900)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	7	24	25	9	4	28	36	47	**180**
	South End Station	2.6	60	0	6	8	1	0	3	7	10	**95**
	West End Station	3.8	217	59	0	1	0	0	1	8	1	**287**
	Rockingham Station	6.0	228	71	8	0	1	0	1	1	0	**310**
	Mill Cove Station	9.0	231	8	0	6	0	0	0	0	0	**245**
	Sunnyside Station	10.5	35	2	0	0	0	0	0	1	0	**38**
	Bedford Common Station	12.7	260	27	8	6	0	2	0	0	0	**303**
	Cobequid Station	15.0	327	67	77	8	0	6	0	0	0	**485**
	Beaver Bank Station	18.6	429	89	14	0	0	0	0	0	0	**532**
	Total		**1787**	**330**	**137**	**54**	**11**	**12**	**33**	**53**	**58**	**2475**

Figure D-6 Cont'd: Projected Ridership, Beaver Bank High Demand Scenario

Afternoon Peak (1500-1800)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	55	201	211	226	32	241	305	398	**1669**
	South End Station	2.6	11	0	54	66	7	2	24	61	83	**308**
	West End Station	3.8	38	10	0	7	0	0	7	71	12	**145**
	Rockingham Station	6.0	40	12	1	0	5	0	5	7	0	**70**
	Mill Cove Station	9.0	14	1	0	1	0	0	0	0	0	**16**
	Sunnyside Station	10.5	6	0	0	0	0	0	2	5	0	**13**
	Bedford Common Station	12.7	46	5	1	1	0	0	0	0	0	**53**
	Cobequid Station	15.0	57	12	14	1	0	1	0	0	0	**85**
	Beaver Bank Station	18.6	75	16	2	0	0	0	0	0	0	**93**
	Total		**287**	**111**	**273**	**287**	**238**	**35**	**279**	**449**	**493**	**2452**

Mid-Day Non-Peak (1200-1300)			Destination									
			VIA Station	South End Station	West End Station	Rockingham Station	Mill Cove Station	Sunnyside Station	Bedford Common Station	Cobequid Station	Beaver Bank Station	Total
		mile	0.0	2.6	3.8	6.0	9.0	10.5	12.7	15.0	18.6	
Origin	VIA Station	0.0	0	5	20	21	7	3	23	30	39	**148**
	South End Station	2.6	5	0	5	6	1	0	2	6	8	**33**
	West End Station	3.8	18	5	0	1	0	0	1	7	1	**33**
	Rockingham Station	6.0	18	6	1	0	0	0	0	1	0	**26**
	Mill Cove Station	9.0	7	1	0	0	0	0	0	0	0	**8**
	Sunnyside Station	10.5	3	0	0	0	0	0	0	0	0	**3**
	Bedford Common Station	12.7	21	2	1	0	0	0	0	0	0	**24**
	Cobequid Station	15.0	27	5	6	1	0	0	0	0	0	**39**
	Beaver Bank Station	18.6	35	7	1	0	0	0	0	0	0	**43**
	Total		**134**	**31**	**34**	**29**	**8**	**3**	**26**	**44**	**48**	**357**

Appendix E Bus Route Modifications

Several hypothetical service adjustments and new routes were studied as part of the Medium and High Demand Scenarios to encourage usage of commuter rail by improving modal connectivity and reducing duplication of service. These adjustments include:

- **New Shuttle Services:** Several new shuttles were designed to provide a direct connection to the commuter rail station to provide or enhance accessibility between the station and a major origin or destination. Shuttle services should be timed to meet commuter rail departure or arrival times for the peak direction of service.
- **New Transit Terminal at Sunnyside Station:** The existing Cobequid Bus Terminal is located 2.5 kilometres away from the proposed Sunnyside Station. Shifting the terminal to the commuter rail station could enhance the integration between Halifax Transit and commuter rail.
- **Adjustments to Existing Routes:** Several existing routes were adjusted to provide enhanced connectivity to the two other proposed commuter rail stations.
- **Elimination of Duplicate Services:** Several long-distance Halifax Transit routes that duplicate the recommended rail corridor were eliminated in the model to reduce duplication of service and encourage a migration to the commuter rail corridor.

