



EXPANSION OF HALIFAX TRANSIT HARBOUR FERRY SERVICES

COVER NOTE

The attached study, “*Expansion of Halifax Transit Harbour Ferry Services: Technical Feasibility Review*”, was prepared by consultant group WSP Canada Inc. for Halifax Regional Municipality (HRM). It forms part of the research that supported the development of the [Rapid Transit Strategy](#) (RTS), HRM’s plan to create Bus Rapid Transit and ferry service, which was adopted by Regional Council in May 2020. The WSP report examines the feasibility of new ferry service and recommends options for its implementation.

The study serves as the basis for many of the recommendations within the RTS for the expanded ferry service, including on vessel type and passenger capacity, terminal locations, travel times, and high-level cost estimates. The recommendations made in the RTS diverge from the study in some key areas, most notably including the following:

- *Terminals*: the RTS uses the study’s integrated and standalone terminal scenarios as baselines, and includes engineering costs, project management and taxes on top of the study’s cost estimates.
- *Service levels*: while the study assumes peak-only service, the RTS assumes a 30- or 60-minute frequency midday service as well.
- *Spare ferries*: as is standard for Halifax Transit’s ferry service, the RTS includes costs for spare ferries to cover for vessels undergoing maintenance.
- *Ridership*: the study estimates both eventual demand and effective service capacity at a high level; the RTS does not directly use these estimates but makes more conservative assumptions for the purposes of revenue projections.
- *Fares*: the study assumes premium fares will be charged for the Mill Cove and Larry Uteck routes; the RTS assumes a standard fare for the purposes of revenue projections. Staff will explore whether to recommend premium fares during ferry implementation.
- *Cost recovery*: Since the RTS makes more conservative ridership and fare assumptions and recommends more service, its cost recovery estimates are more conservative than those of the study.

As the WSP report and RTS acknowledge, further study and work is required to determine the best course for implementing expanded ferry service. HRM will pursue studies to calibrate service levels on each of the routes through ridership and market analysis, to determine how travel times may be impacted in periods of low visibility, and to specify requirements for vessels which can operate safely at higher speeds. The Municipality will also begin to consider options for terminal designs, including complete rebuild of Halifax Ferry Terminal. The study offers one option for a reconfiguration of the Halifax Ferry Terminal to accommodate one additional route, which Halifax Transit will study further.



HALIFAX REGIONAL MUNICIPALITY

EXPANSION OF HALIFAX TRANSIT HARBOUR FERRY SERVICES

TECHNICAL FEASIBILITY REVIEW

FINAL REPORT



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TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
1 INTRODUCTION.....	1
1.1 Background.....	1
1.2 Study Objectives	1
1.3 Study Area.....	1
1.4 Timeline of Events.....	2
1.5 Basis for Assessment.....	5
2 JURISDICTIONAL SCAN	7
2.1 Introduction.....	7
2.2 Bermuda Sea Express	8
2.3 Boston MBTA.....	10
2.4 New York NYC Ferry	15
2.5 San Francisco WETA	18
2.6 Seattle Kitsap Transit.....	22
2.7 King County Water Taxi.....	25
2.8 Vancouver SeaBus	27
2.9 Auckland, New Zealand	29
2.10 Conclusions and Takeaways	36
3 EXPANDING THE FERRY NETWORK.....	39
3.1 Recommended Vessel Features	39
3.2 Recommended Terminal Features.....	43
3.3 Potential Ferry Destinations.....	46
3.4 Potential Ferry Routes	48
3.5 Ridership Potential.....	55
3.6 Comparison of Terminal Locations	57

4	HALIFAX FERRY TERMINAL	63
4.1	Current Capacity	63
4.2	Accommodating More Ferries in Downtown Halifax ..	63
5	THE PREFERRED OPPORTUNITY	67
5.1	Service Components.....	67
5.2	Service Evaluation	81
5.3	Financial Analysis	84
6	SUMMARY & NEXT STEPS	91
6.1	Summary and Recommendations	91
6.2	Other Project Considerations	92
6.3	Risks	94
6.4	Next Steps	95

