HALIFAX
REGIONAL MUNICIPALITY

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

Item No. 3
Halifax Regional Council
February 1, 2011
Committee of the Whole

TO: Mayor Kelly and Members of Halifax Regional Council

SUBMITTED BY: Original Signed by Director
Ken Reashor, P.Eng., Director, Transportation and Public Works

DATE: January 10, 2011

SUBJECT: Bedford Transit Alternatives

INFORMATION REPORT

ORIGIN

August 11, 2009 Halifax Regional Council, item #12.10, Councillor Lund - Request for Report - Metro Transit.

MOVED BY Councillor Lund, seconded by Councillor Rankin that Regional Council request a report, as part of the five year transit plan report to Council, on a cost benefit analysis on shuttle services to the proposed Bedford Fast Ferry and from there to downtown compared with express bus services from the Hammonds Plains Park and Ride to the Mumford Road Terminal and the Halifax downtown. In addition, it was requested the report include, District 16, whether buses will be using Kearney Lake Road, the 102 or the Bedford Highway, including a review of a bus stop for pickups.

MOTION PUT AND PASSED.

January 12, 2010 Committee of the Whole, item #3, Council Focus Areas.

MOVED BY Councillor Outhit, seconded by Councillor Dalrymple, that Halifax Regional Council request a staff report on the feasibility of a commuter train service for HRM, extending beyond HRM boundaries as required. During the discussion Council indicated that the report also needs to address, future transportation requirements and day liner approach.

MOTION PUT AND PASSED.

BACKGROUND

In response to the August 11, 2009 motion, staff retained Delphi-MRC to prepare a comparative analysis of express bus and ferry options in the Bedford to Downtown Halifax corridor. After the January 12, 2010 motion, the terms of reference with Delphi-MRC were modified to include commuter rail in the comparative analysis, with staff supplying commuter rail data to Delphi-MRC based on internal analysis of available information. The final report is attached to this staff report.

The information on Commuter Rail in this study is provided as a comparison for the purposes of this study and, as such, only includes service as far as Bedford. Staff has conducted an analysis of commuter rail separately (including an analysis of service as far as Truro); this information will be brought to Council in a separate information report in response to the January 12, 2010 motion.

DISCUSSION

Overview of Service Concepts Reviewed

Three service types were reviewed as part of this study. A summary of each is provided below; more details are available in the attached report.

It should be noted that the operating characteristics for each service is different with respect to the provision of off-peak and/or weekend service. The MetroLink service model is based on other existing MetroLink routes; the ferry service model is based on past work conducted by HRM; and the commuter rail model is based on common practices in North America that see commuter rail as a primarily peak-oriented service, except in cases where ridership is extremely high.

The detailed planning and scheduling of any service (including the definition of final spans of service) would be refined based on anticipated demand and other factors once the preferred mode entered a detailed service design phase.

MetroLink

The MetroLink option would originate from a new Park & Ride facility near the BMO Centre at Hammonds Plains Road/Gary Martin Drive. It would travel to Scotia Square via Highway 102 and Bayers Road using articulated transit buses.

Service would operate at a 10 minute frequency during peak hours and at a 30-60 minute frequency during off-peak hours. There would be no weekend or holiday service.

Ferry

A ferry terminal near Mill Cove would be served by shuttle buses from a new Park & Ride facility near the BMO Centre at Hammonds Plains Road/Gary Martin Drive. It would travel along the Halifax Harbour to the site of the existing Halifax Ferry Terminal.

Service would operate at a 20 minute frequency during peak hours and at a 60 minute frequency during off-peak hours. Previous work on the ferry option has been based on the provision of hourly weekend service; as such this assumption was carried forward in the study.

Commuter Rail

A rail station near Mill Cove would be served by shuttle buses from a new Park & Ride facility near the BMO Centre at Hammonds Plains Road/Gary Martin Drive. The rail option would service stations at Rockingham, Armdale/Mumford, and the VIA Rail Station. Shuttle buses would then provide transfers to Scotia Square. The commuter rail option is unique in that it would operate on a right-of-way not owned by HRM. This would require significant coordination with a private corporation in order to function.

Service would operate at a 30 minute frequency during peak hours. There would be no weekend or holiday service.

Travel Time Comparisons

The table below summarizes the projected travel times. These represent the complete trip time with the BMO Centre and Scotia Square as the start/finish points. These times include shuttle buses, transfer time and walking time as applicable. More details on the various segments of these trips are included in the attached report.

Mode	Morning Peak (One-Way, Minutes)	Afternoon Peak (One-Way, Minutes)
MetroLink (Current Traffic)	31	36
MetroLink (+20% Traffic)*	45	48
Ferry (Typical Conditions)	43	43
Commuter Rail	38	38

*Assumed traffic growth within a 9-12 year horizon

It should be noted that the travel times shown for ferry are higher than what has been previously reported to Regional Council. A more conservative approach has been taken in this report to better allow for typical operating conditions and schedule reliability in Halifax Harbour.

Under current conditions, the MetroLink option is time competitive with the rail and ferry options. However, under medium-term traffic growth scenarios, the MetroLink travel times will degrade sufficiently such that they will no longer be time competitive. If MetroLink was chosen as a preferred option, additional investment would be needed for in the future transit to remain competitive, whether that was investment in ferry, rail, or enhanced transit priority measures for the MetroLink service.

Life-Cycle Cost Comparisons

The report uses a life-cycle costing analysis methodology rather than a cost-benefit analysis methodology. The rationale for this is explained in the report as follows:

"A life-cycle costing analysis process focuses on capital and operating costs and differs from a benefit/cost analysis by removing some of the uncertainty and subjectivity that is inherent in quantifying the societal benefits of a transit service."

As noted above, the three mode options include different spans of service and different passenger capacities. In order to compare the costs as fairly as possible, the cost figures have been provided in real dollars and on a per peak-hour seat basis. This provides an objective annual per seat cost to operate each mode.

Lifecycle costing also considers the lifespan of various capital assets (and the need to recapitalize these assets) in the calculation of the cumulated cost of each option over a 40-year horizon.

The projected capital and operating costs are summarized in the table below.

	Ferry	MetroLink	Commuter Rail
Start-Up Capital Costs	$35,850,000	$9,050,000	$25,850,000
Start-Up Capital Cost per Peak-Hour Seat	$15,900	$9,100	$13,100
Annual Operating Costs	$4,038,300	$1,809,000	$4,247,700
Annual Operating Costs per Peak-Hour Seat	$1,300	$1,500	$2,100
Cumulated Capital Cost per Peak-Hour Seat in 2050*	$17,200	$14,100	$16,800
Cumulated Annual Operating Costs per Peak-Hour Seat in 2050*	$23,400	$26,400	$39,000
Total Cumulated Costs per Peak Hour Seat in 2050*	$40,600	$40,600	$55,800

* Assumes a 5% discount rate

Mumford Terminal Service

An intermediate stop at Mumford Terminal for the MetroLink service option was not included in the analysis. A deviation to Mumford Terminal from Bayers Road would significantly degrade the travel time to Downtown and impact the travel-time competitiveness of the service. Also, Mumford Terminal is significantly over-capacity at this time and it would be operationally difficult to have a frequent MetroLink route service the terminal.

Strategic Transportation Planning is conducting a study on the Peninsula Transit Corridor that includes an analysis of the potential for a mid-peninsula transfer point for express services. If such a transfer point is found to be feasible, it could provide a transfer opportunity in lieu of serving Mumford Terminal without deviating from the Bayers Road corridor.

Bus Service in District 16

Intermediate stops that would require the MetroLink option to exit and re-enter Highway 102 were not included in the analysis as they would significantly degrade the travel time to Downtown and impact the travel-time competitiveness of the service.

Future service options for District 16 are planned to include a combination of new and enhanced conventional and Urban Express services.

Conclusions/Next Steps

In HRM there is a rare opportunity to have a choice between three modes of transit to serve a particular corridor. However, the issues, opportunities and factors in a multi-model comparison such as this are complicated and varied; as such more detailed study is required. Such studies would include a comparison of land-use/Regional Plan implications, regulatory implications, requirement for external partnerships, ridership generation potential, environmental and community impacts, safety, detailed costing, and other related items.

The report concludes that any of the three options could potentially be implemented in the Bedford – Downtown Halifax corridor and that all mode options have positives and negatives which would have to be considered in an ultimate decision.

Staff was requested to complete this analysis based on a satellite park and ride facility on Hammonds Plains Road. However, it has become clear through the preparation of this report that there is likely a need for parking at the Mill Cove (rail or ferry) transit station if such a service was to be successful due to the perceived inconvenience of transferring between modes.

BUDGET IMPLICATIONS

There are no budget implications at this time. It should be noted that all of the transit options analyzed in this report are currently outside the budget plan.

FINANCIAL MANAGEMENT POLICIES/BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Project and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Project and Operating reserves, as well as any relevant legislation.

COMMUNITY ENGAGEMENT

Community Engagement was not deemed to be necessary in this process as this report is only providing Council with information.

ATTACHMENTS

Final Report – An Operational and Life Cycle Cost Analysis of Transit Service Alternatives in the Bedford-Halifax Corridor

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A copy of this report can be obtained online at http://www.halifax.ca/council/agendasc/cagenda.html then choose the appropriate meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Prepared by: Dave Reage, MCIP, LPP, Supervisor of Service Design & Projects, Metro Transit (490-5138)

Report Approved by: ______________________________
Lori Patterson, A/General Manager, Metro Transit (490-6388)

Original Signed

An Operational and Life Cycle Cost Analysis of Transit Service Alternatives in the Bedford-Halifax Corridor

www.halifax.ca


HRM


Bill Linley

Prepared for:

MetroTransit

A report summarizing the findings from a comparative evaluation of Bus Rapid Transit, Ferry, and Heavy Commuter Rail services between Bedford and downtown Halifax.

Final Report

November 2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Context

In 2006, Halifax Regional Council adopted a new Regional Municipal Planning Strategy (MPS) to help guide and shape the expected population and employment growth throughout the Region over the next 20 years. One of the key strategies with respect to mobility and transportation in the Regional MPS is to increase transit ridership percentages above their existing levels to limit traffic growth and the need for additional roadways and roadway widening. In keeping with this directive, Metro Transit is exploring opportunities for future higher order transit corridors. One of the major corridors under consideration is the Bedford to Halifax corridor – linking these two major growth areas. In this corridor, Metro Transit has identified three potential transit service modes that include bus rapid transit (BRT), ferry and heavy commuter rail. All three of these transit modes have been successfully implemented in various forms in municipalities throughout North America. However, all may not be suitable for the Halifax context due factors such as population/employment numbers, population/employment density, geographical constraints, financial constraints, etc.

It is through this study that these three service modes are evaluated using a comparative format. The analysis specifically focuses on a planning-level operational analysis and life-cycle cost analysis – two important components to any planning exercise. The findings of this study will assist decision makers in determining the appropriateness of each potential transit service mode under study.

1.2 Background information

A future transit service between Bedford and Halifax has been the subject of several studies and evaluations in the recent past. The following is a list of studies carried out on behalf of HRM:

- 1996 – Commuter Rail Feasibility Study (IBI Group)
- 2001 – Halifax Regional Municipality Commuter Service Proposal – Preliminary Infrastructure Requirements (Canadian National Railways), in addition to follow-up correspondence between CN and HRM.
- 2004 – Transit Oriented Development and High Capacity Transit Opportunities Analysis – Logical Feasibility Report (Cansult and LEA & Associates). To date, a final report has not been submitted to HRM.
- 2006 – The Bedford/Halifax Fast Ferry Cultivation Study (TDV Global Inc.)
- 2007 – Terms of reference were established on behalf of HRM for a vessel design/build project and a design concept for the Mill Cove and Halifax ferry terminals. In addition, professional advice was provided to HRM on regulatory matters and general ferry issues (Mariport Group Ltd.)

- 2008 – HRM issued an Expression of Interest for a vessel design/build (to date, no proponent has been selected)

- 2008 – A stated preference market survey of Bedford area residents regarding a ferry service (Harris/Decima)

Our study approach has built upon some of the findings of this past work. However, based on the terms of reference, our evaluation focuses on a planning-level comparison of three transit alternatives as opposed to a more detailed analysis of one particular transit service – as carried out in the past. We expect the findings of this study to add to the knowledge base already provided by this previous work.

1.3 The scope of our work

Delphi-MRC has been engaged by Metro Transit (a department within the Halifax Regional Municipality) to carry out this study that compares bus rapid transit (BRT), ferry, and heavy commuter rail service alternatives between the community of Bedford and downtown Halifax. The following study goals were established by Metro Transit:

- Identify realistic and practical planning-level operational parameters that quantify the needs of each service including fleet size, terminal locations and shuttle services.

- Identify planning-level cost information associated with each transit service through a life-cycle costing process[1].

To facilitate this effort, Delphi-MRC carried out the key informant interviews and the planning-level operational analysis for the BRT and ferry services, and Metro Transit carried out the planning-level operational analysis for the rail service. Based on the findings flowing from these efforts, CPCS Transcom Limited verified costing information and carried out the life-cycle costing analysis process. Figure 1 illustrates our study approach.

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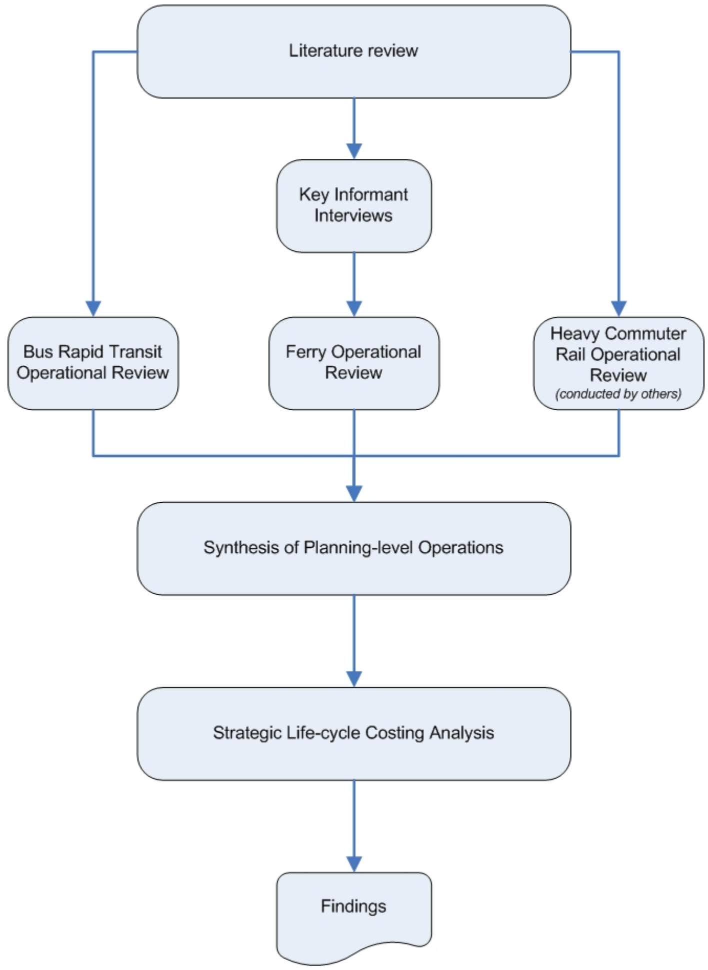
[1] A life-cycle costing analysis process focuses on capital and operating costs and differs from a benefit/cost analysis by removing some of the uncertainty and subjectivity that is inherent in quantifying the societal benefits of a transit service.

Figure 1: Study approach



1.4 Organization of the report

Our discussion begins in Section 2 with a background discussion on the need for improved transit service between Bedford and Halifax as there is limited roadway capacity to accommodate future growth in this corridor. The next phase of our work, summarized in Section 3, involved an interview process with select industry experts that allowed us to gain a more thorough understanding of the proposed ferry operational constraints. In Section 4, we discuss in detail the assumed operating parameters for each of the three transit services. A summary of expected travel times and fleet requirements is also provided. The costs associated with each service are discussed in Section 5 and this discussion provides an indication of the investment that will be required to implement each of the three services. The final section presents a summary of findings that flow from the comparative evaluation of operations and costs.

2 THE NEED FOR IMPROVED TRANSIT SERVICE

2.1 Growth in the Bedford area

The Halifax Regional Municipality (HRM) undertook the development of a new Regional Municipal Planning Strategy (MPS) in 2001. In 2006, Halifax Regional Council approved the new MPS that was to lay a foundation to help shape and influence growth over the next 20 years. As defined in the MPS, a large amount of the future residential growth is planned to take place in the Bedford area – particularly in the Bedford South and West master plan and Bedford waterfront areas – and continued employment growth is expected to take place on the Halifax peninsula.