Each of the new routes, terminals and route adjustments identified above are described in more detail below. These modifications would need to be studied by Halifax Transit as part of a system-wide service strategy based on more detailed operating plans and to ensure integration into the entire local transit network. The modifications in the High Scenarios are particularly significant and designed to encourage more commuter rail ridership.

New Shuttle Services

Six new transit shuttle services are proposed in order to better connect areas not currently served by transit to the proposed commuter rail stations. Four shuttles are designed as feeder services to rural and suburban commuter rail stations without access to local Halifax Transit services and provide direct connections timed to meet the peak direction of rail service. Some of these shuttles are outside the Urban Transit Service Boundary in Halifax's Regional Plan; as such, this boundary would need to be assessed should the high scenario be considered for implementation.[88] Off-peak service would need to be more fully assessed based on demand. Shuttles would use either conventional 40-foot buses or medium-capacity community bus vehicles (depending on demand).

Two new transit shuttles are meant to provide direct connections to major destinations along the railway corridor: one at VIA Station (connecting to the central business district) and the other at South End Station (connecting to Dalhousie and St. Mary's University). The use of an articulated bus and/or several buses may be required to connect with AM peak period rail arrivals or PM peak period rail departures, depending on demand.

Each of the proposed new shuttle services is described briefly below.

VIA Station Shuttle Service

Description: Provides a continuous shuttle service to connect passengers at VIA Station along Barrington Street to Scotia Square in downtown Halifax. The overall round trip time for the service is anticipated to be 20 minutes. The service should be designed to connect to every train arrival during the AM peak period and train departure during the PM peak period. This may require two-three buses depending on the demand for the service. Off peak service should be further assessed and provided based on demand.

Rationale: The VIA Station is located about a 10-15 minute walk from the major employment area in downtown Halifax. This may reduce the attractiveness of rail service for passengers commuting to downtown employment opportunities, particularly during inclement weather conditions. The proposed shuttle service would provide a convenient connection opportunity for downtown passengers.

Connecting Rail Station: VIA Station

Applicable Scenarios: Medium Demand and High Demand, all concepts

St. Mary's/Dalhousie Shuttle Service

Description: Provides a continuous loop to connect passengers at South End Station to Dalhousie University and St. Mary's University before returning back to the station. The overall round trip time for the service is anticipated to be 20 to 25 minutes. The service should be designed to connect to every southbound train arrival during the AM peak period and northbound train departure during the PM peak period. During the peak periods, this may require two buses depending on the demand for the service. During the peak, one bus would travel to Dalhousie University first and St. Mary's University second while the second bus would do the reverse. During the off-peak periods, only one bus travelling along the loop would be required.

---

[88] Urban Transit Service Boundary Map : http://www.halifax.ca/regionalplanning/documents/Map7UrbanTransitServiceBoundaryRP5.pdf

Rationale: The South End Station is located about a 7 to 10 minute walk from both universities (depending on the destination within the campus). This may reduce the attractiveness of rail service for passengers commuting to both universities, particularly during inclement weather conditions. The proposed shuttle service would provide a convenient connection opportunity for university passengers.

Connecting Rail Station: South End Station

Applicable Scenarios: Medium Demand and High Demand, all concepts

Fall River Shuttle Service

Description: The proposed route would travel from Cobequid Station to Fall River via Windsor Junction Road, Winley Drive, Ingram Drive, Concord Avenue, Richardson Drive, Fall River Road, Lockview Drive and High Road, before heading back to the station. The overall round trip time for the service is anticipated to be 50 to 60 minutes. To connect to every train, two shuttle buses would be required to operate during the peak periods (off-set by half hour). During the off-peak period, service may not be required.

Rationale: Fall River does not have access to local transit services. This shuttle is proposed to help increase ridership and transit access to the commuter rail station. It is recommended that Halifax Transit assess the ridership potential relative to the cost of the service.