APPENDICES

A	STAKEHOLDER INTERVIEW SUMMARIES
B	EXISTING FERRY TERMINAL TIME MEASUREMENTS
C	FERRY RIDERSHIP MODELING AND ANALYSIS
D	TRIP IMPEDANCE COMPARISON BY MODE

EXECUTIVE SUMMARY

Overview

The Halifax–Dartmouth Ferry is the oldest saltwater ferry in North America, and the second oldest in the world (after the Mersey Ferry linking Liverpool and Birkenhead). The first ferry charter was issued in 1752 and cross-harbour ferries have played a part in Halifax Regional Municipality's (HRM's) growth ever since. Today, ferries carry 1.77 million passengers per year across the harbour.

Regional growth has seen development on both sides of the harbour and the circumference of the Bedford Basin. The influence of traffic growth and congestion on commuting times has also become more evident. Given the success of, and the affection for, the current two cross-harbour ferry routes, it is only natural that an interest in expanding the ferry network to new destinations would arise.

To provide effective service to longer-distance destinations, a new type of higher-speed vessel is required and how this integrates into Halifax Harbour and Bedford Basin will need to be explored.

The objective of this study is to develop a better understanding of what opportunities exist to service areas around Halifax Harbour and Bedford Basin with new ferry routes as well as the vessel, terminal and marine operating characteristics that would make this a safe and successful service. Ultimately, the study will determine how a ferry component might tie into the Region's aggressive plan to develop a rapid transit network and increase the transit mode share.



The Whaling City Express conducted several demonstration runs between Mill Cove and Halifax in October, 2005 (see section 1.4.3)

Urban ferries are used successfully in many cities

We have based our recommendations and assessment of a ferry operating plan on background information we have gathered from other jurisdictions operating urban ferry services. As of 2019, there were about 1,800 fast ferries operated by 600 agencies around the world. We focused our information-gathering on seven cities with services that would be similar to HRM's:

- Bermuda – like HRM's, fully government owned and operated
- Boston – similar climate conditions with several cross-harbour routes
- New York – high volume services and an ongoing expanding network
- San Francisco – longer suburban routes with reliance on park-and-ride at terminals
- Vancouver – like HRM's, currently a short cross-harbour route with thoughts of expansion
- Seattle – two private-sector operators with an innovative funding model
- Auckland – extensive network in a harbour the scale of HRM's

Choosing the right locations for new services

We examined potential routes from the Halifax Ferry Terminal to five destinations around Bedford Basin:

- Shannon Park
- Wright's Cove
- Birch Cove
- Larry Uteck Drive
- Mill Cove

A cross-basin connection from Larry Uteck or Birch Cove to Wright's Cove was also considered.

An evaluation matrix that considered sixteen different criteria associated with marine operations, managing and attracting passengers, and site characteristics was applied to the potential terminal sites. This evaluation led to a focus on Mill Cove as the primary site for a new ferry route with consideration for additional service to Larry Uteck and Shannon Park.



Potential for transit-oriented development at the ferry sites

A key consideration in selecting the preferred sites was the potential for transit-oriented development. Development processes have been initiated for both the Shannon Park and Mill Cove locations. These are two large and currently-vacant sites with the majority of the land owned by federal and provincial crown corporations respectively. A municipal partnership with these bodies could see a ferry terminal integrated into the future development with the community benefitting from the presence of a strong transit connection to downtown Halifax.

Projecting ridership

A recent household travel survey (NovaTRAC, 2018) combined with a regional travel demand model provides a good indication of how many trips would be attracted to each of the ferry terminals. This information is valuable in determining the right size for new ferries and projecting revenue.

Features of the service

Drawing on aspects from services in other cities that are best suited to Halifax, we have defined several characteristics for new ferry services. From this, we have developed a proposed service model consisting of several potential routes and operating plans. In the peak commuting hours, all routes would be single-stop between the new terminal and downtown Halifax. During mid-day and weekend hours, when additional service may be considered, multiple-stop routes would become practical. The general operating plan for the three potential new routes is shown in the table below.