Based on the findings of the transportation demand modeling carried out as part of the analysis process for the Regional MPS, the magnitude of the current transportation desire line between the residential communities in Bedford and the major employment nodes on the Halifax peninsula is expected to strengthen. We also know from past transportation studies that there is limited vehicular capacity available to access the Halifax peninsula during peak travel times of the day. The ability to widen these existing roadways for commuter traffic is possible but not without extraordinary expenditures and significant impacts to adjacent neighbourhoods. As such, alternative transportation solutions must be developed to service the expected growth in demand.

2.2 How transit can play a role

The Regional MPS has identified transit as playing a key role in servicing the future transportation demand throughout the region, including the Bedford area. Through the MPS document HRM has established aggressive modal share targets. To achieve these targets, some commuters will be required to shift away from single-occupant commuter vehicles. Therefore, a substantial investment will be required in Metro Transit's system – both to maintain the current percent transit mode share (as the population grows) and to increase the percentage to the target level. In order to address longer term growth, it is imperative that planning begin now for a future system of higher order public transit that services the Halifax peninsula and meets the goals established in the Regional MPS.

3 KEY INFORMANT INTERVIEWS – FERRY OPERATIONS

3.1 Background

The operational analysis assumptions associated with the proposed BRT service are well defined as they can be developed based on readily available information from the existing MetroLink BRT services in Sackville and Portland Hills. In terms of the proposed ferry service, the operating assumptions were less defined - as the proposed service model is expected to be different to that of the current ferry service between Halifax and Alderney Landing and Woodside. Therefore, prior to developing an operating profile for the proposed ferry operations, it was imperative to carry out the following tasks:

- Review the work that had been carried out in the past for HRM with respect to planning a ferry service;
- Hold discussions with industry experts (i.e. key informants) that are knowledgeable with harbour operating procedures; and
- Review Metro Transit's current operating practices and schedule performance criteria.

This Section focuses on the second item, the key informant interviews. To facilitate this effort, discussions were held with industry experts and focused on the ferry industry and Halifax harbour operations. The general findings of this process formed the basis of the proposed ferry service operational review, discussed in more detail Section 4.3.

3.2 The key informants

An initial set of key informants were identified through our discussions with the Project Steering Committee and included the Halifax Port Authority operations manager (i.e. harbour master), a naval architect and a fast ferry specialist with international experience. We also obtained input from two Captains and a harbour pilot – all with working experience in Halifax harbour.

The ferry service key informants that were selected are considered to be experts in vessel operations. They came from a broad range of backgrounds in the industry and some of the individuals had been involved in the past ferry evaluations on behalf of HRM. This provided us with independent expert opinions from various perspectives and thus strengthened our findings – as well as the operating assumptions that flowed from this effort.

3.3 Summary of interview findings

In total, six experts were interviewed (separately) using an open ended questionnaire that focused on operating speeds, weather influences, regulations and wake wash. The following is a summary of key findings that flowed from the interviews:

- Generally, all informants indicated that implementing a future ferry service between Bedford and Halifax was possible as long as the proper operating parameters were established. In their opinion, this would be best achieved through live trials under a variety of conditions (i.e. ridership demand, traffic in the narrows, weather limitations, etc.). The local practices and procedures for operating vessels in the harbour could be modified (if necessary) to address any challenges that may arise.

- Those with international experience indicated that many other jurisdictions around the world have successfully implemented a similar service concept in varied traffic and weather conditions.

- The majority felt that there was a need to reduce operating speeds through the "Narrows" – given the physical constraints and other traffic in this corridor – and that a reasonable operating speed would be in the range of 10 to 14 knots. These speeds are based on operator experience in the "Narrows", observations made through the fast ferry trial (in October 2005), and the Navy's ship simulator study.

- Those with operating experience in the "Narrows" with large container ships indicated that there would be adequate width to also accommodate a ferry and that the ferry would not necessarily have to travel in the navigation channel – given its reduced draft depth. However, the operating speed would still be a factor.

- Based on our discussions it appeared that there was no maximum speed limit in the Bedford Basin as long as regulations were met and safe operating conditions were achieved (given the conditions).

- All but one respondent indicated a need to maintain a visual watch during low visibility weather (as per operating regulations), and therefore, to plan for a reduction in speed under these conditions. This conservative assumption was carried forward to our operational review.

- The wake wash specification required by HRM appears to be too restrictive and the necessity for such a strict wake wash specification was questioned by the respondents. This issue should be re-visited if the proposed ferry service is further explored.

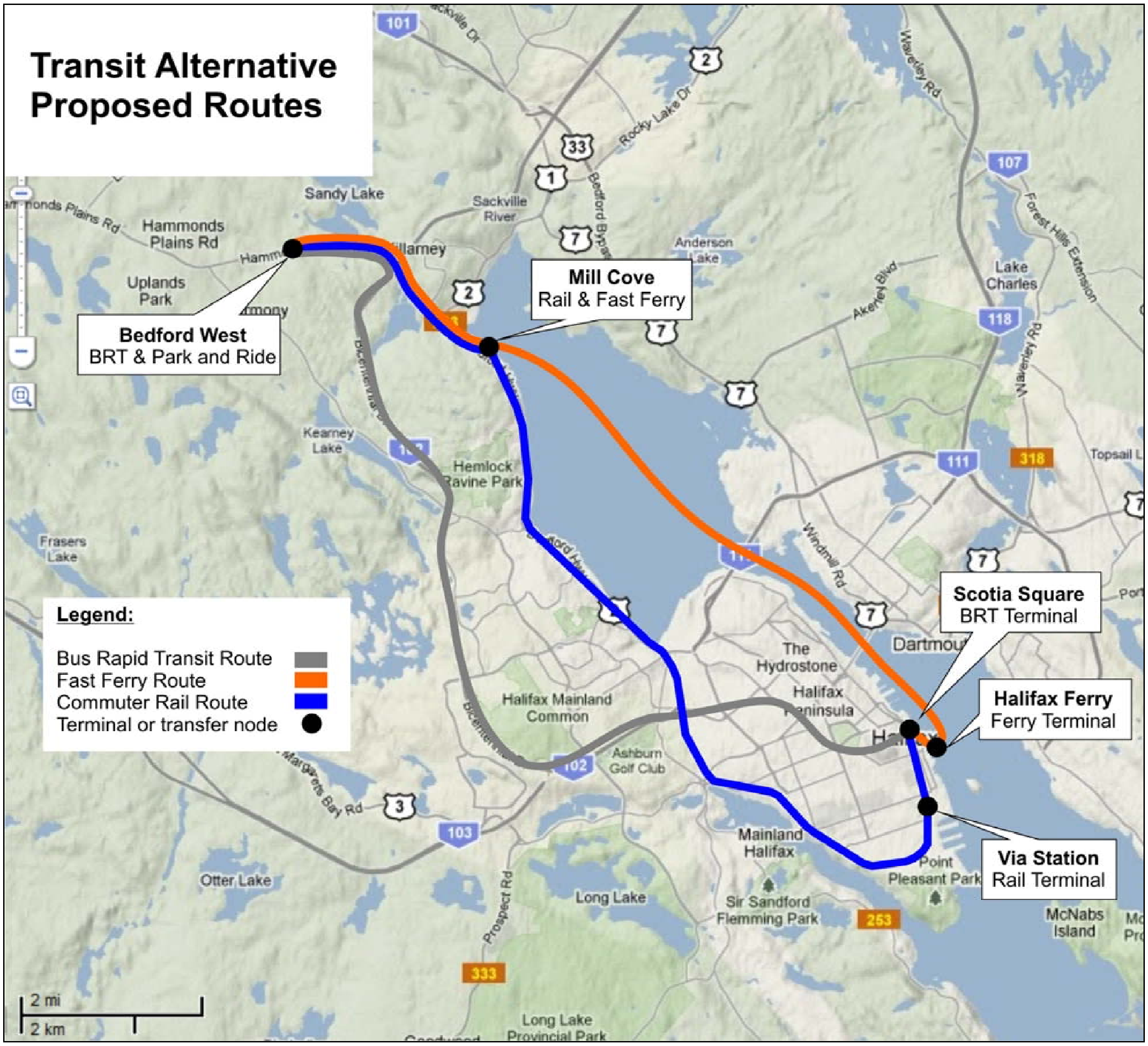
- It will be important to engage the pleasure craft and sailing communities to discuss general right-of-way issues for any future ferry operations.

4 THE OPERATIONAL REVIEW

4.1 Overview of service options

An operational review was carried out for the three proposed transit services to determine travel times, departure headways and fleet requirements. Based on the study terms of reference, Delphi-MRC carried out the review for the Bus Rapid Transit (BRT) and ferry options, and Metro Transit completed the review of the commuter rail service concept. The proposed routes for the three transit services – including shuttle services – are illustrated in Figure 1 and described in the following sections.

Figure 2: Proposed transit option routing between Bedford and Halifax



4.1.1 Assumed BRT route description

The assumed BRT route was developed based on discussions with the Project Steering Committee. In Bedford, the BRT terminal and park and ride facility was assumed to be located on Hammonds Plains Road, immediately east of Blue Water Road (in the Bedford West Master Plan area). Buses would travel along Hammonds Plains Road and turn south on Highway 102. From Highway 102 the route would travel along Bayers Road to southbound Windsor Street. The route then would travel along Quinpool Road / Cogswell Street in the eastbound direction and then southbound along Barrington Street to Scotia Square.

4.1.2 Assumed ferry route description

To remain consistent with the BRT service assumptions, the proposed ferry route was developed with the same start and end locations. The travel route would begin at the BRT terminal / park and ride facility on Hammonds Plains Road. A shuttle bus would take passengers from the park and ride facility to the Mill Cove ferry terminal. From here the route would travel to the Halifax ferry terminal. Transit patrons are then expected to walk from the Halifax ferry terminal to Scotia Square on Barrington Street.

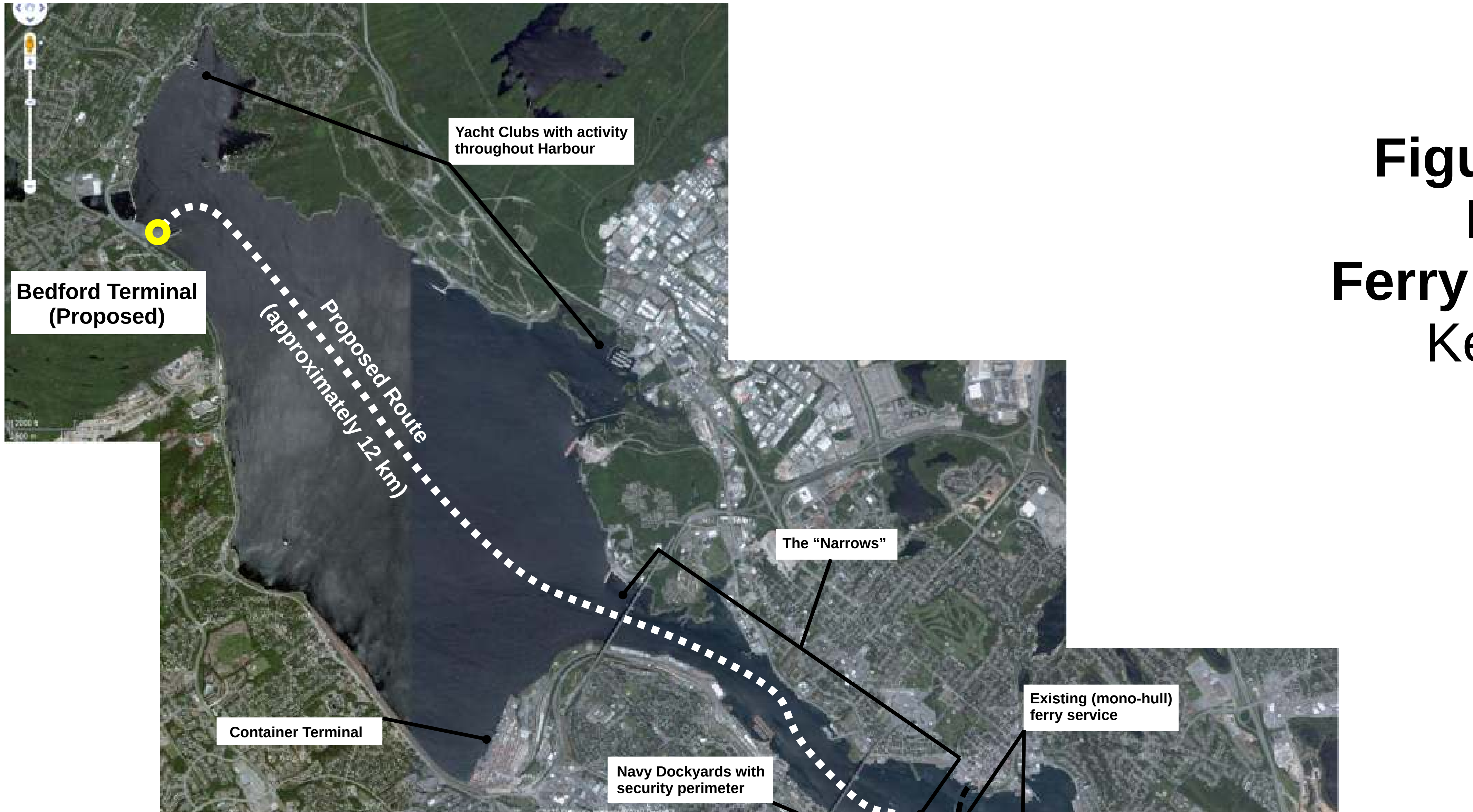
A significant portion of this trip occurs across Halifax harbour. To assist the reader in understanding some of the operating conditions along the water based portion of the trip, we have illustrated the route in Figure 3 on the following page.

4.1.3 Assumed commuter rail route description

In order to be consistent with the other transit service alternatives the commuter rail route also begins at the BRT terminal / park and ride facility on Hammonds Plains Road. A shuttle bus would provide service between the park and ride facility and a proposed Mill Cove rail station. Passengers would then travel by rail to the Halifax VIA station, located near the Hollis Street / South Street intersection, and then take a shuttle from the VIA station to Scotia Square. In addition, there are two intermediate stops assumed to be in place in this analysis; one at Rockingham (near Mount St. Vincent University) and another at Mumford Road (near the Halifax Shopping Centre).

Figure 3: Proposed Bedford-Halifax Ferry Transit Service

Key Features Map




Context Map:

4.2 Bus rapid transit operational review

4.2.1 Current travel time

As described in the previous Section, the proposed BRT service is assumed to operate between a new terminal and park and ride facility on Hammond Plains Road and Scotia Square. We also assumed that there would be no new bus-related roadway improvements (i.e. queue jump lanes or bus priority signals) added by HRM to reduce travel times. The resulting BRT travel times for the weekday morning and afternoon peak period under current conditions are provided in Table 1.

Table 1: Current travel times for BRT - weekday morning and afternoon peak periods

Bus Rapid Transit (Metro Link)	
Trip Element	**Time (minutes)**
Depart terminal (West Bedford)	0
BRT trip to Scotia Square Terminal	29
Unload time	2
Total Trip Time	**31**

Weekday morning peak

Bus Rapid Transit (Metro Link)	
Trip Element	**Time (minutes)**
Depart Scotia Square	0
BRT trip to West Bedford terminal	34
Unload time	2
Total Trip Time	**36**

Weekday afternoon peak

The total trip times provided in Table 1 are based on several travel time runs carried out by Delphi-MRC in November 2009. The average recorded travel time for the weekday morning peak period was 29 minutes (with a low/high range of 28.4 to 29.6 minutes). During the weekday afternoon peak period the average recorded travel time was 34 minutes (with a low/high range of 30.5 to 37.5 minutes). These times were recorded under current operating conditions and we expect that the travel time will continue to increase as traffic volumes grow.

4.2.2 Future impacts to travel time

A sensitivity analysis was carried out using a vehicle traffic simulation model developed as part of this study to explicitly evaluate the proposed BRT route and associated bus travel times. A baseline simulation model was first developed and calibrated using existing peak period traffic conditions and current roadway capacity. Once the calibration parameters were within an acceptable range, the model was used to test future traffic conditions and bus travel times. Traffic volumes in this model were increased incrementally to determine the associated impact to the BRT travel times in both the weekday morning and afternoon peak periods.

The findings of the sensitivity analysis indicate that if traffic volumes were to increase by 20% - and no other transit priority improvements are implemented - we can expect BRT travel times of about 45-48 minutes during the peak periods. This amount of time exceeds the forecast travel times for both ferry and rail service modes.

Changes in vehicle traffic volumes are dynamic and volumes can be quite different from one day to the next. However, using a simple calculation, we can put the 20% growth rate into perspective. We know that typical yearly traffic volume growth in the HRM can range from 1.5% to 2%. Assuming compounding traffic growth occurs, within 9 to 12 years, the BRT travel times are likely to exceed that of the other competing modes.

4.2.3 Service Schedule and fleet requirements

A sample schedule for a proposed BRT service is contained in Table 2. A 40-minute trip time was assumed – longer than the baseline observed trip times – to account for minor schedule adjustments and delays in order to maintain Metro Transit's current schedule performance standards. In selecting the departure headway times we balanced the positive impacts associated with increasing the service capacity with the negative impacts of over-saturating the corridor with buses. We determined that a 10 minute headway best addressed both the positive and negative impacts.