Connecting Rail Station: Cobequid Station

Applicable Scenarios: High Demand, all concepts

Beaver Bank Shuttle Service

Description: The proposed route would travel from Cobequid Station to Beaver Bank via Windsor Junction Road, Windgate Drive, Beaver Bank Road, Laurel Ridge Drive, Lost Creek Drive and Kinsac Road, before heading back to the station. The overall round trip time for the service is anticipated to be 50 to 60 minutes. To connect to every train, two shuttle buses would be required to operate during the peak periods (off-set by half hour). During the off-peak period, service may not be required.

Rationale: The Windsor Junction area does not have access to local transit services and would benefit from a direct connection to Cobequid Station. Although the Beaver Bank area is served by community transit Route 400, it is connected only to the Sackville Bus Terminal. This shuttle is proposed to help increase ridership and transit access to the commuter rail station. It is recommended that Halifax Transit assess the ridership potential relative to the cost of the service.

Connecting Rail Station: Cobequid Station

Applicable Scenarios: High Demand, all concepts

Provide a Sunnyside Rail Station Bus Terminal in Addition to the Cobequid Terminal

The Cobequid Terminal is located in Lower Sackville, immediately adjacent to the highway on-ramps that provide access to the 101 and 102 Highways, in addition to the Bedford Highway and Bedford Bypass. The majority of bus routes in Sackville serve this terminal, making it an important connection point between local and longer-distance (i.e., to Downtown Halifax) routes. The terminal operates primarily as a transfer point, as there are no major destinations within walking distance of the terminal. The Cobequid Bus Terminal is located approximately 2.5 kilometres to the north of the proposed Sunnyside commuter rail station. In 2011, there were 3,823 daily boardings that connect to the terminal via eight bus routes: Routes 66, 80, 82, 84, 85, 87, 88 and 89.

If commuter rail service is implemented, consideration should be made to connecting these bus services to the Sunnyside commuter rail station. In the High Demand Scenario, for the purposes of our study, we relocated the Cobequid Terminal to Sunnyside and made the following route adjustments. In practice, the Sunnyside terminal would need to be provided in addition to the Cobequid Terminal.

- **Route 66 Penhorn** – Adjust route to terminate at the Sunnyside Station instead of the existing Cobequid Bus Terminal. The portion of the route eliminated is primarily on the Bedford Highway between the Sunnyside Mall and the Cobequid Bus Terminal. This would reduce the length of the route by 2.5 kilometres per direction.
- **Route 80 Sackville** – Adjust route to connect to the Sunnyside Station. There should be no impact to service hours as a result of the modification. There is a potential to reduce the frequency of service south of Sunnyside Station, depending on the reduction in demand once commuter rail service is in place.
- **Route 82 Millwood** – Adjust route to connect to the Sunnyside Station. The route already passes by the Sunnyside Station and there would be no adjustment other than the location of the transfer point and route timings. There should be no impact to service hours as a result of the modification.
- **Route 86 Basinview** – This route currently passes by the Sunnyside Station. A new stop would need to be added to the Sunnyside Station bus terminal. There would be no significant impact to service hours (other than potential addition of 3-5 minutes of layover time).
- **Route 87 Glendale** – Adjust route to connect to the Sunnyside Station instead of the existing Cobequid Bus Terminal. The route would continue to pass by the existing Cobequid Bus Terminal. Instead of heading immediately to the Bedford Bypass Highway, the route would be adjusted to travel on Bedford Highway to the Sunnyside Station and then along Dartmouth Road before rejoining the Bedford Bypass Highway. This would add approximately 0.5 to 0.75 kilometres of service per direction to the existing route an increase travel time by two to three minutes.

- **Route 89 Bedford** – Adjust route to terminate at the Sunnyside Station instead of the existing Cobequid Bus Terminal. The portion of the route eliminated is primarily on the Bedford Highway between the Sunnyside Mall and the Cobequid Bus Terminal. This would reduce the length of the route by 2.5 kilometres per direction.

Connecting Rail Station: Sunnyside Station

Applicable Scenarios: High Demand, all concepts

Modified Transit Routes

The routes listed below were modified in order to provide more convenient timed connections to other commuter rail stations.