	Mill Cove	Larry Uteck	Shannon Park
Vessels	3	2	1
Departure Frequency in Peak	15 min	20 min	30 min
Dock-to-Dock Travel Time	18 min	16 min	10 min
Projected Peak Ridership*	1460	1030	300
Recommended Fare	Regional (\$4.25)	Regional (\$4.25)	Conventional (\$2.75)

* Based on 2016 population and employment, see Section 3.5

The proposed service model assumes that the new ferries will be a catamaran design to minimize wake generation at higher speeds. They will be a single deck with bow-loading and have a passenger capacity of 150. The choice of a smaller vessel like this is important in minimizing regulatory requirements and cost as well as being able to provide more frequent service compared to using fewer, higher-capacity vessels.

The proposed service model assumes that the new terminals will be like the Woodside Terminal with washrooms, indoor waiting and loading area, and an enclosed pedway crossing a rail line (where necessary) to connect to the street network. Unlike the Woodside facility, we see opportunities to integrate a terminal into a new multi-use building, rather than constructing a stand-alone terminal.

Shortening the commuter trip

By making a direct trip downtown and avoiding chronic roadway congestion, the ferries can deliver a competitive travel time to many commuters. This is illustrated on the two figures on the next page. The first figure shows the actual travel time for various commuting modes. The second figure compares travel “impedance” which includes the time walking to and waiting for the ferry/bus as well as out-of-pocket costs. Here, too, the ferry is competitive with car driving.

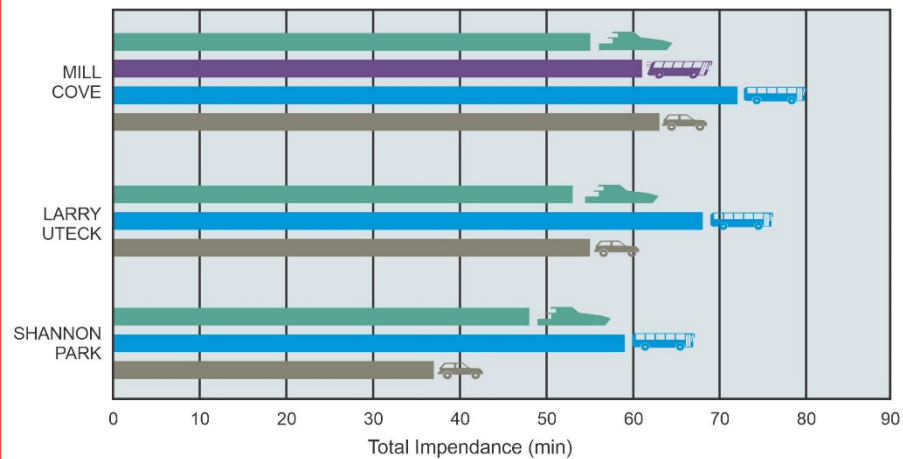
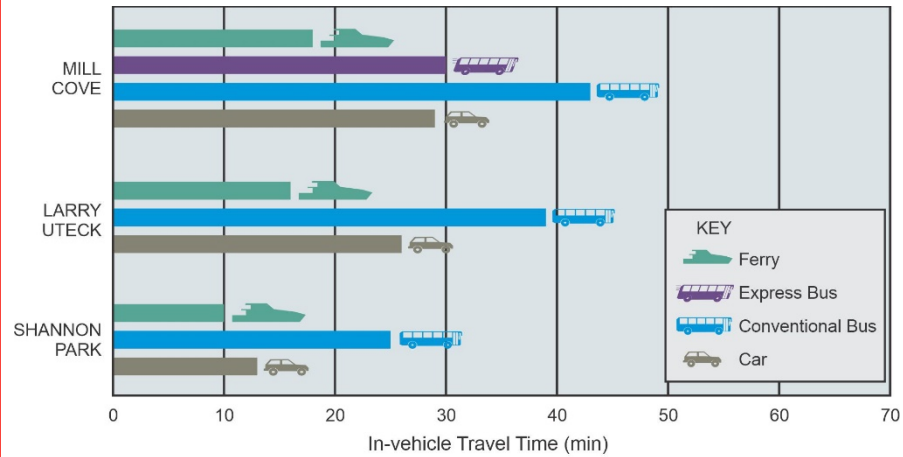
Three implementation scenarios