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Table 2: A sample BRT service schedule with 10-minute departure headways

	Bus No.	Depart Bedford West	Arrrive Scotia Square	Depart Scotia Square	Arrive Bedford West
Weekday	1	6:00	6:40	6:45	7:15
Morning peak period:	2	6:10	6:50	6:55	7:25
	3	6:20	7:00	7:05	7:35
	4	6:30	7:10	7:15	7:45
	5	6:40	7:20	7:25	7:55
	6	6:50	7:30	7:35	8:05
	7	7:00	7:40	7:45	8:15
	8	7:10	7:50	7:55	8:25
	1	7:20	8:00	8:05	8:35
	2	7:30	8:10	8:15	8:45
	3	7:40	8:20	8:25	8:55
	4	7:50	8:30	8:35	9:05
	5	8:00	8:40	8:45	9:15
	6	8:10	8:50	8:55	9:25
	7	8:20	9:00	9:05	9:35
	8	8:30	9:10	9:15	9:45
	1	8:40	9:20	9:25	9:55
	2	8:50	9:30	9:35	10:05
Weekday	3	9:30	10:00	10:00	10:30
Midday	2	10:30	11:00	11:00	11:30
	3	11:30	12:00	12:00	12:30
	2	12:30	13:00	13:00	13:30
	3	13:30	14:00	14:00	14:30
	2	14:30	15:00	-	-
Weekday	2	-	-	15:00	15:40
Afternoon	3	14:30	15:00	15:10	15:50
peak period:	4	14:45	15:15	15:20	16:00
	5	14:55	15:25	15:30	16:10
	6	15:05	15:35	15:40	16:20
	7	15:15	15:45	15:50	16:30
	8	15:25	15:55	16:00	16:40
	1	15:35	16:05	16:10	16:50
	2	15:45	16:15	16:20	17:00
	3	15:55	16:25	16:30	17:10
	4	16:05	16:35	16:40	17:20
	5	16:15	16:45	16:50	17:30
	6	16:25	16:55	17:00	17:40
	7	16:35	17:05	17:10	17:50
	8	16:45	17:15	17:20	18:00
	1	16:55	17:25	17:30	18:10
	2	17:05	17:35	17:40	18:20
	3	17:15	17:45	17:50	18:30
	4	17:25	17:55	-	-
Weekday	4	-	-	18:00	18:30
Evening:	5	18:00	18:30	18:30	19:00
	6	18:30	19:00	19:00	19:30
	4	19:00	19:30	19:30	20:00
	5	19:30	20:00	20:00	20:30
	6	20:00	20:30	20:30	21:00
	4	20:30	21:00	21:00	21:30
	5	21:00	21:30	21:30	22:00
	6	21:30	22:00	22:00	22:30
	4	22:00	22:30	22:30	23:00
	5	22:30	23:00	23:00	23:30
	6	23:00	23:30	23:30	0:00
	4	23:30	0:00	-	-

Note: No planned weekend or holiday service

In order for the BRT service to provide a service capacity similar to the other transit alternatives (under typical operating conditions), we estimate that the BRT service would require 8 articulating buses to be in operation during the peak period. A service with 8 buses at 10 minute departure headways provides a total peak period capacity of 990 passengers.

4.3 Ferry transit operational review

4.3.1 Overview

The initial step of the ferry operational analysis was to gain a thorough understanding of the issues associated with operational constraints in the harbour. There were three key components to this work that included:

- a review of the findings of past studies carried out for the ferry service between Bedford and Halifax;
- holding informal discussions with knowledgeable experts of vessel operations in Halifax harbour (i.e. the key informant interviews summarized in Section 3); and
- a review of historical weather and visibility data and how this could potentially impact the ferry schedule performance using Metro transit's schedule performance criteria (i.e. on-time 95% of the time).

The information gleaned from these efforts formed the basis for our operating assumptions and allowed us to develop a reasonable ferry operating profile across the harbour.

4.3.2 Visibility review

Discussions with the key informants indicated that the prevalence of low visibility conditions in Halifax harbour was one of the key constraints to operating a high-speed vessel. This operating constraint was considered in the selection of an appropriate ferry operating speed to achieve Metro Transit's schedule performance criteria.

Metro Transit has established a schedule performance criterion to maintain adequate levels of service for its patrons. The criterion is based on its current bus fleet. We have assumed that this criterion would also apply to other transit technologies offered in the future. The criterion has been set to limit late arrivals/departures to less than 5%. If we focus on weekday service only, and use 250 working days per year for calculation purposes, then the 5% criterion equates to being late no more than 12 days/year.

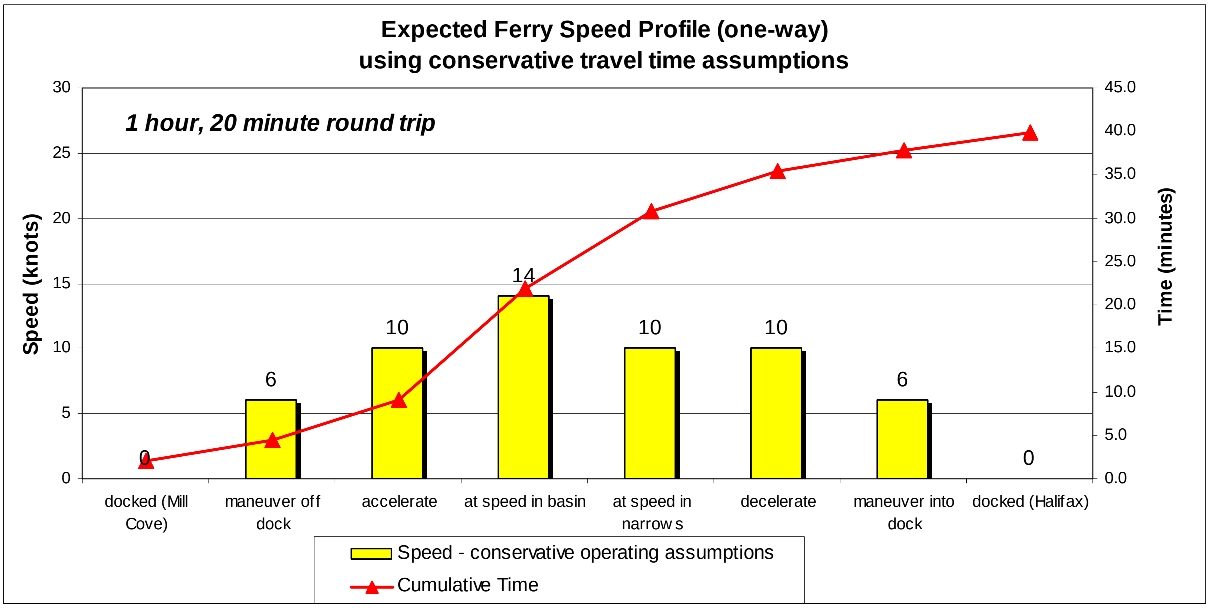
A review of historical Environment Canada weather data recorded at the Shearwater weather station was carried out. Over a 20-year period, conditions with visibility of "less than 1km" occurred an average of 619.5 hours/year. If we assume that all 619.5 hours occurred in succession it would equate to 25.8 days – which is greater than the 12 day threshold outlined above. However, we expect low visibility conditions (e.g. fog) to be spread out over the year and fog is likely more prevalent during the morning hours (likely coinciding with the weekday peak period of transit operations). This suggests that the number of low visibility days would be greater than 25.8.

Based on these findings, it appears that travel time assumptions used for ferry scheduling purposes at the planning stage should be conservative.

4.3.3 Expected Travel time

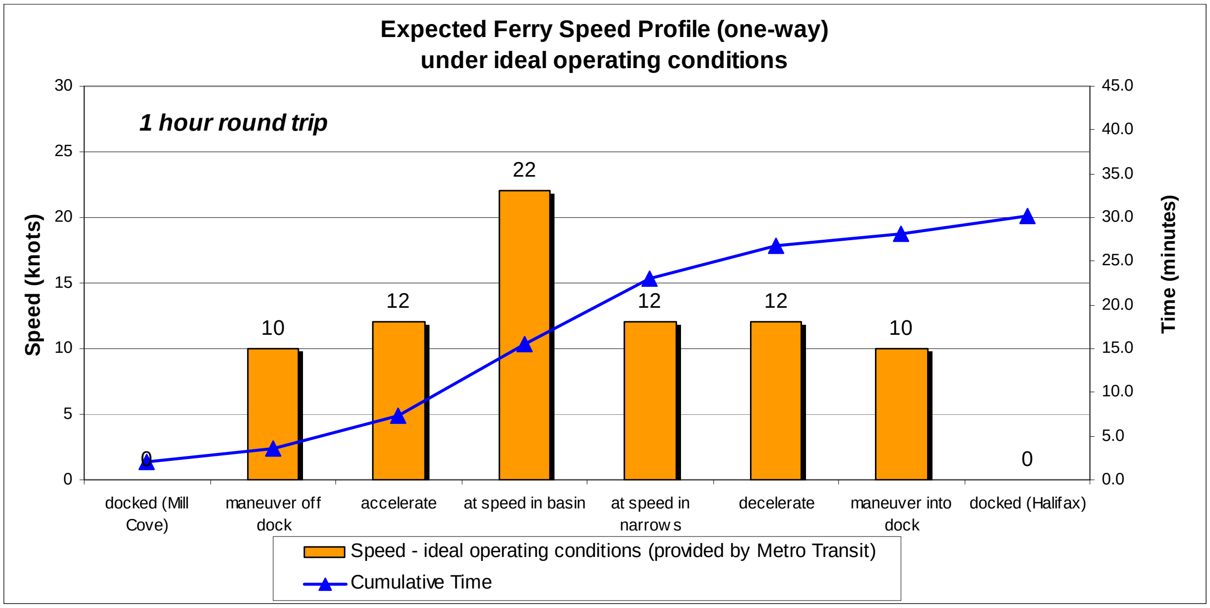
Past studies of the proposed ferry service in this corridor assumed vessel operating speeds of up to 35 knots. However, in a concurrent ferry planning study being conducted on behalf of Metro Transit, it appears that any future vessel on this route would now likely operate at a maximum speed of less than 35 knots. We also know from our key informant interviews and visibility review that reduced operating speeds will be required to conform to international vessel operating regulations under low visibility conditions. All of this information was then used to develop a conservative vessel operating profile that is illustrated in Figure 4. Using this operating profile we estimate that the one-way ferry travel time will be about 40 minutes.

Figure 4: Conservative estimate of ferry travel time (water based portion of trip)



Despite information that appears to indicate a need to plan for a conservative speed profile, we expect that "ideal operating" conditions will be more common throughout the year. As such we provide the reader with an estimate of travel times under these conditions. At this point in the planning process it is difficult to clearly state the vessel operating times under ideal conditions until a specific vessel is procured and tested under live conditions. However, an operating speed profile was developed by Metro Transit and is based on an assumed top operating speed of 22 knots. This "ideal conditions" speed profile is illustrated in Figure 5. Using this operating profile we estimate that the one-way ferry travel time will be about 30 minutes.

Figure 5: Estimated ferry travel time under ideal operating conditions



Further discussions were held with Metro Transit regarding the assumed operating speeds. Metro Transit acknowledged the scheduling risks associated with using a 30-minute travel time and the potential schedule impacts associated with poor weather / low visibility days. However, given the greater likelihood of "ideal conditions" it was their desire to use a 30-minute travel time for analysis purposes. Therefore, the ideal operating conditions, illustrated above, were applied to the analysis in this report.

In order to be consistent with the operating assumptions of the other transit modes, we also assumed that a shuttle bus service would be provided from the park and ride facility on Hammonds Plains Road to the ferry terminal at Mill Cove (4 minutes). We also factored in time to walk from the shuttle to the ferry (2 minutes), and time to walk from the Halifax ferry terminal to Scotia Square (7 minutes). The overall "ideal" travel time for the entire trip from Bedford West to Scotia Square is estimated to be 43 minutes and, unlike the BRT service, the time is not expected to change (i.e. deteriorate) over the long term due to traffic congestion.

4.3.4 Service schedule and fleet requirements

For the purposes of this study we have assumed a ferry capacity of 250 passengers. This value is consistent with HRM's 2008 call for Expressions of Interest (EOI) for vessel designs, as well as recommendations flowing from a concurrent ferry planning study being carried out on behalf of Metro Transit. Table 4 contains a sample schedule for a 30-minute ferry trip (over the water) with 20-minute departure headways from Mill Cove and the Halifax ferry terminal.

Table 3: A sample weekday ferry schedule with 20-minute departure headways

	Vessel No.	Depart Mill Cove	Arrive Halifax	Depart Halifax	Arrrive Mill Cove
Weekday	1	6:00	6:30	6:30	7:00
Morning	2	6:20	6:50	6:50	7:20
peak period:	3	6:40	7:10	7:10	7:40
	1	7:00	7:30	7:30	8:00
	2	7:20	7:50	7:50	8:20
	3	7:40	8:10	8:10	8:40
	1	8:00	8:30	8:30	9:00
	2	8:20	8:50	8:50	9:20
	3	8:40	9:10	-	-
Weekday	1	9:00	9:30	9:30	10:00
Midday	1	10:00	10:30	10:30	11:00
	1	11:00	11:30	11:30	12:00
	1	12:00	12:30	12:30	13:00
	1	13:00	13:30	13:30	14:00
	1	14:00	14:30	14:30	15:00
Weekday	3	-	-	15:10	15:40
Afternoon	1	15:00	15:30	15:30	16:00
peak period:	2	15:20	15:50	15:50	16:20
	3	15:40	16:10	16:10	16:40
	1	16:00	16:30	16:30	17:00
	2	16:20	16:50	16:50	17:20
	3	16:40	17:10	17:10	17:40
	1	17:00	17:30	17:30	18:00
	2	-	-	17:50	18:20
Weekday	3	17:45	18:15	18:15	18:45
Evening:	3	18:45	19:15	19:15	19:45
	3	19:45	20:15	20:15	20:45
	3	20:45	21:15	21:15	21:45
	3	21:45	22:15	22:15	22:45
	3	22:45	23:15	23:15	23:45
	3	23:45	0:15	-	-

Note: Weekend service with 60-minute headways (1 vessel), no planned holiday service

The requirement for 3 ferry vessels was based solely on meeting a peak period service schedule that provided headways of less than 30-minutes to maintain the relative attractiveness of such a service. Based on the above sample service schedule, a ferry service with three departures per hour over a 3-hour peak period would provide a peak period service capacity of 2,250 passengers.

4.4 Heavy commuter rail transit operational review

4.4.1 Expected Travel time

The evaluation of the commuter (heavy) rail transit service was carried out by Metro Transit and the results were provided for inclusion in the life-cycle costing phase of the study. Although Metro Transit carried out a comprehensive evaluation that reviewed potential service to a larger geographic area, to be consistent with our assumptions of the BRT and ferry services, we have only summarized the findings for service between Mill Cove and the Via Rail station in the south end of Halifax.

Table 4: Estimated travel times for commuter rail - morning and afternoon peak periods

Trip Element	Time (minutes)
Depart terminal (West Bedford)	Start
Shuttle to Mill Cove terminal	4
Walk from shuttle to rail	2
Rail trip to Via station	23
Unload/load time	2
Shuttle to Scotia Square	7
	38

Weekday morning peak

Trip Element	Time (minutes)
Depart Scotia Square	Start
Shuttle to Via station	7
Unload/load time	2
Rail trip to Mill Cove terminal	23
Walk from rail to shuttle	2
Shuttle to terminal (West Bedford)	4
	38

Weekday afternoon peak

The entire trip from the Bedford park and ride to Scotia Square is estimated to be 38 minutes and, unlike the BRT service, the time is not expected to change over the long term. This estimate includes an assumption that the shuttle would make a connecting stop at the Barrington Street/Spring Garden Road intersection. The 23-minute rail trip assumes intermediate stops at the Rockingham and Mumford stations and is based on the previous work carried out on the 1996 Commuter Rail Feasibility Study[2].

4.4.2 Service Schedule and fleet requirements

It was assumed that two train sets comprised of 3 cars each plus one spare car would be required to provide a minimum peak-period service. This combination could provide 30-minute headways. It should be noted that Metro Transit has assumed the appropriate rail sidings would be in place to ensure compatibility with other rail activity (such as CN's freight rail service) and minimize disruption to the commuter rail schedule. Based on this information, a sample weekday morning peak period schedule was developed and is contained in Table 6.

[2] Commuter Rail Feasibility Study. Prepared by IBI Group for Halifax Regional Municipality, 1996.