- **Route 82 Millwood –** This route currently connects Sackville Terminal with Cobequid Terminal, with peak-hour service direct to downtown Halifax. The route runs along Millwood Drive and Stokil Drive, just 600 metres south of the proposed Beaver Bank Station location. A simple modification to the route would involve buses turning on Beaver Bank Road to access the station, drop off and pick up passengers, and resume the existing route. This minor route change would improve the transit network's connectivity by offering a direct link for residents of the Millwood Village and Upper Sackville neighbourhoods to the new commuter rail station.

  Connecting Rail Station: Beaver Bank Station

  Applicable Scenarios: High Demand Beaver Bank Concept

- **Route 88 Bedford Commons** – This route is located approximately 700 metres from the Bedford Common Station. A small extension of this route to this station would provide Sackville residents another link to the commuter rail line and also provide a connection to employment areas along Damascus Road and Duke Street.

  Connecting Rail Station: Bedford Common Station

  Applicable Scenarios: High Demand, all concepts

- **Route 90 Larry Uteck** – This route could be extended from its existing north terminus at the top of Larry Uteck Boulevard and Starboard Drive to Mill Cove Station. This would involve extending the route north on Nine Mile Drive and east on Oceanview Drive/Nelsons Landing Boulevard to the Mill Cove Station. This would extend the route by approximately 2.2 kilometres in each direction. The scheduling and service hours for this revised route would need to be vetted through Halifax Transit. If this is done, it may eliminate the need for a dedicated Mill Cove shuttle service.

Connecting Rail Station: Mill Cove Station

Applicable Scenarios: High Demand Beaver Bank and Cobequid concepts

- **Route 400 Beaver Bank –** This Community Transit route passes within 400 metres of the proposed Beaver Bank station travelling in a north-south direction along Beaver Bank Road. New bus stops and shelters should be located, in either direction, immediately adjacent to the Beaver Bank station. The Route 400 schedule should also be adjusted to conveniently connect with arriving and departing trains (where feasible).

  Connecting Rail Station: Beaver Bank Station

  Applicable Scenarios: High Demand, Beaver Bank concept

Eliminate Duplicate Services

A number of long-distance bus routes were removed in the High Scenario travel forecasts. The purpose of doing so was to test the implications of removing bus service that duplicated the proposed commuter rail service.

- **Route 84 Glendale** – This Urban Express Route begins in Lower Sackville at the Sackville Terminal and travels along Glendale Drive and the Bedford By-Pass to downtown Halifax. This route is recommended to be eliminated entirely. Passengers who currently use this route would likely be attracted to the Cobequid or Sunnyside rail stations, which would be accessed using Routes 88 and 87, respectively. A local service along Glendale Drive between the Sackville Terminal and a proposed relocated Cobequid Terminal (at the Sunnyside Station) would be required and may be accommodated by an increased service for Route 87.

  Applicable Scenarios: High Demand, all concepts

- **Route 85 Downsview** – This Urban Express Route begins in Lower Sackville at the Sackville Terminal and travels along Highway 101 and the Bedford By-Pass to downtown Halifax. This route is recommended to be eliminated entirely. Passengers who currently use this route would likely be attracted to the Sunnyside Rail Station, which would be accessed via Route 80.

  Applicable Scenarios: High Demand, all concepts

Costing

Bus routes were only removed or significantly modified in the high scenarios. For the bus routes that were modified but not removed, we estimated the increase or decrease in the number of buses required for a given route and multiplied this value by the approximate period (in hours) of operation of the bus per day, which results in the approximate number of bus-hour increase/decrease per day. The estimated change in the number of buses was based on the information in the 2014/2015 Metro Transit Weekday Service Summary (Excel Workbook) and calculated as follows:

$$\text{Change in Number of Buses} = \frac{\text{New Round Trip Time}}{\text{Headway}} - \text{Existing Number of Buses Req}$$

Once we had the approximate change in bus-hours per day, we annualized the figure and applied a cost of $102.47 per bus-hour. Figure E-1 shows the results of these calculations.

Most of the bus routes that changed involved extending bus service from Cobequid Terminal to Sunnyside Station, or reducing service from Sunnyside Station to Cobequid Terminal. One exception is the extension of Route 88 to serve Bedford Common Station and Route 90 to serve Mill Cove Station. These changes amount to a net increase of approximately $142,000 per year in bus operating costs.