Infrastructure to support each of the ferry terminal sites may be built at various stages in the host site’s development or through different delivery mechanisms. To simplify our analysis, we have created three scenarios under which terminals might be constructed:

Quick Start Scenario - is relevant to implementation of the Mill Cove service and strives to minimize start-up costs by modifying existing facilities and making minor improvements to vacant Mill Cove land. For the Halifax Ferry Terminal, this scenario involves construction of a new wharf and renovating the existing building to expand passenger waiting capacity.

Integration Scenario - assumes that the ferry terminal is closely integrated into the area’s overall site development or redevelopment plans and that the terminal is part of a multi-use public building. It may also be leased space in a commercial building. A dedicated passenger dropoff and bus connection area is part of the project, but parking is assumed to be integrated into other elements of the site planning. Master planning for the area may, in fact, determine that parking for park-and-ride is not appropriate for that site.

Stand-alone Scenario - assumes that all of the required infrastructure would be purpose-built, including parking. It would still be closely integrated with overall site planning, but not involve any sharing of space.



Note: Details and sources are provided in Appendix D

Financial analysis

A financial analysis of capital costs, operating costs and revenue was conducted for peak period (7 hours per day) operation of each of the routes. The results of that are summarized in the tables below and on the next page.

Capital costs

		CAPITAL COST (\$ MILLION)					
		Halifax	Mill Cove	Larry Uteck	Shannon Park	Spare	Total
Scenario 1 – Mill Cove Quick Start	Ferries		\$19.5				\$23.7
	Terminal	\$1.3	\$2.9				
Scenario 2 - Integration	Ferries		\$19.5	\$13.0	\$6.5	\$6.5	\$72.7
	Terminal	\$15.0	\$4.4	\$4.8	\$3.0		
Scenario 3 – Stand Alone	Ferries		\$19.5	\$13.0	\$6.5	\$6.5	\$87.4
	Terminal	\$15.0	\$15.3	\$5.0	\$6.6		

Operating costs

	ANNUAL OPERATING COST			
	Halifax	Mill Cove	Larry Uteck	Shannon Park
Crew		\$861,000	\$574,000	\$287,000
Terminal Staff	\$102,000	\$102,000	\$102,000	\$102,000
Terminal Operating	\$40,000	\$30,000	\$30,000	\$30,000
Fuel		\$2,100,000	\$1,400,000	\$700,000
Ferry Maintenance		\$90,000	\$60,000	\$30,000
Misc. Ferry Oper.		\$60,000	\$40,000	\$20,000
TOTAL	\$142,000	\$3,243,000	\$2,206,000	\$1,169,000

Revenue and cost recovery

	Mill Cove	Larry Uteck	Shannon Park
Annual Revenue	\$1,755,000	\$1,334,000	\$588,000
Annual Operating Cost*	\$3,234,000	\$2,206,000	\$1,169,000
Revenue as Pct. of Operating	54%	60%	50%

* Does not include operating costs of the Halifax Ferry Terminal

Summary

It is evident from our jurisdictional scan that many cities have a long and successful history operating ferries for public transit with networks that are much larger and reach more broadly than HRM's current two-route network. We can learn from these successes in expanding HRM's network.

In exploring five potential sites for new ferry service, it was clear that Mill Cove in Bedford exhibits more of the characteristics that will make for a successful destination. The terminal site, water lot, and surrounding lands are all owned by the Provincial government (and administered by Develop Nova Scotia) which may lead to a partnership that will benefit both levels of government. Ideally, the development of the ferry terminal as part of a multi-use municipal building and the launch of the ferry service will go hand-in-hand with development of the Mill Cove site.