Table 5: Estimated peak period commuter rail schedule

Station	Train Set & Departure Time					
	1	2	1	2	1	2
Mill Cove	6:15	6:45	7:15	7:45	8:15	8:45
Rockingham	6:22	6:52	7:22	7:52	8:22	8:52
Mumford	6:26	6:56	7:26	7:56	8:26	8:56
VIA Station	6:35	7:05	7:35	8:05	8:35	9:05
VIA Station	15:30	16:00	16:30	17:00	17:30	18:00
Mumford	15:39	16:09	16:39	17:09	17:39	18:09
Rockingham	15:43	16:13	16:43	17:13	17:43	18:13
Mill Cove	15:50	16:20	16:50	17:20	17:50	18:20

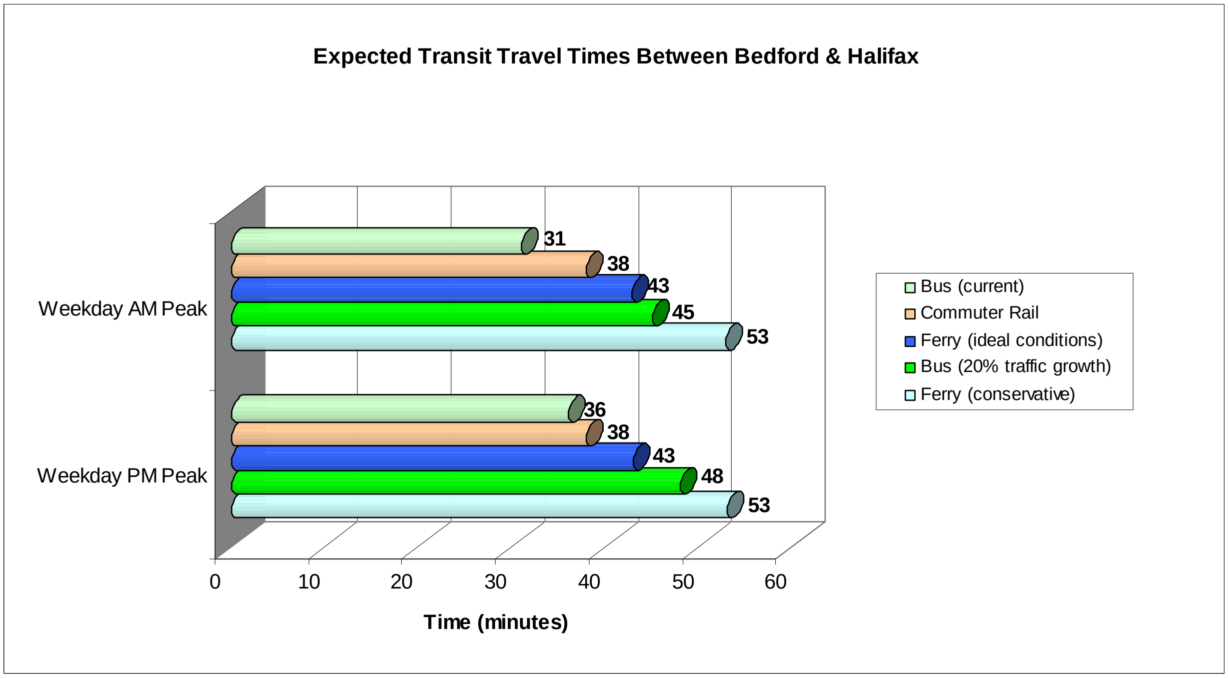
The assumed capacity of each train set is 330 passengers. Therefore, the weekday peak period capacity is expected to be 1,980 passengers if six departures are provided. In a separate exercise, Metro Transit developed planning-level ridership forecasts and determined that demand would not exceed the 1,980-passenger capacity. Notwithstanding, additional rail cars could easily be added to each train set if needed in the future.

4.5 Summary of findings

4.5.1 Summary of expected travel times

The estimated total peak period trip times for each service are summarized graphically in Figure 6. Two travel time estimates are provided for the proposed bus rapid transit and ferry services and summarizes the range of travel times that could be expected. The BRT times illustrate the change in travel times between now (31/36 minutes) and after a 20% increase in traffic due to growth occurs (45/48 minutes). The range of ferry travel times illustrate the difference between ideal operating conditions (39 minutes) and conservative operating conditions that account for reduced visibility and poor weather (53 minutes).

Figure 6: Summary of estimated transit travel times



If these services were implemented today, the overall trip time results (including shuttle bus times and mode transfer times, if applicable) indicate the BRT service would have a slightly shorter travel time. However, it must be noted that the BRT time estimate is based on current traffic conditions. As traffic volumes continue to grow and no new roadway capacity is added to access the peninsula, the travel time can be expected to increase. Therefore, in the medium-term we expect the BRT travel time will approach the estimated travel times for the ferry and commuter rail services (which are expected to remain constant). If the proposed BRT service were to remain competitive, there is a need for significant investment in infrastructure that explicitly supports BRT, such as exclusive right-of-ways (over long distances). Investments such as this were not considered in this analysis.

4.5.2 Summary of fleet requirements

The ultimate goal of the operational review was to determine an estimate of fleet requirements for each of the three transit alternatives as it is a necessary input to the next step in the evaluation process – the life cycle costing analysis phase. A summary of the fleet needs is summarized in Table 6.

Table 6: Peak period service requirements

Service Type	Peak Period Departure Headway (minutes)	Fleet Unit Description	Basic Fleet Required (units)	Estimate of Spare Fleet (units)	Total Fleet (units)
BRT	10	Articulating bus (55 seats)	8 buses	3 buses	11
Fast Ferry	20	Catamaran (250 seats)	3 vessels	0 vessels	3
Rail	30	Rail car (110 seats)	6 rail cars	1 rail car	7

In addition to the basic fleet requirements, both the ferry and commuter rail service concepts will require shuttle bus service. A description of each is provided below:

- In the case of the ferry, a shuttle bus will be required to connect the Mill Cove ferry terminal in Bedford to the park and ride facility on Hammonds Plains Road. It is expected that 2 articulating (i.e. 55 seats) shuttle buses will be required.

- The commuter rail concept will require the following shuttle bus services:

    - A shuttle bus connecting the VIA station to Scotia Square in downtown Halifax. The Project Steering Committee has indicated that two articulating buses (i.e. 55 seats/bus) would provide sufficient capacity for this service; and

    - A shuttle bus connecting the Mill Cove rail station in Bedford to the park and ride facility on Hammonds Plains Road. It is expected that two articulating buses (i.e. 55 seats/bus) would provide sufficient capacity for this service.

5 LIFE-CYCLE COSTING ANALYSIS

5.1 What is a life-cycle costing analysis (LCCA)

A decision to invest in a transportation project should rely, in part, on the findings of an economic analysis. There are two major types of economic analysis processes that are typically carried out to evaluate the merits of transportation projects and they include a benefit-cost analysis (BCA) and a life-cycle cost analysis (LCCA). A traditional BCA compares the societal benefits and costs over the life span of a given project – and if the benefits outweigh the costs a decision to invest becomes more attractive. On the other hand, the LCCA is a subset of a BCA and focuses only on the costs associated with a project. Despite the LCCA not considering the benefits of a project – which can often be difficult to accurately quantify and in some cases, when dealing with external benefits, tend to be subjective in nature – the LCCA process tends to provide more tangible information to decision-makers. In the case of this study, the LCCA process appeared to be a useful and suitable method of providing high-level, strategic cost-effectiveness results as one input to the overall findings of the study.

The Sections that follow provide an overview and brief summary of the LCCA process and results of the work carried out by CPCS Transcom. Their full report is provided in Appendix A.

Despite the added value provided by conducting a LCCA process, it is still important to note that future decisions should not be made solely on the LCCA findings. Decisions should not only rely on costs, but also on projected revenues, potential risks, available funding, environmental issues and political concerns[3]. This is an important point to be made as this study only focuses on the supply-side issues and not the demand-side issues associated with each transit alternative.

5.2 Key assumptions

5.2.1 Inflation

For investments made by the public sector, life-cycle costs are generally estimated without accounting for inflation (i.e. in real or base year dollars). Not only is inflation difficult to predict, but it must in any case be netted out before costs can be compared on a uniform basis (e.g. using base year dollars).

Inflation, on the other hand, is very important in financial analysis. Indeed, it will affect the budgeting of the project, which is generally done in current dollars. In this case, given that the costing analysis is comparative rather than financial, inflation will not be taken into account. The implicit assumption is that costs across all three options will rise in tandem. The cost level of the base year (2010) will be used.

5.2.2 Real discount rates

Despite not taking inflation into account, the timing of costs remains important. Indeed, a dollar will be worth less in the future than it is today because we must account for the uncertainty of the future, the expectation that future generations will have higher income

[3] Life-cycle Cost Analysis Primer. US Department of Transportation, Office of Asset Management. August 2002.

than the present generation,[4] and a simple preference for immediate gratification rather than delayed gratification. These effects remain in place even in a world without inflation

Another way to explain discounting is the fact that there is a cost associated with diverting the resources needed for an investment from other productive uses within the economy. This cost is equal to the economic return that could be earned on the invested resources (or the dollars used to buy them) in their next best alternative use. The discount rate reflects the compensation that must be provided to use the resources now rather than later.[5]

As such, a discount rate must be applied to the annual costs, so that costs in the distant future receive less weight than those incurred today. The Canadian guide to cost-benefit analysis suggest a discount rate of 8% if based on the cost-of-funds (CoF) methodology, and 3% if based on the social time preference (STP) methodology. In earlier versions of the guide, a discount rate of 10% was suggested. For this study, we will use three different discount rates to provide a range of possible outcomes. The three discount rates used will be 3%, 5% and 10%. The 'base case' discount rate will be assumed to be 5%, roughly in the middle of the range provided by the CoF and STP methodologies. In general, lower discount rates are used for projects funded by the public sector as the public sector's cost of fund is lower, and its time-preference discount rate is also lower than for the private sector.

5.2.3 Asset useful life

In order for all alternatives to be compared on a level playing field, it is important to consider the significant differences in the life expectancy of the different assets. For instance, a terminal, a ferry, a bus and a parking lot do not need to be replaced at the same frequency.

In LCCA, standard practice is to evaluate all alternatives based on a fixed period. The period used is generally that of the asset with the longest expected useful life – in this case the ferry terminal at 40 years. This will be the reference duration for the analysis.

Assets with shorter useful lives are assumed to be replaced entirely at the end of their life cycle. For assets with an expected life that is not a factor of 40, the cost of the last renewal reflects only the portion covered within 40 years. For example, if an asset has a expected life of 16 years, at year 32 it will be renewed for an additional 8 years at half its costs (since its only for half its expected life).

5.2.4 Timing of costs

In LCCA, costs are applied when they are incurred. Costs are not counted based on a depreciation schedule, as would be the case in an accounting-based analysis (accrual

[4] This means that an additional dollar of costs will be easier to bear for future generations, and an additional dollar of income will provide them with fewer benefits.

[5] Assume, for example, that $100 today would buy the same basket of goods and services in 20 years than today (i.e. no inflation) with full certainty. Would a person thus be able to borrow, or willing to lend, money at zero interest rate? The answer is 'no' as this money could instead be invested with positive returns elsewhere. Thus, people must be compensated for making money available even if there is no inflation. If, for example, people require at least $105 after one year as compensation for making $100 available today, then they are equating the value of $105 after one year to $100 in the present. This represents a discount rate of 5 percent. (Source: US DOT's *Economic Analysis Primer)*

basis). Instead, all measures are on a cash basis, albeit in constant rather than current dollars. Indeed, what is of interest is the timing of actual expenses, rather than the financial structure of the project. If a financial model was built, alternative financing possibilities could be assessed, and the most appropriate one established. This is, however, outside the scope of this assessment.

5.2.5 Infrastructure and operational costs

Infrastructure and operational costs were developed based on data provided by Metro Transit, Delphi-MRC and previous studies. A cursory analysis by CPCS suggests that these estimates are in an appropriate range, but no further analysis of these estimates was completed.

In most cases, the challenge was to ensure the estimated costs for each alternative were comparable. For example, it would not be appropriate to include marketing costs for one service and not the other, as that would skew the analysis in favour of the alternative with no marketing costs. Comparability of cost categories was thus deemed paramount and significant efforts were expanded with that objective in mind.

5.3 Summary of cost estimates

5.3.1 Overview

In carrying out the LCCA process, two types of costs were reviewed and estimated for each of the transit alternatives – capital costs which occur at the beginning of the project, and operational costs (which will depend on whether the service is maintained and on the frequency of the service). Based on the assumptions discussed in previous sections of this report, we provide the fixed and variable costs associated with each service in the following Sections. A detailed discussion regarding the assumptions for each service are provided in Appendix A.

It should be noted that Metro Transit has plans to build a transit terminal as part of the Bedford West development on Hammonds Plains Road. This terminal will be used for local bus service, and could also serve as the park and ride facility (and boarding/alighting platform) necessary to support future ferry, rail or BRT services. Therefore, this study assumes no additional costs will be incurred for a terminal and park and ride facilities for the BRT service, and the rail and ferry service would not require any additional park and ride infrastructure. This infrastructure is the only component common to all three services.

5.3.2 BRT cost estimates

The following Table contains the estimated capital and annual operating costs associated with the proposed BRT service. It should be noted that costs associated with roadway upgrades that would allow the BRT service to maintain current travel times into the future have not been included in this analysis.

Table 7: Estimated costs associated with the proposed BRT service

Capital Costs		Service Life
Articulated buses (11 buses)	$8,800,000	16 years
Other start-up costs	$250,000	N/A
Total	**$9,050,000**	N/A
Operational Costs (annually)		**Service Life**
Bus maintenance, fuel & operator (11 buses)	$1,469,000	N/A
Terminal management and other services	$340,000	N/A
Total	**$1,809,000**	N/A

Source: CPCS analysis.

5.3.3 Ferry cost estimates

The following Table contains the estimated capital and annual operating costs associated with the proposed ferry service.

Table 8: Estimated costs associated with the proposed ferry service

Capital Costs		Service Life
Terminal construction/upgrades	$8,500,000	40 years
Vessel procurement (3 vessels)	$25,500,000	30 years
Shuttle procurement (2 buses)	$1,600,000	16 years
Other start-up costs	$250,000	N/A
Total	**$35,850,000**	N/A
Operational Costs (annually)		**Service Life**
Crew costs	$1,100,000	N/A
Fuel	$1,393,900	N/A
Vessel Maintenance	$862,500	N/A
Shore-side management services	$555,000	N/A
Shuttle Service	$126,900	N/A
Total	**$4,038,300**	N/A

Source: CPCS analysis.

5.3.4 Commuter rail cost estimates

The following Table contains the estimated capital and annual operating costs associated with the proposed commuter rail service.

Table 9: Estimated costs associated with the proposed commuter rail service

Fixed Costs		Service Life
CN track infrastructure	$6,200,000	40 years
3 Stations	$1,200,000	40 years
Remanuf. rolling stock (5 powered, 2 unpowered)	$15,000,000	20 years
Shuttle procurement (4 buses)	$3,200,000	16 years
Other start-up costs	$250,000	N/A
Total	**$25,850,000**	N/A
Variable Costs (annually)		**Service Life**
Train operations and maintenance	$3,553,900	N/A
Station management and other services	$440,000	N/A
Shuttle Service (x2)	$253,800	N/A
Total	**$4,247,700**	N/A

Source: CPCS analysis.

5.4 Results of the LCCA

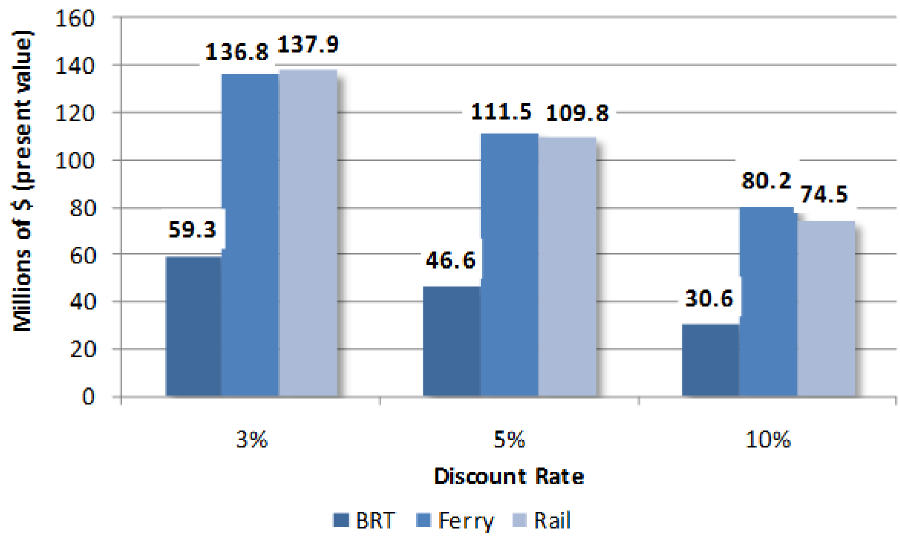
5.4.1 Overview

Following the methodology discussed in Section 5.2 and using the estimated costs identified in Section 5.3, the strategic life-cycle costing analysis was carried out to determine relative cost comparisons between each proposed transit alternative. The results have been provided using two techniques. The first is based on the assumed operating schedules presented in Section 4 of this report. The second technique is based the assumption that all three transit service options only operate during the weekday peak period. A more detailed examination of the costs associated with each transit alternative are presented in the Sections that follow.