For the bus routes that would be completely removed (84 and 85), we estimated the reduction in costs using the "Annual Hours" from the 2014/2015 Metro Transit Weekday Service Summary (Excel Workbook) and applied a rate of $102.47 per bus-hour.

These savings, including the incremental costs associated with bus route modifications and eliminations, amounted to approximately $700,000 per year.

Figure E-1: Changes in Bus Operating Costs, High Scenarios Only

Route		Total Incremental Annual Operating Hours	Expected Incremental Annual Cost
Provide Sunnyside Station Transit Terminal	66 Penhorn	-1875	-$191,250
	80 Sackville	0	$0
	82 Millwood	1173	$119,676
	86 Basinview	0	$0
	87 Glendale	1992	$203,213
	89 Bedford	-900	-$91,800
Route Modifications	88 Bedford Commons	298	$30,345
	90 Larry Uteck	706	$71,995
Route Eliminations	84 Glendale	-7102	-$724,404
	85 Downsview	-1071	-$109,242

Source: CPCS analysis of Halifax Transit data

Figure E-2 and Figure E-3 provide the estimated cost of the shuttles identified in this appendix. The shuttle services from the VIA Station and to the universities would operate in all operating concepts, regardless of where the service terminates, and are considered in both the medium and high scenarios (Figure E-2). The two shuttle services from Cobequid are only considered in the high scenarios (Figure E-3). All four shuttles would only operate during the peak periods.

Figure E-2: New Shuttle Services, Medium and High Scenarios

Shuttle Bus	Total Annual Operating Hours	Expected Annual Cost	Operating Concepts
VIA Station Shuttle	4,500	$459,000	All
St. Mary's/Dalhousie Shuttle	1,500	$153,000	All

Figure E-3: New Shuttle Services, High Scenario

Shuttle Bus	Total Annual Operating Hours	Expected Annual Cost	Station Scenarios
Cobequid - Fall River Shuttle	3,000	$306,000	All
Cobequid - Beaver Bank Shuttle	3,000	$306,000	All

Appendix F Station Quantities and Unit Costs

Station Quantities

Number of Platforms

	Halifax-Cobequid			Halifax-Beaver Bank		
	High	Med	Low	High	Med	Low
VIA	1	1	1	1	1	1
South End	1	1	1	1	1	1
West End	1	1	1	1	1	1
Rockingham	1	1	1	1	1	1
Mill Cove	2	2	2	2	2	2
Sunnyside	2	2	2	2	2	2
Bedford Common	1	1	1	1	1	1
Cobequid	1	1	1	1	1	1
Beaver Bank	1	1	1	1	1	1

Platform Sizes (square metres)

	Halifax-Cobequid			Halifax-Beaver Bank		
	High	Med	Low	High	Med	Low
VIA	390	390	260	520	390	26
South End	312	312	208	416	312	20
West End	312	312	208	416	312	20
Rockingham	312	312	208	416	312	20
Mill Cove	624	624	416	832	624	41
Sunnyside	624	624	416	832	624	41
Bedford Common	312	312	208	416	312	20
Cobequid	312	312	208	416	312	20
Beaver Bank				416	312	20

Park and Ride Spots

	Halifax-Cobequid			Halifax-Beaver Bank		
	High	Med	Low	High	Med	Low
VIA						
South End						
West End						
Rockingham						
Mill Cove	150	150		150	150	
Sunnyside						
Bedford Common	395	174		252	174	
Cobequid	338	357		291	309	
Beaver Bank				592	509	

Kiss and Ride Spots

	Halifax-Cobequid			Halifax-Beaver Bank		
	High	Med	Low	High	Med	Low
VIA						
South End						
West End	3			3		
Rockingham	3	3		3	3	
Mill Cove	3	3		3	3	
Sunnyside	4	4		4	4	
Bedford Common	3	3		3	3	
Cobequid	12	5		8	5	
Beaver Bank				9	9	