We used recently-collected and robust transportation data produced by the Dalhousie Transportation Collaboratory to conservatively project over 1400 trips per day in each direction for the Mill Cove route. Even with high ridership potential, we have recommended acquiring three relatively smaller ferries with a capacity of 150 passengers each. Vessels this size are beneficial primarily because they allow delivery of service every fifteen minutes during commuting peaks, same as the existing routes. The smaller size also eases regulatory and crewing requirements. The operating plan we have designed requires speeds of 25 knots in the Bedford Basin and 20 knots through the Narrows and Harbour. These are speeds that are lower than many similar services operating in similar conditions, but provide comfort in meeting the service needs and expectations of other harbour stakeholders.

The capital cost of our recommended Mill Cove service plan and supporting infrastructure is roughly estimated to be \$38.9 million including the three vessels at an expected cost of

\$6.5 million each. If the Halifax Ferry Terminal is refurbished instead of replaced, as an interim measure, that cost drops to \$25.2 million.

We have recommended the Halifax Transit Regional Express fare rate (\$4.25 adult cash fare) to be applied to the service, resulting in a projection of \$1.8 million in revenue each year. This amount is expected to cover approximately 54% of the operating cost of the service, a proportion that is fairly standard for urban transit services.

Ferry routes to Larry Uteck and to Shannon Park were also shown in the study to be viable and to perform as well as the Mill Cove route. A successful operation of the Mill Cove Ferry can be expected to spur on the implementation of these two, and possible other, routes.

1 INTRODUCTION

1.1 BACKGROUND

The Halifax–Dartmouth Ferry is the oldest saltwater ferry in North America, and the second oldest in the world (after the Mersey Ferry linking Liverpool and Birkenhead). The first ferry charter was issued in 1752 and cross-harbour ferries have long played a part in the Halifax region’s growth ever since. Today, ferries carry 1.77 million passengers per year across the harbour.

Ferries have turned what could otherwise be a physical barrier between Halifax and Dartmouth into a reliable transport corridor. A ferry trip is, arguably, the most desirable mode of transport offered in the region. Ferries are not only the most reliable component of the Halifax Transit network, but cost about ten percent less to operate per passenger than a conventional transit bus¹. Ferries have contributed significantly to the region’s tourism product and have become a local icon.

Regional growth has seen development on both sides of the harbour and the circumference of the Bedford Basin. The influence of traffic growth and congestion on commuting times has also become more evident. Given the success of, and the affection for, the current two cross-harbour ferry routes, it is only natural that an interest in expanding the ferry network to new destinations would arise.

To provide effective service to longer-distance destinations, a new type of higher-speed vessel is required and how this integrates into Halifax Harbour and Bedford Basin will need to be explored.

Considerable effort has been undertaken in the past to understand the implications of expanding the ferry network, with Mill Cove in Bedford being of particular interest. Destinations farther from downtown Halifax will require higher ferry operation speeds to be effective and some uncertainty has arisen in the past regarding the suitability of higher speeds in Halifax Harbour. Adding to that uncertainty is the notion that commuter rail service along the shore of the Bedford Basin may prove to be a more effective means of transporting commuters.

1.2 STUDY OBJECTIVES

The objective of this study is to develop a better understanding of what opportunities exist to service areas around the Halifax Harbour and Bedford Basin with new ferry routes and the vessel, terminal and marine operating characteristics that would make this a safe and successful service. Ultimately, the study will determine how a ferry component might tie into the Region’s aggressive plan to develop a rapid transit network and increase the transit mode share.

1.3 STUDY AREA

HRM has defined a study area that includes the existing ferry terminals and five additional potential terminals around Halifax Harbour and the Bedford Basin. The study area is shown in Figure 1.