5.4.2 Discounted (5%) cumulative life-cycle costs

As discussed earlier in this report, the decision to further examine a particular transit service technology must be based on more than initial capital costs. Changes to the real discount rate can increase or decrease the impacts that future expenses can have on the real costs of the service. Therefore, a sensitivity analysis using three discount rates 3%, 5% and 10% was carried out as part of the LCCA. The results are shown in Figure 7.

Figure 7: Cumulative present value costs with varied discount rates by 2050



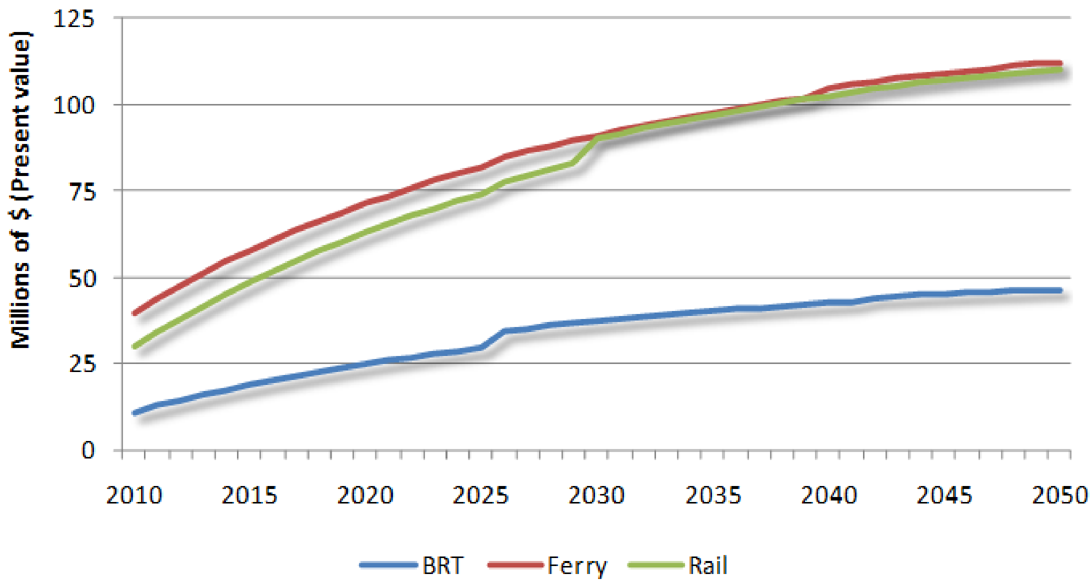
Source: CPCS analysis

It was determined that a long term discount rate of 5% was an appropriate "most likely" value for this analysis. The results of the cumulative LCCA presented in the following Sections use a 5% discount rate.

5.4.3 Cost as a function of assumed full service

The results presented in this section flow from the operational analysis in Section 4 and the associated proposed schedules. It should be noted that the costs presented below are based on varying levels of service between the three transit options and therefore the operating costs vary between the transit options. Nonetheless, if the three services were to be implemented, we expect them to be implemented as contemplated in Section 4.

Figure 8: Cumulative present value for total costs based on full service assumptions



Source: CPCS analysis

The BRT service, which has both lower capital and operating costs, remains much more affordable. When we look at ferry versus rail, the rail has a lower initial capital outlay but this is somewhat offset over time by its slightly higher operating costs and the lower asset life of the rolling stock compared to the ferry vessels.

5.4.4 Cost as a function of weekday peak period service only

As discussed earlier in this report, the three transit options have been assumed to operate with different "service levels" (i.e. operating with different departure headways and operating at different times of the day and days of the week). Additional analysis was therefore undertaken to provide a better comparison among alternatives.

To facilitate this analysis, costs associated with the weekday off-peak and weekend services were removed from the analysis for the ferry and BRT transit options[6]. The commuter rail service was only assumed to operate during the weekday peaks and therefore no adjustments were made to its operating costs.

The number of seats offered by each service during the weekday peak period was used as a coarse-level proxy for the level of service. It is considered to be coarse-level as it does not consider off-peak and weekend service, external impacts on traffic, environmental impacts, job creation and other intangibles. Nonetheless, it provides a reasonable strategic approximation of the life-cycle cost per seat. A summary of the number of weekday peak period seats for each transit service are provided in Table 10.

[6] More detailed information with respect to the operating cost impacts associated with this analysis is provided in Appendix A.

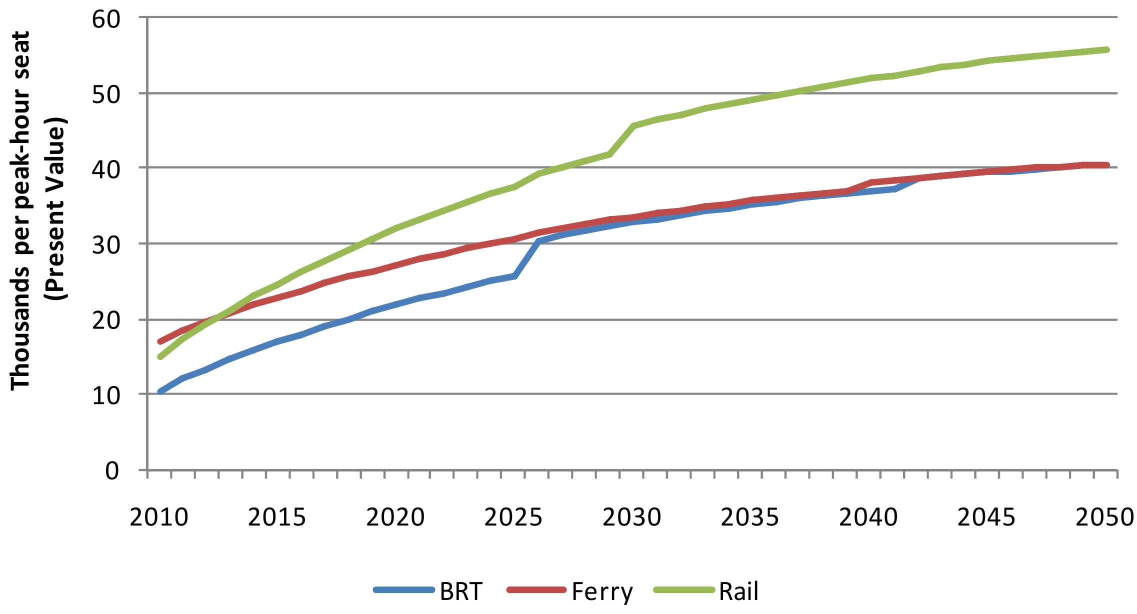
Table 10: Expected service seat capacity for the weekday peak period

	Ferry	BRT	Rail
No. of peak period departures	9	18	6
Headway (minutes)	20	10	30
Seat capacity per departure	250	55	330
Total peak period seat capacity	**2250**	**990**	**1980**

Source: CPCS analysis, based on the sample schedules developed through the operational review

Using a discount rate of 5%, the cumulative discounted lifecycle costs are expressed as a function of the weekday peak period (i.e. one peak period) capacity and are illustrated in Figure 9.

Figure 9: Cumulative present value for total costs based on weekday peak service



Source: CPCS analysis

Figure 9 illustrates the cumulative total costs based on peak period service only, divided by the total number of seats offered during the peak. A more detailed breakdown of the costs is provided in Table 11. The capital and operating costs at the 2010 and 2050 planning horizons is provided for each transit option.

Table 11: Present value capital and operating costs at 2010 and 2050 planning horizons

	Ferry	BRT	Rail
Capital cost per peak-hour seat in 2010	15,900	9,100	13,100
Annual operating cost per peak-hour seat in 2010	1,300	1,500	2,100
Total cost per peak hour seat in 2010	**17,200**	**10,600**	**15,200**
Cumulated discounted* capital cost per peak-hour seat in 2050	17,200	14,100	16,800
Cumulated discounted* operating cost per peak-hour seat in 2050	23,400	26,400	39,000
Total cumulated discounted* cost per peak hour seat in 2050	**40,600**	**40,600**	**55,800**

Source: CPCS analysis. *Discounted at 5%

The results of the peak period service analysis indicate that in 2010 the BRT is the least costly per seat followed by rail, then ferry. However, by the 2050 planning horizon the relative ranking of the transit options are expected to change. The ferry and BRT options are forecast to have the same "per seat" cost and commuter rail will likely be about 40% higher.

Of course, these results are based on the assumption that each peak hour seat is filled. When we compare the number of peak period seats offered by each transit option, the ferry provides 2,250, BRT 990 and rail 1,980. If the demand required to fill all the peak period seats does not materialize, then the "per seat" costing results would obviously increase. For example, if the peak period demand is 2,000 riders, then the cost per seat for ferry would increase relative to rail – reducing the relative differences in their respective "per seat" costs.

This emphasizes the need for a service that has the flexibility to meet future demand (i.e. the ability to easily add or remove vessels/buses/rail cars) for it to remain cost-effective. This caveat also emphasizes the need to further study the potential demand for the three transit options as this can have a significant impact on the findings of this report.

6 CONCLUDING THOUGHTS

6.1 An overview of the findings

The key findings that flowed from the operational and life-cycle costing evaluation of transit alternatives in the Bedford-Halifax corridor are summarized below:

- Although each has specific strengths and weaknesses, operationally, it appears any of the three alternatives could be implemented in the Bedford-Halifax Corridor. Their respective strengths and weaknesses are discussed further in Section 6.2

- The proposed BRT service option currently has the shortest travel time during peak periods and the lowest initial (2010) capital cost of the three transit options evaluated. However, the proposed BRT will experience increasing peak period travel times that will eventually equal and exceed times expected for the proposed ferry and commuter rail. In order to improve the BRT trip time competitiveness in the short to medium-term, moderate investments in transit priority will be required. Alternatively, significant investments will be required in exclusive rights-of-way if BRT is to serve as a long-term transit solution. The cost of these improvements is not included in the analysis.

- The findings of the BRT operational analysis indicate that, given the continually increasing travel times due to congestion, BRT cannot serve as a long-term solution unless exclusive rights-of-way are established. As physical constraints in the Regional Centre make creation of such a corridor a significant challenge, HRM should consider other longer-term public transit solutions for this corridor such as heavy commuter rail or ferry.

- If a decision is made to implement the BRT service in the short-term due to the reduced travel times and attractive initial (2010) capital cost, Metro Transit would have the opportunity to phase out this particular service model and move to another model such as commuter rail or ferry. If this were the case, the bus fleet serving this particular corridor could be reestablished on another corridor, minimizing the costs to the agency.

- Knowing the travel time limitations of BRT, and assuming there is no investment in dedicated rights-of-way, the proposed rail and ferry service options appear to offer a better long-term transit option for HRM.

- The life-cycle cost analysis results presented in Figure 8 (in the previous Section) estimate the proposed ferry and rail options to have similar long term cost implications based on the operational analysis carried as part of this study.

- If the transit options are assumed to operate during the weekday peak only, and <u>all</u> seats are filled, then the ferry and BRT options are expected to have the same cost per seat and offer a more cost-effective option relative to rail.

- Investment in either the ferry or rail options provides an opportunity to offer a greater market reach than the BRT service to Bedford. The ridership demand implications associated with this greater market reach (i.e. future expansion opportunities to serve other neighbourhoods in the Region) should be considered in future analyses.

6.2 Summary of strengths and weaknesses

In developing the concluding thoughts for this report a summary of the strengths and weaknesses was prepared for the three proposed transit options. These are contained in Table 12.

Table 12: Summary of strengths and weaknesses

	Strengths	Weaknesses
Bus Rapid Transit (BRT)	• Current travel times shorter than other services. • Flexibility to easily add/remove buses to meet ridership demands. • Riders are not required to transfer to other modes.	• Travel times are expected to increase as peak period traffic volumes grow over time. • May require roadway improvements (i.e. queue jump lanes and priority signals) to remain competitive with other services. • Travel time susceptible to traffic congestion or weather related delays, adding to the unreliability of the service.
Ferry	• Assumed schedule accounts for potential delays, increasing reliability. • Approximately 50% higher peak period capacity than the proposed BRT service. • Directly serves the major downtown employment node. • Opportunity for transfers to/from multiple bus routes at Ferry terminal. • Potential for greater market reach than BRT.	• Requires shuttle service to/from park and ride facility in Bedford. • No spare vessel in event maintenance is required. • Metro Transit will be required to build expertise in operations and maintenance for this type of service.
Heavy Commuter Rail	• Assumed schedule accounts for potential delays, increasing reliability. • Flexibility to easily add/remove rail cars to meet ridership demands. • Approximately 100% higher peak period capacity than the proposed BRT service. • Opportunity for transfers to/from multiple bus routes at Mumford terminal. • Potential for greater market reach than BRT (along existing rail corridor).	• Additional rail infrastructure may be required (such as sidings) to minimize commuter rail service disruptions. • Requires shuttle service to/from VIA rail station as well as to/from park and ride facility in Bedford. • A rail maintenance facility may be required.

6.3 Going Forward

The Regional MPS document has defined where long-term growth should be encouraged in the HRM and establishes public transit mode share targets to help serve the mobility needs of the future population. Based on our transportation demand analyses carried out on other studies in the past that deal with regional transportation issues, it is expected that Metro Transit will need to rely on higher order transit service technologies beyond the current BRT concept to meet the targets established in the MPS. This is not to suggest Metro Transit should abandon the Metro Link service in the future, as express bus services are an important component to any transit system offering, particularly where water or rail routes do not already exist.

A decision on the most appropriate public transit service technology in this corridor cannot be made based solely on the analysis carried out for this study. Therefore, it is imperative that an overarching, long term regional/provincial transit planning study be carried out to provide Metro Transit and HRM with additional direction on long term transit investments. Through this type of analysis, questions such as: “is it better to serve the neighbourhoods around the harbour by investing in a ferry service, or is it better to serve communities along the rail corridor by investing in a commuter rail service” can be better addressed.

APPENDIX A

Life-cycle Costing Analysis Study Report

Source: CPCS Transcom Limited

Working Paper

Bedford Transit Alternatives Study

Life-Cycle Cost Analysis

prepared for:

Delphi MRC

prepared by:

CPCS Transcom Limited

CPCS Ref: 09207
November 2, 2010

Table of Contents

1 Introduction

1.1 Background

There is significant growth planned in the Bedford area – namely the major communities of Bedford West and Bedford South. Bedford South is planned for 5,000 housing units and a population of 17,000, while Bedford West is planned to accommodate 18,000 people. These growth centres are in close proximity to Halifax Peninsula as well as Bedford Basin and are therefore well suited to being serviced by public transit. In anticipation of this growth, HRM undertook planning work for a fast ferry transit service between Bedford and downtown Halifax in 2005. Following that work HRM Council approved the fast ferry service in August 2006.

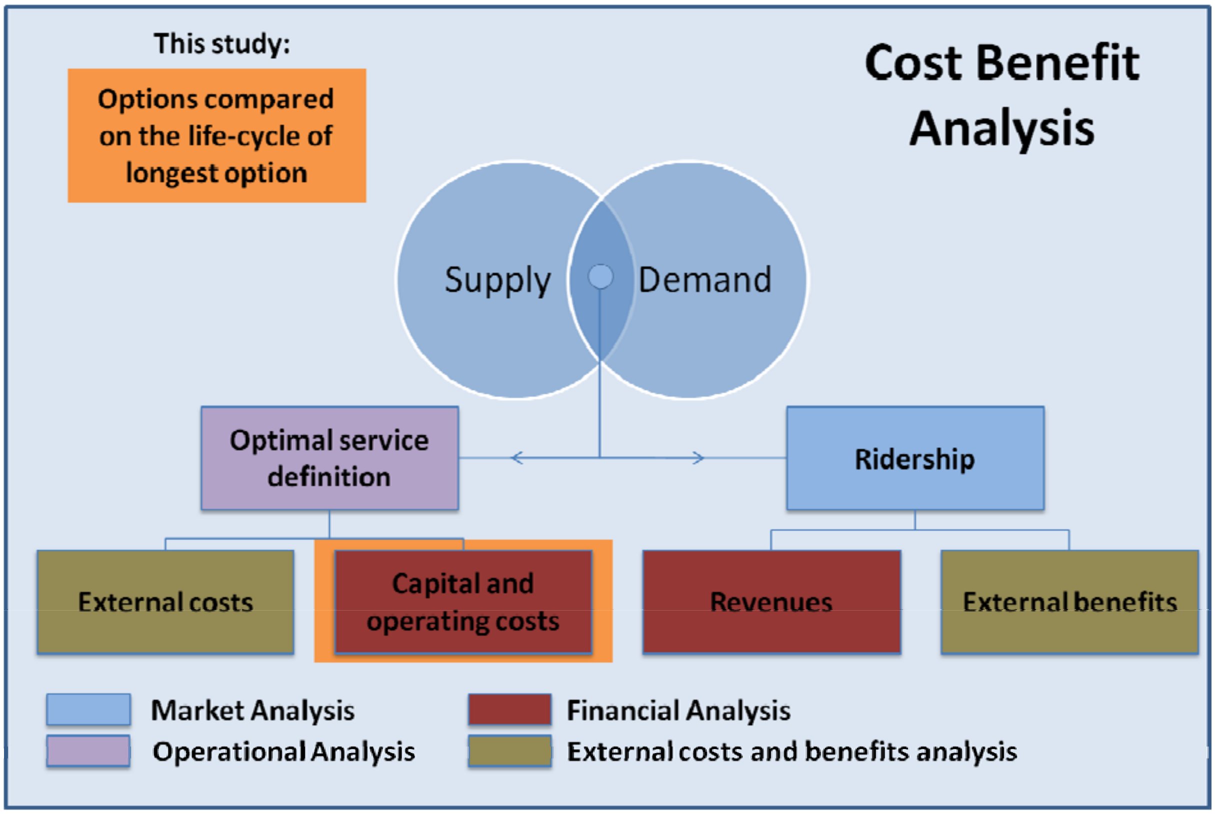
In light of the recent success of Metro Transit's BRT service, MetroLink, further analysis is necessary to determine whether the ferry, the bus rapid transit (BRT) or the heavy rail commuter service is most appropriate to serve these growth centres. The analysis of this section specifically focuses on life-cycle costs analysis – an important components to any planning exercise.