Bus Stops

	Halifax-Cobequid			Halifax-Beaver Bank		
	High	Med	Low	High	Med	Low
VIA						
South End	3	3		3	3	
West End	2	1		2	1	
Rockingham		0			0	
Mill Cove	2	2		2	2	
Sunnyside	2			2		
Bedford Common	6			6		
Cobequid	1			1		
Beaver Bank	2			2		

Lot Size (square metres)

	Halifax-Cobequid			Halifax-Beaver Bank		
	High	Med	Low	High	Med	Low
VIA						
South End	702	512	308	806	512	308
West End	502	502	308	606	502	308
Rockingham	702	702	308	806	702	308
Mill Cove	4,794	4,594	516	5,002	4,594	516
Sunnyside	1,414	814	516	1,622	814	516
Bedford Common	10,743	4,919	308	7,143	4,919	308
Cobequid	9,366	9,658	308	8,253	8,415	308
Beaver Bank				16,056	13,587	308

Station Unit Costs

Site Work	Unit Cost	Unit
Platform - asphalt - 15" higher than rail	50	$/sm
Park and ride	3000	$/spot
Bus spot	60,000	$/spot
Kiss and ride spot	25,000	$/spot
Site Preparation	25	$/sm
Road access into site	100,000	$/platform
Platform Facilities		
Outdoor Electronic Displays	8,000	$/platform
Electrical Upgrades & Lighting	60,000	$/platform
Outdoor Station Shelter	120,000	$/platform
Trash receptacle/bench	5,000	$/platform
Signage	12,000	$/platform
Ticket Vending Machine	50,000	$/platform
Cost per platform	255,000	$/platform
Kiss & Ride / Bus Stop Facilities		
Bus Shelter	15,000	$/station
Trash receptacle/bench	5,000	$/station
Cost per station	20,000	$/station

Land Values

Total Cost per Station	$/acre
VIA	n/a
South End	5,000,000
West End	2,000,000
Rockingham	2,000,000
Mill Cove	1,000,000
Sunnyside	1,000,000
Bedford Common	250,000
Cobequid	250,000
Beaver Bank	250,000

Appendix G Fare Analysis Methodology

The objective of the revenue analysis is to determine the incremental revenue that can be expected from the implementation of a commuter rail service. The incremental revenue is defined as follows:

$$\text{Incremental Revenue} = \text{Commuter Rail Ridership Revenue} - \text{Traffic Shift from Bus to Rail Revenue Loss}$$

In order to calculate this value, the following methodology was used:

1. Estimate the Commuter Rail Ridership Revenue:

    a. Calculate an average fare each for each zone. Average fare is a calculation of total system revenue over total revenue passengers. The existing Halifax Transit average fare is $1.64 compared to the adult Halifax Transit bus fare of $2.50. A ratio of the existing Halifax Transit adult fare and average fare was calculated and used to estimate the average fare for each zone category.

    b. Using the commuter rail ridership output from the Halifax Travel Demand Model (in VISUM) as the starting point, reduce the expected traffic using the commuter rail system by adjusting for the increase in fare (from the base average fare of $1.64), using an elasticity of demand with respect to fare of -0.4.[89]

    c. Multiply the traffic by the appropriate average fare.

2. Calculate the Traffic Shift from Bus to Rail Revenue Loss:

    a. Based on post-VISUM ridership reduction in 1.b., assume these passengers who have been priced out of rail would continue to use the Halifax Transit bus services.

[89] Typical fare elasticity rates for transit systems range between 0.3 and 0.5. Rail systems tend to be more inelastic due to the higher level of service provided, particularly when paralleling congested corridors. The 0.4 was selected due to the various express bus alternatives provided by Halifax Transit, which would make it slightly more elastic (or sensitive) to a fare change.

   b. Determine the number of people switching completely from using bus to commuter rail service (based on VISUM assessment of total transit trip before and after the introduction of rail service).

   c. Reduce the total revenue by this modal shift in traffic from bus to rail multiplied by the average fare paid for Halifax Transit bus service ($1.64)

3. Calculate Fare Integration Revenue Loss with Halifax Transit

   a. Assume a mode share by station of the number of people arriving to the commuter rail system by bus

   b. Multiply by average Halifax Transit fare of $1.64 and calculate the difference between the rail fare from that station.

4. Calculate the Total Incremental Revenue