¹ 2018-2019 Halifax Transit Year-end Performance Report

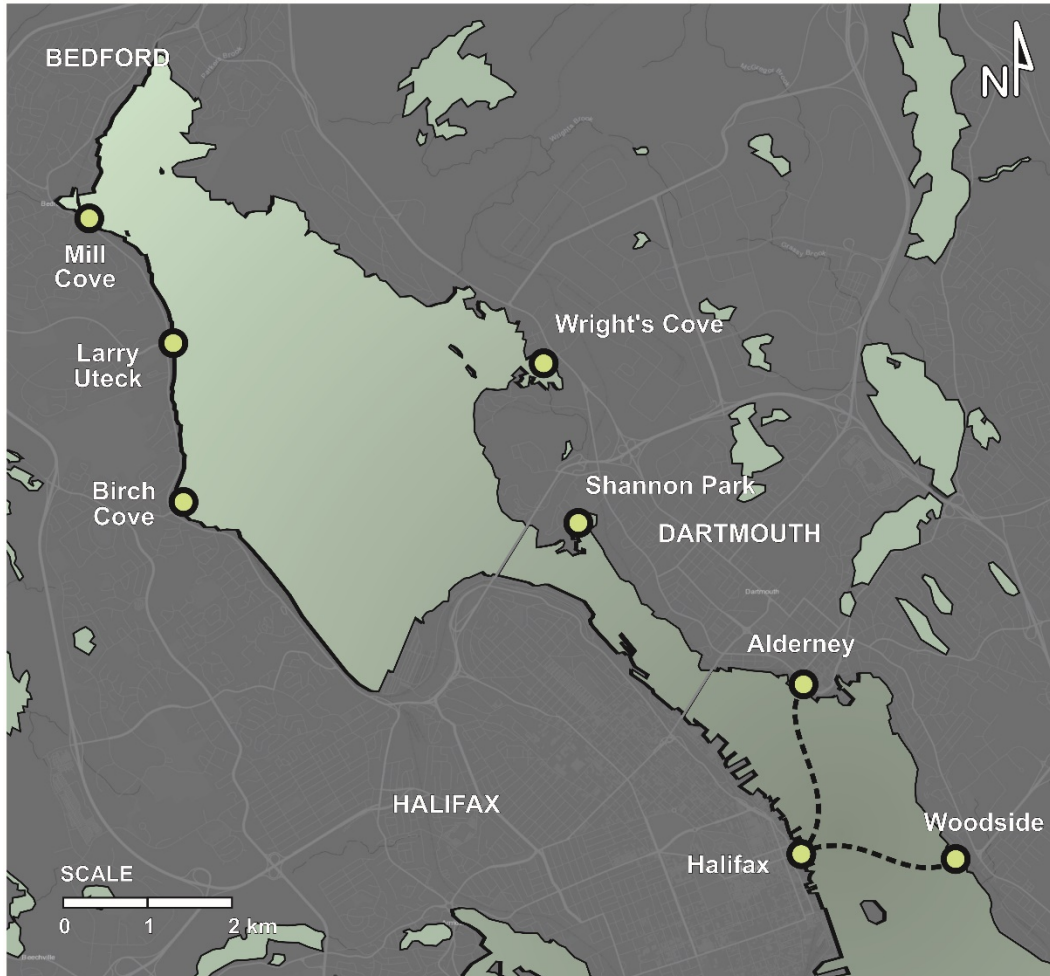


Figure 1 Study Area

1.4 TIMELINE OF EVENTS

The idea of using higher-speed ferries to service more destinations around the harbour first became the subject of serious consideration during the development of the 2006 Regional Plan. Since that time, additional efforts have been made to examine ferry feasibility, sometimes in comparison to other alternative transit modes. The following sections provide an overview of that work.

1.4.1 2006 REGIONAL PLAN

As part of the development of HRM's first Regional Plan, which was approved in 2006, extensive work was done to develop a regional transportation plan. As part of the background work, Cansult & Lea Consulting (with MariNova) undertook a transit options assessment in 2004 for the Bedford area and concluded that the cost of operating rail service to Bedford would be too expensive for the size of the market. As a result of this assessment, commuter rail was not included as a part of the transportation plan. The plan did, however, include a recommendation of "increased use of Halifax Harbour as a transportation corridor". The study also included a brief examination of the feasibility of operating a fast ferry to and from Convoy Quay (the Mill Cove site examined in this study).

1.4.2 MARKET SURVEY

During July 2005, the Marketing Clinic undertook surveys and focus group sessions to determine the potential market for a higher-speed ferry route between Mill Cove and downtown Halifax. The results helped to characterize the potential commuting market and determined the propensity to pay for the ferry (and for park-and-ride parking) for a set of possible fares. The study found that the number of residents likely to use the ferry from the core Mill Cove and surrounding areas was between 60% and 70%.