2 Life-Cycle Cost Analysis (LCCA): Background

2.1 Context

Figure 2-1 shows the usual flow used when conducting economic analysis with the objective of comparing different alternatives. In this section, we focus strictly on the direct cost aspect of the analysis. The service definition for each of the three services – including number of buses/cars/ferries needed, their characteristics, the frequency of services, etc. – were provided to CPCS by Metro Transit through Delphi-MRC. These inputs were not verified by CPCS. CPCS assumed there were valid reasons to adopt the stated service definition.

Figure 2-1: Conceptual Flow of Cost Benefit Analysis



Source: CPCS

It is also important to note that this analysis should not be taken alone when making a decision. As is shown in the figure above, the decision-making must not only rely on costs, but also on the projected revenues (especially since the number of clients will likely differ across alternatives because of supply constraints or demand elasticity) and on external costs and benefits (pollution, time-savings/loss due to introduction of service, accidents, etc.). In other words, life-cycle cost analysis (LCCA) can be used to compare two or more alternatives only if all alternatives are designed to achieve identical levels of service (benefits). [1, 2]

[1] In this case, the different services do not offer equivalent service. The bus offers headway of 10 minutes, compared to 20 minutes for rail and the ferry. The bus and ferry offer service all-day long, while the rail offers no off-peak service. The ferry offers week-end service, unlike the other two services.

2.2 Key Assumptions

2.2.1 Inflation

For investments made by the public sector, life-cycle costs are generally estimated without accounting for inflation (i.e., in real or base year dollars). Not only is inflation very hard to predict, but it must in any case be netted out before costs can be compared on a uniform basis (in dollars of the base year for example).

Inflation, on the other hand, is very important in financial analysis. Indeed, it will affect the budgeting of the project, which is generally done in current dollars. In this case, given that the costing analysis is comparative rather than financial, inflation will not be taken into account. The implicit assumption is that costs across all three options will rise in tandem. The cost level of the base year (2010) will be used.

2.2.2 Real Discount Rate

Despite not taking inflation into account, the timing of costs remains important. Indeed, a dollar will be worth less in the future than it is today because we must account for the uncertainty of the future, the expectation that future generations will have higher income than the present generation,[3] and a simple preference for immediate gratification rather than delayed gratification. These effects remain in place even in a world without inflation

Another way to explain discounting is the fact that there is a cost associated with diverting the resources needed for an investment from other productive uses within the economy. This cost is equal to the economic return that could be earned on the invested resources (or the dollars used to buy them) in their next best alternative use. The discount rate reflects the compensation that must be provided to use the resources now rather than later.[4]

As such, a discount rate must be applied to the annual costs, so that costs in the distant future receive less weight than those incurred today. The Canadian guide to cost-benefit analysis suggest a discount rate of 8% if based on the cost-of-funds (CoF) methodology, and 3% if

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Moreover, the passenger capacity of each service is quite different. This issue is somewhat alleviated by the provision of a cost per peak-hour-seat analysis in the last section of this report.

[2] It should also be noted that LCCA best practices call for taking user costs into account. For example, work zones often reduce capacity and can create significant delays to travelers. Best-practice LCCA should reflect these costs. These costs, which are external to the project, are not in our scope of work.

[3] This means that an additional dollar of costs will be easier to bear for future generations, and an additional dollar of income will provide them with fewer benefits.

[4] Assume, for example, that $100 today would buy the same basket of goods and services in 20 years than today (i.e. no inflation) with full certainty. Would a person thus be able to borrow, or willing to lend, money at zero interest rate? The answer is 'no' as this money could instead be invested with positive returns elsewhere. Thus, people must be compensated for making money available even if there is no inflation. If, for example, people require at least $105 after one year as compensation for making $100 available today, then they are equating the value of $105 after one year to $100 in the present. This represents a discount rate of 5 percent. (Source: US DOT's *Economic Analysis Primer)*

based on the social time preference (STP) methodology.[5] In earlier versions of the guide, a discount rate of 10% was suggested. For this study, we will use three different discount rates to provide a range of possible outcomes. The three discount rates used will be 3%, 5% and 10%.[6] The 'base case' discount rate will be assumed to be 5%, roughly in the middle of the range provided by the CoF and STP methodologies. In general, lower discount rates are used for projects funded by the public sector as the public sector's cost of fund is lower, and its time-preference discount rate is also lower than for the private sector.

2.2.3 Asset useful life

In order for all alternatives to be compared on a level playing field, it is important to take into account that there are significant differences in the life expectancy of the different assets. For instance, a terminal, a ferry, a bus and a parking lot do not need to be replaced at the same frequency.

In LCCA, standard practice is to evaluate all alternatives based on a fixed period. The period used is generally that of the asset with the longest expected useful life. In this study, the asset with the longest expected life is the ferry terminal (40 years), so that will be the reference duration of the analysis.

Assets with shorter useful lives are assumed to be replaced entirely at the end of their life cycle. For assets with an expected life that is not a factor of 40, the cost of the last renewal reflects only the portion covered within 40 years. For example, if an asset has a expected life of 16 years, at year 32 it will be renewed for an additional 8 years at half its costs (since its only for half its expected life).

2.2.4 Timing of costs

In LCCA, costs are applied when they are incurred. Costs are not counted based on a depreciation schedule, as would be the case in an accounting-based analysis (accrual basis). Instead, all measures are on a cash basis, albeit in constant rather than current dollars. Indeed, what is of interest is the timing of actual expenses, rather than the financial structure of the project. If a financial model was built, alternative financing possibilities could be assessed, and the most appropriate one established. This is, however, outside the scope of this assessment.

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[5] See "Canadian Cost-Benefit Analysis Guide" (2007), p. 35-36 (http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys-eng.pdf). In Europe, the discount rate is based only on the social rate of time preference, and is estimated at 3.5%.

[6] It is important to get some perspective on the importance of discounting on the value of future production. The most commonly used discount rates used for public projects are between 4 and 12 per cent. For example, at a 4 per cent discount rate, $100 received next year is worth $96.15 today, and $100 received in 50 years is worth only $14.07 today. The following table provides an overview of the effect of discounting over different periods and at different rates:

The Present Value of $100					
Discount Rate	Today	1 Year	10 Years	25 Years	50 Years
4%	100	96.15	67.56	37.51	14.07
8%	100	92.59	46.32	14.60	2.13
12%	100	89.29	32.20	5.88	0.35

2.2.5 Infrastructure and operational costs

Infrastructure and operation costs were developed based on data provided by Metro Transit, Delphi and previous studies. A cursory analysis by CPCS suggests that these estimates are in an appropriate range, but no in-depth analysis of these estimates was completed.

In most cases, the challenge was ensuring that estimated costs for each alternative covered comparable grounds. For example, it would not be appropriate to include marketing costs for one service and not the other, as that would skew the analysis in favour of the alternative with no marketing costs. Comparability of cost categories was thus deemed paramount and significant efforts were expanded with that objective in mind.

3 Costs Estimates

Metro Transit has plans to build a transit terminal in the Bedford West development. This terminal will be used for bus services, and could also provide the park and ride facility (and boarding/alighting platform) necessary to support ferry, rail or BRT service identified in this current study. As a result, this study assumes that no additional costs will be incurred in terms of terminal and or Park'n'Ride facility for the BRT service, and that the rail and ferry service will not need any additional Park'n'Ride infrastructure. This infrastructure is the only component common to all three services.

3.1 Ferry

One of CPCS' roles was to establish, mainly based on past studies, the infrastructure and operational cost of the ferry service. For other services, costs were obtained directly from Metro Transit and/or Delphi. The following section provides the analysis behind the costing of the ferry components.

3.1.1 Infrastructure

Establishing the desired service will entail significant infrastructure and set-up costs. In terms of infrastructure, the following components could be required:

- Terminal construction/upgrades
- A Park'n'Ride facility
- Start-up costs

The cost of the required infrastructure has been estimated using a combination of previous studies and recent consultations with HRM. The cost for the terminal construction and upgrades was estimated by HRM to be around $8.5 million. The cost of the Park'n'Ride facility is assumed to be included in the planned transit terminal to be built by Metro Transit. Other start-up costs, which include printing, computer systems, training and legal advice, were estimated at $250,000.

3.1.2 Vessels

Previous studies have explored a number of potential ferry specifications for this service. The TDV Ferry Cultivation Study explored two vessel sizes, 206 and 350 passengers. Their financial analysis showed much better results with the larger vessels, mainly because smaller vessels appear to provide insufficient capacity/supply to fully serve the market area at peak hours based on a previous stated preference survey.

Mariport, on the other hand, focused on a ferry with 250 passengers. Based on a two-vessel service, Mariport found that the service was unlikely to meet market demand, and recommended a three-vessel service. Based on the recommendations of the steering committee and Mariport's analysis, we adopted a 250 passenger/three-vessel service as the base for our analysis. The key vessel specifications assumed in our analysis are outlined in Figure 3-1.

Based on the findings flowing from a concurrent study on the proposed ferry operations, Metro Transit has established that a 24 knot vessel would be more appropriate. A slower vessel will not have a major impact on the price of the vessel, which could be reduced by roughly 5 percent. Previously, Mariport estimated the cost at $9.0 million, with a range between $7.5 and $12.5 million. They also mentioned that in current shipbuilding market conditions, lower prices could be negotiated. Nonetheless, we use their estimates of $9 million as a base, to which we remove $500,000 to take into account the lesser needs of a slower vessel. Each vessel is thus estimated to cost $8.5 million.

Figure 3-1: Proposed Vessel Specifications

Proposed Vessel	
Capacity	250 passengers
Speed	24 knots
Other characteristics	Low wake design
Estimated Cost	$8.5 million per vessel
Estimated Lifecycle	30 years

Source: CPCS, based on Mariport (2009).

3.1.3 Operating cost

The cost analysis of the proposed service is built on the following information:

- Scheduling and number of trips
- Crew requirements
- Fuel consumption and fuel prices
- Other operational considerations

The following sections discuss each of these elements.

3.1.3.1 Scheduling

We are assuming a three vessel service during the peak period with a total travel time of about one and a half hours, and a two-vessel service during the non-peak period. This means one departure each 20 minutes during the peak period, and one departure each hour during the non-peak period.

During the week, the ferry service would run between 6:00AM and 12:15AM. This means 29 round-trips per day. Saturday service would be hourly between 9:30AM and 11:30PM (15 trips), and Sunday service would operate between 9:30AM and 5:30PM (9 trips).

3.1.3.2 Crew Requirements

A four person crew will be necessary to operate each vessel. The equivalent of five full-time crews should be sufficient to operate the proposed service on the proposed schedule. Two crews will be necessary to run one vessel over the 16 hours daily schedule during the weekdays. One additional crew will be necessary to run each of the other two vessels at peak times (a total of about 30 hours per week). The two peak-time crews, along with another crew, would be sufficient to cover the week-end service. The average compensation (including benefits) is expected to be around $55,000 per year, adding up to $1,100,000 in annual crewing costs. This assumes that no engineer is needed on board.

3.1.3.3 Fuel Consumption and Fuel Prices

Based on an analysis of the service, fuel consumption is estimated at 95 litres per leg, for a total consumption of 190 litres per round-trip. This estimate is in line with the Mariport study which indicates that "estimated fuel consumption per trip would be less than 200 litres".[7] For the purpose of this analysis, a consumption of 190 litres per round-trip is used.

Fuel prices fluctuate significantly. On January 26, 2010, the price of marine fuel (MDO) in Montreal was US$798 per tonne. The exchange rate was around 1.07 CAD/USD, translating into a price of CA$854 per tonne. In Canadian currency, this price was similar to that observed in March 2009 (CA$838.50) and August 2005 (CA$768.00), but much lower than prices at the peak of the cycle (e.g. $1,200 in August 2008). For the purpose of this analysis, a price of $850 will be used.

Based on the schedule outlined above, the proposed service will complete 169 round-trips each week, or 8,788 trips per year. Based on fuel prices of $850 and fuel consumption of 190 litres, the annual fuel cost for the proposed service would be roughly $1.4 million (assuming 10 days without service due to holidays).

3.1.3.4 Maintenance

Engine and hull maintenance, deck and engine stores, lubricants, and other maintenance expenses were estimated using TDV's study. TDV estimated maintenance costs to be $470,000 per year for two 206 passenger vessels (28 knots) and $680,000 per year for two 350 passenger vessels (35 knots). The capital cost of each vessel, however, was estimated at only $5.5 million and $8 million, much lower than the $9 million estimated by Mariport for the current vessel under analysis.

It is assumed that the per-vessel maintenance expense would be an average of those estimated for the two vessels. In other words, maintenance expenses for each vessel would be around $287,500 per vessel, or a total of $862,500 per year.

3.1.3.5 Shore Side Management

Based on TDV's study, the following components must be considered as costs for shore-side management:

- Printing, Markets, Promotion ($100,000 per year)
- Parking snow removal for park and ride ($100,000 per year)
- Terminal maintenance ($195,000)
    - Terminal & ship cleaning ($50,000 per year)

[7] It should be noted, however, that an analysis of the financial model used by Mariport suggests fuel consumption of only 134 litres per round-trip, an estimate which is much too low given the service characteristics. Mariport estimated fuel costs to be $860,000 at $838.50/litres for an average of 21 round-trips/day ($860,000 / $838.50 / (21*365) = 134 litres).

    - Utilities ($40,000 per year)
    - Insurance ($105,000 per year)
- Ticketing Staff ($110,000 per year)

Adding up all these components, the shore-side management annual costs are estimated at $555,000. These costs are very similar to those that will be incurred by the other alternatives.

3.1.3.6 Shuttle Operations

A shuttle service between the park'n'ride facility and the Mill Cove terminal will be operated alongside the ferry. In terms of operational costs, TDV estimated the annual costs related to the park'n'ride shuttle at $616,000 per year (including parking management) based on an all-day service. On the other hand, Metro Transit estimated the annual cost at $126,900 per year for a peak only service, which will be the estimate used in this study. The procurement cost for two articulated buses was estimated at $1,600,000 ($800,000 per bus) by Metro Transit.

3.1.4 Asset Life

In terms of assets, the ferry services will make use of the following: (1) the ferry terminal, (2) the vessels, (3) and the shuttle buses.

The estimated useful life of the ferry terminal was estimated at 40 years. This was based on the service life used by BC ferries (Figure 3-2), and was corroborated by CPCS marine experts. In fact, 50 years is the most often used design life for port structures. However, the proposed terminal is a much smaller structure, justifying a slightly shorter useful life. The University of Regina "Policies and Procedures Manual" also uses 40 years for all permanent structures.[8]

Figure 3-2: Asset class and estimated useful life, BC Ferries Financial Statements, 2008

Asset class	Estimated useful life
Ship hulls	40 years
Ship propulsion and utility systems	20 to 30 years
Marine structures	20 to 40 years
Buildings	20 to 40 years
Equipment and other	3 to 20 years

Source: BC Ferries, available online at:
http://www.bcferries.com/files/AboutBCF/investor/quarters_new/0708_Q4_Consolidated_Financial_Statements.pdf

The useful life of the ferry vessels was conservatively estimated at 30 years, also based on BC Ferries estimates. BC Ferries uses different asset lives for ships' hulls and as well as propulsion and utility systems. We chose to use the upper-bound asset life of the propulsion system in order to strike a balance between the two components (Figure 3-2). BC Ferries' vessels also

[8] See http://www.uregina.ca/presoff/vpadmin/policymanual/fs/307005.html

tend to be much larger, while new ferries are generally smaller and have not yet proven their durability.

The shuttle buses' useful life was estimated at 16 years, based on estimates by the Canadian Urban Transit Association (CUTA) obtained by Delphi.

3.1.5 Summary of costs and asset life

Two types of costs have been reviewed – capital costs which occur at the beginning of the project, and operational costs which will depend on whether the service is maintained and on the frequency of the service. Based on the assumptions discussed in previous sections, Figure 3-3 summarizes the capital and operational costs associated with the ferry service.

Figure 3-3: Estimated Costs Associated with the Ferry Service

Capital Costs		Service Life
Terminal construction/upgrades	$8,500,000	40 years
Vessel procurement (3 vessels)	$25,500,000	30 years
Shuttle procurement (2 buses)	$1,600,000	16 years
Other start-up costs	$250,000	N/A
Total	**$35,850,000**	N/A
Operational Costs (annually)		**Service Life**
Crew costs	$1,100,000	N/A
Fuel	$1,393,900	N/A
Vessel Maintenance	$862,500	N/A
Shore-side management services	$555,000	N/A
Shuttle Service	$126,900	N/A
Total	**$4,038,300**	N/A

Source: CPCS analysis.

3.2 Bus Rapid Transit (BRT)

Unlike the ferry analysis, the infrastructure and operational cost of the BRT service was not performed by CPCS, but rather obtained directly from Metro Transit and/or Delphi. The following section provides a summary of the relevant information concerning the BRT service for this LCCA.

3.2.1 Infrastructure

Establishing the desired BRT service will entail some infrastructure and set-up costs. In terms of infrastructure, the following components will be required:

- Terminal construction/upgrades in Bedford/Halifax
- A Park'n'Ride facility
- Start-up costs

There is no cost for the terminal construction and parking, since these are already part of the planned transit terminal to be built in the Bedford West development by Metro Transit. Other start-up costs are assumed to be identical for all three services, and were estimated at $250,000. They include printing, computer systems, training and legal advice.

3.2.2 Other fixed costs

Delphi estimated that 11 new articulated buses would be needed to provide the level of service required. The cost of each of these buses was estimated at $800,000 by using Metro Transit information. The total cost of the 11 buses was estimated at $8.8 million.

3.2.3 Operational costs

In terms of operational costs, Metro Transit provided an estimate of hourly costs which included labour, maintenance and fuel ($77/hour). Little detail was given on how this variable was constructed. Nonetheless, this estimate appears to be well in line with those provided for other services.

The sample schedule provided by Delphi suggests that for each day of operation, there will be roughly 64 hours of service. Our estimate is that about 9 drivers will be necessary to provide this level of service. For each of these drivers, we estimate an additional 40 minutes to position the bus in the morning and 40 minutes in the evening. As a result, each day of operation represents 76 hours.

Using Metro Transit estimates of maintenance and operational costs, we find that each day of service represents a cost of $5,852. Service will be offered only on weekdays and no holiday service is planned. On an annual basis, the operational cost is thus estimated at $1,468,900.

In addition to operational costs, terminal management costs will have to be incurred. Metro Transit estimates terminal management services at $140,000 per year. In addition, there will be costs for printing, marketing and promotion ($100,000 per year) and snow removal for park and ride ($100,000 per year). The total operational costs for these other activities are thus estimated at $340,000 per year.

3.2.4 Asset Life

In terms of assets, the BRT will make use only of the articulated buses. As was noted earlier, the bus's useful life was estimated at 16 years, based on estimates by the Canadian Urban Transit Association (CUTA) obtained by Delphi.

3.2.5 Summary of costs and asset life

Two types of costs have been reviewed – capital costs which occur at the beginning of the project, and operational costs which will depend on the frequency of the service. Based on the assumptions discussed in previous sections, Figure 3-4 summarizes the fixed and variables costs associated with the BRT service.

Figure 3-4: Estimated Costs Associated with the BRT Service

Capital Costs		Service Life
Articulated buses (11 buses)	$8,800,000	16 years
Other start-up costs	$250,000	N/A
Total	**$9,050,000**	N/A
Operational Costs (annually)		**Service Life**
Bus maintenance, fuel & operator (11 buses)	$1,469,000	N/A
Terminal management and other services	$340,000	N/A

Total	**$1,809,000**	N/A

Source: CPCS analysis.

3.3 Commuter Rail

The following section provides a summary of the relevant information concerning the commuter rail service for this LCCA. Once again, it must be noted that the infrastructure and operational costs of the commuter rail service were not estimated by CPCS, but rather based on the findings of a review carried out by Metro Transit. CPCS did, however, review the information provided and made adjustments based on relevant and current industry data, where it was deemed appropriate. These adjustments made are noted in the text.

3.3.1 Infrastructure

Establishing the desired heavy commuter rail service will entail significant infrastructure and set-up costs. In terms of infrastructure, the following components will be required:

- CN track infrastructure
- Rail stations
- Start-up costs

Over the last 15 years, CN's track infrastructure and operations have changed significantly in the Halifax area. The double track that was controlled by an OCS (occupancy control system) has been replaced by single track; which from Fairview to Windsor Junction (and beyond) is controlled with CTC (Central Traffic Control) and from Rockingham to Halifax is locally controlled by the traffic coordinator at Rockingham. Much of the double track was removed due to washouts caused by Hurricane Juan in September, 2003. At this time, the roadbed was eroded into the sea and the single track was positioned (somewhat) in the centre of the remaining roadbed. Over that period, passenger service has remained the same (6 trains in each direction per week), and freight traffic levels have generally declined. On a typical day, one train departs and one arrives in Rockingham from points west. In addition, CN operates local switchers daily between Halifax Ocean Terminal and Rockingham Yard and less frequently between Rockingham Yard and Dartmouth (via Windsor Junction). In recent years, CN has abandoned service on the remaining portions of the Chester spur.

The implications of all these changes on operating and capital costs are not exactly clear. Although the capacity of the rail network between Windsor Junction and Halifax is about the same now as it was in 1996, and traffic levels are lower, a passing siding will be required between Windsor Junction and Rockingham and another possibly between Fairview and Halifax. Fortunately, the roadbed exists in these locations. In 1995, CN Rail was privatized. Since that time, they have been less willing to cooperate with municipalities on matters such as commuter rail on the network. Yet, CN was involved in fruitful discussions with stakeholders in Halifax for a potential commuter rail service up to and including 2003. The current situation, however, suggests that costs for access rights will be much higher than discussed in 1995.

According to Metro Transit, the infrastructure costs would be twice as high as they were in 1996, at $13.2 million. Although more infrastructure will be required now than in 1995, CPCS considers that estimate to be too high, largely on account of fairly stable costs for track components and labour, and because the costs seem to be high in the 1995 report. We recommend instead using a 50 percent increase, which represents inflation of 3 percent per year.[9] A cost of $9.9 million is thus deemed more reasonable as an estimate of required CN track infrastructure. Since only 62.5 percent of the initial alignment is now considered (15km instead of 24km), the cost of CN track infrastructure for this project is estimated at $6.2 million.

According the 1996 study, the following stations would be used along the way between Bedford and downtown Halifax: Mill Cove, Rockingham, Mumford, Via Rail station. Proponents of rail service have also pointed out that stations at the foot of South St. and at the end of Robie St. could attract student riders.

According to Metro Transit, a station would cost around $400,000. This estimate was deemed reasonable and was taken at face value. It was assumed that three stations would have to be built (in addition to the existing Via station) to provide the required level of service. A fourth station, at Dalhousie University, would attract a significant number of students, but would entail a much larger capital investment. It was left out of the analysis.

In line with the analysis for the BRT and ferry, other start-up costs are assumed to be identical for all three services, and were estimated at $250,000. They include printing, computer systems, training and legal advice.

3.3.2 Rolling stock

The proposed rolling stock in 1995 were Budd RDC cars. Even today, these cars should be at the top of the list of rolling stock to be considered. Since 1995, there has been much interest and demand for remanufactured Budd cars. Although still available now, at some point these cars may no longer be an option as the cars are no longer manufactured and demand is strong for remanufactured used cars.

In terms of rolling stock, Metro Transit suggested that 5 powered cars and 2 unpowered cars be provided for a service with two 3-car trains, with one spare car. Our analysis is based on this suggestion.

The price of powered cars was estimated at $2.4 million by Metro Transit, and the price of unpowered cars was estimated at $1.5 million. These estimates appear reasonable. As a result, the total cost of rolling stock was assumed to be $15.0 million.

3.3.3 Operational costs

Operational costs were based on the costs from the 1996 study. The cost per car-kilometre in 1996 was estimated at $10.57 per car-km, including fuel and oils, labour and supervision for operations and maintenance, and access fee (to CN). CPCS believes that the cost per car-kilometre would be around $13.68 in 2010, based on a doubling of fuel prices and an increase in other costs in line with inflation. These operational costs would also be escalated by 15 percent to take into account the additional labour costs associated with short shifts.

Based on the sample schedule prepared based on Metro Transit's operational review, which includes 6 trips in the morning and 6 in the evening (equivalent to 10 round-trips, with 3 cars

[9] This compares to an actual inflation of 30% over the period (Source: Bank of Canada), or an average of about 2%.

per train), and a one-way trip of 15 kilometres, the operational cost of the commuter rail was estimated at $3,553,900 per year.[10]

In addition to operational costs, station management costs will have to be incurred. Metro Transit estimated terminal management services at $140,000 per year, in line with the BRT and ferry terminal. In addition, there will be costs for printing, marketing and promotion ($100,000 per year) and snow removal for the park and ride ($100,000 per year). The total operational costs for these other activities are thus estimated at $340,000 per year. Finally, ticketing staff costs are estimated at $110,000 per year, identical to costs for the ferry. This is explained by shorter service hours, which are offset by the need to service 4 rather than only 2 stations. Overall, management costs are thus estimated at $440,000 per year.

3.3.4 Shuttle Operations

The shuttle service for the rail option assumes one downtown and one Bedford service, each with two articulated buses. For consistency, the price for each shuttle service is assumed to be identical to that of the ferry, at $126,900 per year for peak hour service only. The procurement costs for 4 articulated buses was estimated at $3.2 million ($800,000 per articulated bus).

3.3.5 Asset Life

In terms of assets, the commuter rail service will make use of the following: (1) the stations, (2) the track infrastructure, (3) the rolling stock, and (4) the shuttle buses.

Track infrastructure service life can range significantly depending on traffic levels and maintenance. For comparability purposes with previous assumptions, the service life of fixed infrastructure, including stations and track infrastructure, was assumed to be 40 years. The rolling stock, if bought new, would have a service life of about 30 years. Remanufactured cars should have a service life of about 20 years, according to information obtained from Industrial Rail Services Inc (IRSI) which, among other things, remanufactures rail cars.

As noted earlier, the bus's useful life was estimated at 16 years, based on estimates by the Canadian Urban Transit Association (CUTA) obtained by Delphi.

3.3.6 Summary of costs and asset life

Two types of costs have been reviewed – capital costs which occur at the beginning of the project, and operational costs which will depend on whether the service is maintained and on the frequency of the service. Based on the assumptions discussed in previous sections, Figure 3-5 summarizes the capital and operational costs associated with the commuter rail service.

Figure 3-5: Estimated Costs Associated with the commuter rail service

Fixed Costs		Service Life
CN track infrastructure	$6,200,000	40 years
3 Stations	$1,200,000	40 years
Remanuf. rolling stock (5 powered, 2 unpowered)	$15,000,000	20 years

[10] The estimate is based on the following calculation : 10 roundtrips * 30 km per roundtrip * 251 weekday per year * 3 cars per train * ($13.68 * 1.15 for short shifts).

Shuttle procurement (4 buses)	$3,200,000	16 years
Other start-up costs	$250,000	N/A
Total	**$25,850,000**	N/A
Variable Costs (annually)		**Service Life**
Train operations and maintenance	$3,553,900	N/A
Station management and other services	$440,000	N/A
Shuttle Service (x2)	$253,800	N/A
Total	**$4,247,700**	N/A

Source: CPCS analysis.

4 Results of LCCA

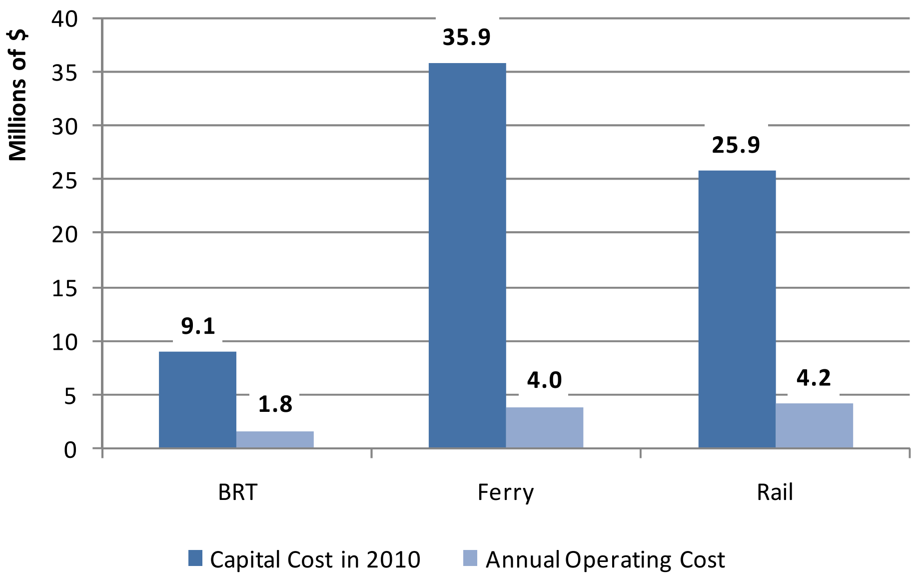
Using the estimates presented in Chapter 3, and the methodology outlined in Chapter 2, we can compare the different options based on their life cycle costs. The caveats mentioned in Chapter 2 remain.

4.1 Non-Discounted Results

We can get a good idea of the key findings by simply looking at the capital expense in the first year, as well as the operational cost level which will prevail over the period under analysis.

Figure 4-1 shows that the BRT service is by far the least expensive in terms of capital outlay in the initial year, and also has lower annual operating costs. The ferry has higher capital cost, but slightly lower annual operating costs than the rail.

Figure 4-1: Initial Capital and Operational Costs - BRT, Ferry and Commuter Rail Services

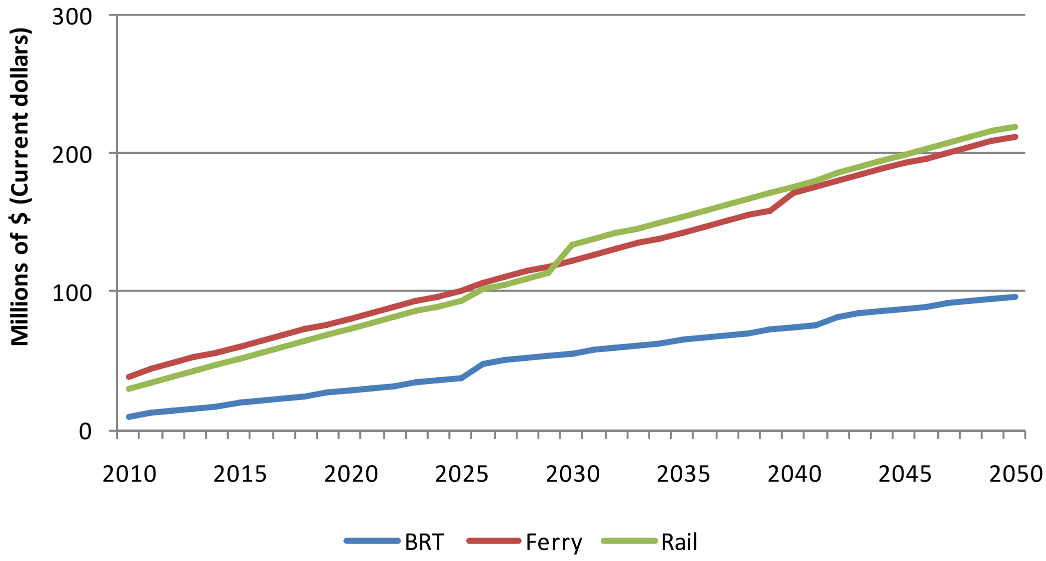


Source: CPCS analysis

Two factors could swing the analysis in a different direction: the life cycle approach, which means more or less cost over the next 40 years than is shown in initial capital outlay, and the discount rate, which puts more or less weight on future expenses.

The effect of the life cycle component assets is shown in Figure 4-2. This figure shows the cumulative non-discounted expenses for each service. The BRT service, which has both lower capital and operating costs, remains much more affordable. The lower initial capital outlay of the rail is offset by its slightly higher operating costs, and the lower asset life of the rolling stock compared to the ferry vessels.