1.4.3 WHALING CITY EXPRESS DEMONSTRATION

While work on the 2006 Regional Plan was underway, the Municipality commissioned the service of a fast ferry from New Bedford, Massachusetts. In October, 2005, the Whaling City Express was brought to Halifax for the purpose of providing a better understanding of this type of vessel for regulators, decision-makers, and the public. A number of demonstration runs between Mill Cove and downtown Halifax over a period of two days were hosted for key stakeholders and the general public. The Whaling City Express made the trip from Mill Cove to downtown Halifax (without docking) in 18 minutes.

1.4.4 WAKE MEASUREMENT

During the Whaling City Express fast ferry demonstration Stumbo & Associates, a company specializing in the characterization of wake-wash, was hired to take measurements of the Whaling City Express and other harbour vessels for comparison. The results are shown in Table 1.

Table 1 Wake Measurements for Vessels in Halifax Harbour

Vessel	Speed (knots)	Distance (metres)	Wake Height (cm)	Wave Energy (Joules/metre)
Peggy's Cove Express	15.0	94	36.7	1,906
Dartmouth III	9.4	100	49.5	2,210
Cdn. Navy RIB	20.0	215	21.9	928
Pleasure Boat 1	20.0	103	18.0	629
Pleasure Boat 2	18.0	115	40.4	1,903
Cdn. Navy YTB 642	12.0	235	36.3	919
Maintainer 1	12.0	130	36.3	871
Atlantic Compass	10.0	255	26.9	980
Whaling City Express	27.0	300 ¹	37.2	3,630
River Runner 15 ²	22.0	50	15.0	1,700
	22.0	100	12.5	1,200
	22.0	300	8.1	500

¹ Corrected to 300m by Stumbo & Associates. Actual measured data not given.

² Mainly interpreted from charts in the report.

Wake wash measures showed that, even with higher speeds, the wake height created by the Whaling City Express is consistent with other vessels currently operating in the harbour. Unlike many ferries, the Whaling City Express was not designed to produce low wave energy as it's normal tourist route in Massachusetts is primarily in open seas. For this reason, Stumbo & Associates included in their comparison measurements from the River Runner 15, a vessel designed more appropriately for harbour use.

1.4.5 2006 FAST FERRY CULTIVATION STUDY

To further explore the notion of expanded ferry service, the *Bedford/Halifax Fast Ferry Cultivation Study* was undertaken by TDV Global Inc. and completed in 2006. This study evaluated a total of 72 scenarios for providing ferry service between downtown Halifax and Mill Cove. The study suggested that a ferry capable of 35 knots could make a round trip, including docking and passenger loading, of 40 minutes. Combined with data from a previous marketing survey (see section 1.4.2), the study suggested that larger capacity vessels (350 passengers) would be more optimal than smaller vessels and that a one-way fare in the range of \$4 to \$5 would maximize return. The evaluation showed that some scenarios could actually achieve a net operating profit.

1.4.6 HARBOUR TRAINER SIMULATION

In conjunction with the Fast Ferry Cultivation Study, the Department of National Defence (DND) was asked to employ their Harbour Training Simulator to run a ferry operational scenario. This is a simulator that provides 270-degrees of view from the bridge of a vessel and can reflect the dynamics of the Halifax Harbour including variables such as wind, tide and weather. The simulation scenario involved a large (post-panamax) container ship transiting “the narrows” while a ferry passed it on either side. Those attending (HRM, DND, Halifax Port Authority and Harbour Pilots) were able to experience the potential challenges involved in the scenario and concluded that no significant issues were evident. Some recommendations came out of this simulation regarding how a track for the ferries might be set through the narrows.

1.4.7 VESSEL DESIGN/BUILD EXPRESSIONS OF INTEREST

In September, 2008, Expressions of Interest were received from firms and partnerships capable of designing and building catamaran ferries suited for operation of service between Mill Cove and downtown Halifax. Seven submissions were received (including two that would see the vessels built in Nova Scotia). Although no further action was taken on this call for Expressions of Interest, some valuable budgeting and operational information was obtained.