Figure 4-2: Undiscounted Cumulative Life-Cycle Costs - BRT, Ferry and Commuter Rail Services

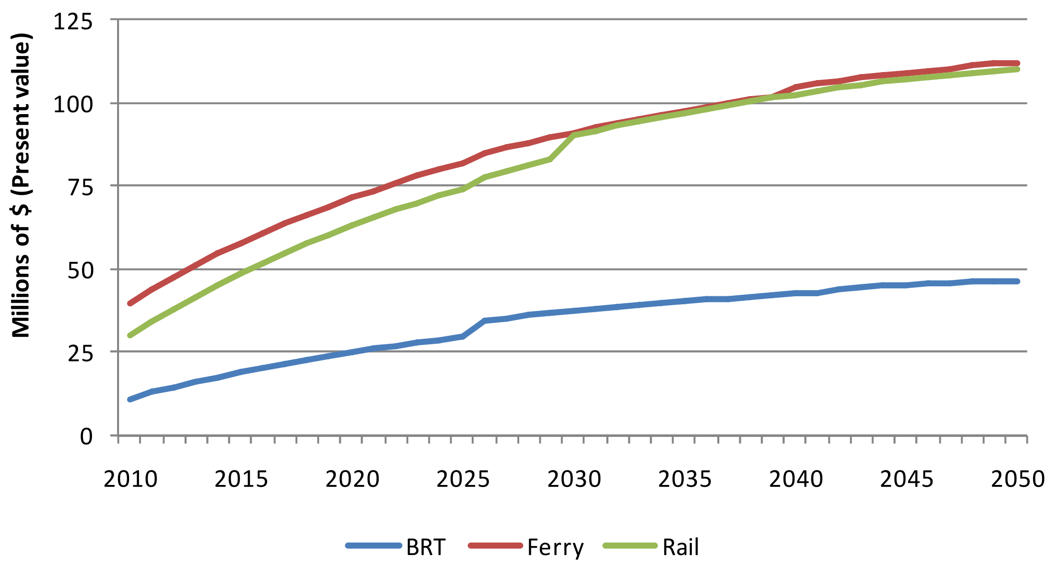


Source: CPCS analysis

4.2 Discounted Results

However, when the discount rate is taken into effect, the ferry advantage largely disappears. Both ferry and rail services have very similar costs in the long term. Figure 4-3 shows the cumulative costs in present value cost at a 5 percent discount rate.[11]

Figure 4-3: Discounted (5%) Cumulative Life-Cycle Costs - BRT, Ferry and Commuter Rail Services

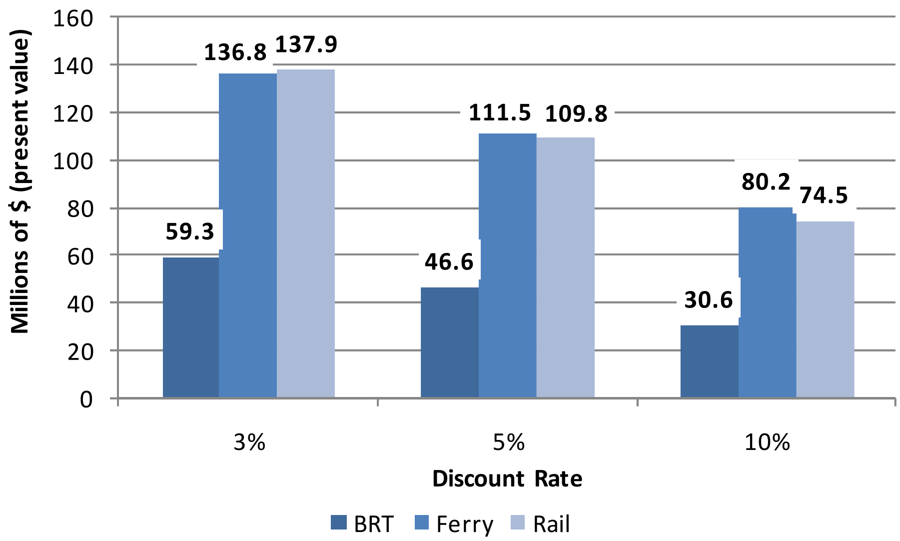


Source: CPCS analysis

[11] See section 2.2.2 for a discussion of the choice of discount rate.

Finally, Figure 4-4 shows the present value cost of all three services at three different discount rates. Once again, the BRT is cheaper on a life-cycle basis than any of the other two services. The ferry is cheaper at low discount rates, while the rail option is cheaper when higher discount rates are used. A discussion of the discount rates is included in section 2.2.2.

Figure 4-4: Present Value Costs - BRT, Ferry and Commuter Rail Services, at different discount rates



Source: CPCS analysis

4.3 Costs per peak period seat capacity

As was noted earlier, costs are only one side of the equation. The "service level" is also important to take into account when it varies across services. While it is inherently a supply-side concept, it can capture some of the demand-side factors, in particular when demand is forecasted to be very strong as is the case in Bedford.

A crude proxy for the level of service for transit options is the number of seats (or people potentially served) by the service during the peak hour period (Figure 4-5). It is crude because it fails to take into account off-peak service, week-end service, and external impact on traffic, the environment, job creation and other intangibles. Nonetheless, it provides a good first approximation, and showcases the importance of taking more than costs into account in decision-making.

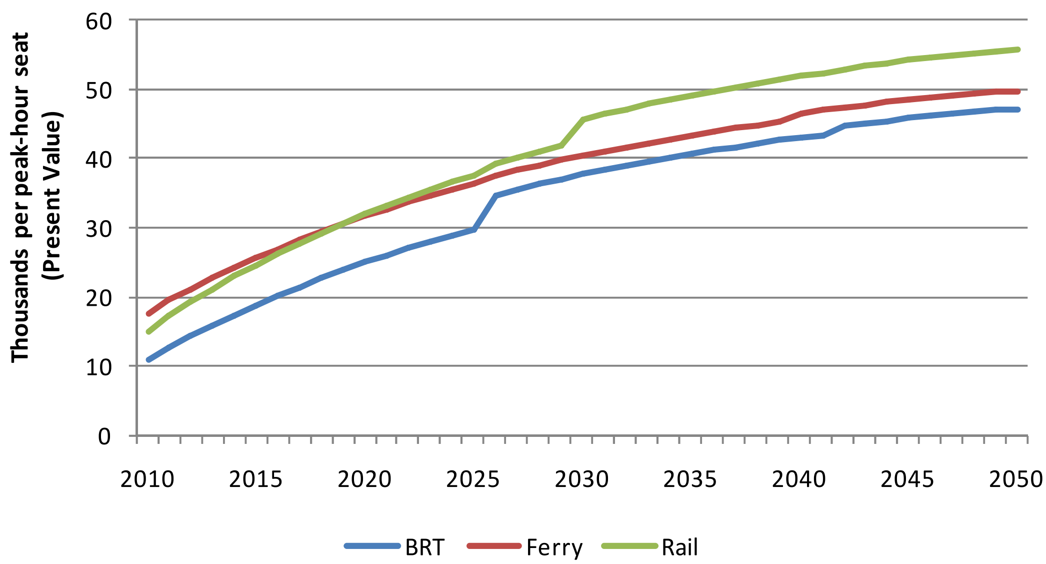
Figure 4-5: Expected Service Seat Capacity - Weekday Peak Period

	Ferry	BRT	Rail
No. of peak period departures	9	18	6
Headway (minutes)	20	10	30
Seat capacity per departure	250	55	330
Total peak period seat capacity	**2250**	**990**	**1980**

Source: CPCS analysis, based on the sample schedules developed through the operational review

Using service seat capacity at peak period as a denominator changes the cost level for each service (Figure 4-6). The cumulated present value of costs per peak period seat is similar for all three services. On this basis, the difference between BRT and ferry services narrows down considerably, while the rail option has a cost per seat about 15% higher than the BRT.

Figure 4-6: Discounted (5%) Cumulative Life-Cycle Costs per Daily Peak Hour Seat Capacity - BRT, Ferry and Commuter Rail Services



Some of the key results from this analysis are also summarised in Figure 4-7.

Figure 4-7: Indicators of cost per peak period seat capacity, in 2010 dollars

	Ferry	BRT	Rail
Capital cost per peak period seat in 2010	15,900	9,100	13,100
Annual operating cost per peak period seat in 2010	1,800	1,800	2,100
Total cost per peak period **seat in 2010**	**17,700**	**11,000**	**15,200**
Cumulated discounted* capital cost per peak period seat in 2050	17,200	14,100	16,800
Cumulated discounted* operating cost per peak period seat in 2050	32,600	33,200	39,000
Total cumulated discounted* cost per peak period seat in 2050	**49,800**	**47,300**	**55,800**

Source: CPCS analysis. *Discounted at 5%

4.4 Effect of off-peak service

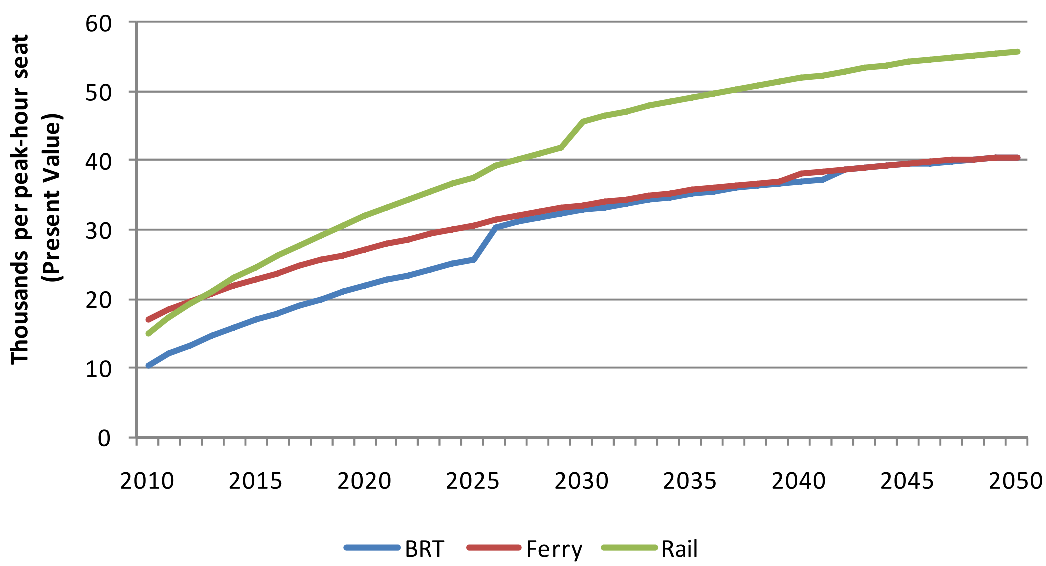
In the previous analysis, off-peak service was not taken into account. This is quite important, especially for the ferry service for which off-peak service may make most sense given the high capital costs. Indeed, obtaining a higher asset utilization rate is particularly important for capital intensive services. The following two sections provide alternative ways to take into account off-peak services offered by the ferry.

4.4.1 Removing ferry off-peak service

First, we verified whether removing off-peak and weekend service offered by the ferry had a major impact on the results. For this, we simply removed all week-end service and most off-peak service for the ferry, keeping only 15 round-trips a day. We also removed the off-peak bus services, reducing the hours of service from 76 to 57 hours per day (and associated operating cost per hour).[12]

In practice, this reduced the number of crew required for the ferry (from 5 to 3) and massively reduced the fuel cost (cutting it in half). All other costs remained identical. These changes reduced the ferry service cost per peak period seat, bringing them to the level of the BRT (Figure 4-8). This shows that the definition of the service can lead to important differences in costs, and should not be disregarded when assessing the value proposition of each of the three options.

Figure 4-8: Discounted (5%) Cumulative Life-Cycle Costs per Peak Service Seat Capacity - Peak-Period Only BRT, Ferry, and Commuter Rail Services



Some of the key results from this analysis are also summarised in Figure 4-9.

Figure 4-9: Indicators of cost per peak-hour seat capacity, excluding off-peak ferry and BRT operational costs, in 2010 dollars

	Ferry	BRT	Rail
Capital cost per peak-hour seat in 2010	15,900	9,100	13,100
Annual operating cost per peak-hour seat in 2010	1,300	1,500	2,100
Total cost per peak hour seat in 2010	**17,200**	**10,600**	**15,200**
Cumulated discounted* capital cost per peak-hour seat in 2050	17,200	14,100	16,800

[12] The rail option does not include any off-peak service.

Cumulated discounted* operating cost per peak-hour seat in 2050	23,400	26,400	39,000
Total cumulated discounted* cost per peak hour seat in 2050	**40,600**	**40,600**	**55,800**

Source: CPCS analysis. *Discounted at 5%

4.4.2 Using peak and off-peak seat capacity as a measurement basis

As another alternative metric, we estimated the service cost based on average daily seats capacity, rather than only peak period seats capacity. Of course, for this metric both peak and off-peak costs for the ferry and BRT were included. These estimates are trickier, because they suggest that all off-peak seats will provide a valuable service (no empty seats), which is likely not the case. Figure 4-10 provides the average daily number of seats for each of the three services (only includes seats for one-way service, i.e. excludes deadhead service).

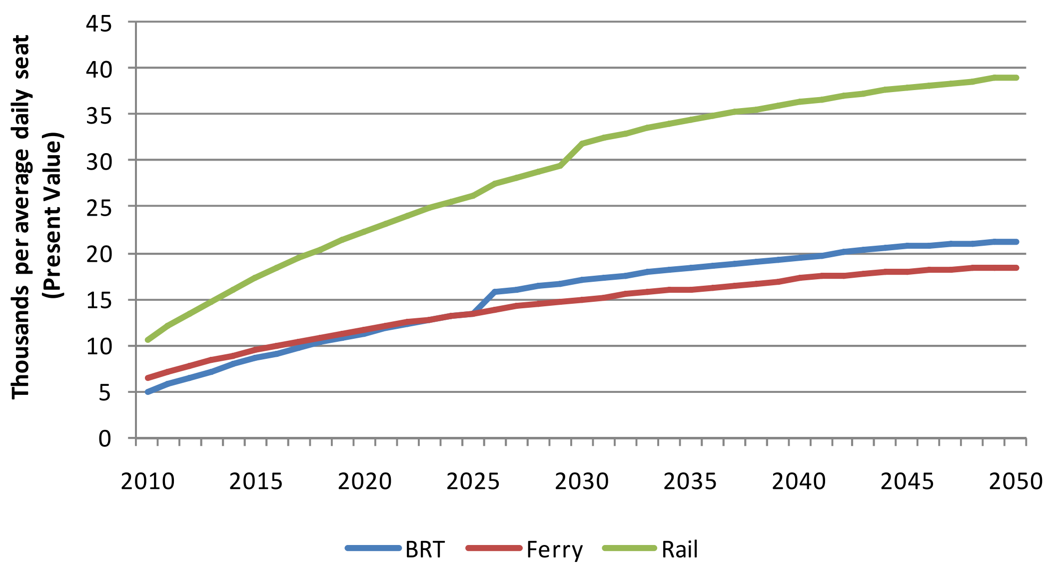
Figure 4-10: Average Daily Seat Capacity – Peak and Off-Peak Periods

	Ferry	BRT	Rail
No. of weekly trips with passengers* (A)	169	280	60
Seat capacity per departure (B)	250	55	330
Weekly seat capacity (C = A*B)	42,250	15,400	19,800
Average daily seat capacity (D = C / 7)	**6,036**	**2,200**	**2,829**

Source: CPCS analysis, based on the sample schedules developed through the operational review
* The number of seats assumed that seats are provided on a one-way basis only (no seats on deadhead trip)

Of course, differences in capacity have significant impact on the estimated cost per seat. Indeed, under this scenario, the ferry performs best, with rail still offering the worst value proposition of the three services (Figure 4-11). Once again, these estimates serve primarily to show the importance of having comparable services in order for a strict cost comparison to be a strong decision-making tool.

Figure 4-11: Discounted (5%) Cumulative Life-Cycle Costs per Average Daily Service Seat Capacity - BRT, Ferry and Commuter Rail Services



Some of the key results from this analysis are also summarised in Figure 4-12.

Figure 4-12: Indicators of cost per average daily seat capacity, in 2010 dollars

	Ferry	BRT	Rail
Capital cost per average daily seat in 2010	5,900	4,100	9,100
Annual operating cost per average daily seat in 2010	700	800	1,500
Total cost per average daily seat in 2010	**6,600**	**4,900**	**10,600**
Cumulated discounted* capital cost per average daily seat in 2050	6,400	6,400	11,800
Cumulated discounted* operating cost per average daily seat in 2050	12,100	14,900	27,300
Total cumulated discounted* cost per average daily seat in 2050	**18,600**	**21,300**	**39,000**

Source: CPCS analysis. *Discounted at 5%