1.4.8 HRM APPROVALS AND BUDGETING

Provided with the results of the Fast Ferry Cultivation Study, Halifax Regional Council approved the ferry project (then called HarbourLink) in principle subject to funding on August 8, 2006. That approval was re-affirmed at Council’s June 12, 2007 meeting.

On November 18, 2008, Regional Council approved a five-year transit plan that included the HarbourLink project. On March 10, 2009 funding for the HarbourLink project was reallocated to construction of a new transit terminal at Ragged Lake which was deemed to be a more pressing need.

1.4.9 MARKET SURVEY UPDATE

In February, 2009, Harris/Decima undertook an update of the 2005 market survey. It showed that support for the ferry project remained high in the core Bedford area (76%) and the surrounding areas (63%).

1.4.10 HARBOURLINK PLAN

HRM staff submitted a document titled “HarbourLink Plan – Interim Report” to Regional Council on April 28, 2009. In this report, staff provided additional information on steps to implement ferry service to Mill Cove and linked it to the evolving higher-order elements of the transit network including MetroLink and MetroX services.

1.4.11 2010 TRANSIT SERVICE ALTERNATIVES STUDY

In 2010, a study was completed by DelphiMRC for Metro Transit (now Halifax Transit) titled “*An Operational and Life Cycle Cost Analysis of Transit Service Alternatives in the Bedford-Halifax Corridor*”. After having interviewed Halifax Transit staff and other stakeholders, the authors concluded that ferries should travel only 12 knots (in the harbour) to 22 knots (in the basin) and reduce to 10 to 14 knots in poorer weather conditions. At these speeds, the authors suggested that a 60-minute Mill Cove-to-downtown cycle could be achieved and that 20-minute headways during the peak commuting hours would require three vessels.

The result of this is that the same level of service achieved with two vessels in the Fast Ferry Cultivation Study would now take three vessels and that the travel time from Bedford had now lost its competitive edge with other alternatives such as driving, bus rapid transit (BRT) and rail transit.

1.4.12 FERRY DESIGN REVIEW

The 2011 *New Conventional Ferry for Metro Transit* study by Sagaris Nautical recommended that in order to serve new destinations a new 150-passenger ferry should be capable of 18 knots as a minimum. With optimal designs, higher speeds could be realized with minimal increase in fuel consumption and lower emissions. A faster vessel would provide quicker transit times and added capacity because of the potential for increased sailing frequency.

1.4.13 COMMUTER RAIL STUDY

The 2015 CPCS *Commuter Rail Feasibility Study* is relevant to this study because the catchment area for commuter rail would be similar to that of a ferry service in the Basin. This study examined five aspects of rail service delivery: 1) ridership; 2) technical feasibility; 3) track access; 4) financial affordability; 5) economic benefits. It looked at 11 possible station locations as far as Elmsdale and Beaver Bank. Ridership projections ranged from 1,588 to 4,287 daily weekday boardings. Technical constraints included the need for a second main track on the Halifax-Elmsdale portion. Track access would depend on negotiations with CN, which owns it. Estimated capital costs for the Cobequid portion were estimated at \$45 million with operating costs of \$9 million to \$10 million and revenues ranging from \$800,000 to \$2.5 million. One aspect the study did not address is the location of HRM employment nodes compared with the rail route and station sites.

1.5 BASIS FOR ASSESSMENT

We have based our recommendations and assessment of a ferry operating plan on background information we have gathered from two sources: a scan of other jurisdictions operating urban ferry services and interviews with harbour transportation stakeholders. We interviewed the following stakeholders:

- Halifax Transit Ferry Operations
- Halifax Transit Planning
- HRM Regional Planning
- HRM Parks and Recreation
- Halifax Port Authority
- Develop Nova Scotia
- Transport Canada

These interviews are summarized in Appendix A. Our jurisdictional scan is summarized in Section 2.

2 JURISDICTIONAL SCAN

2.1 INTRODUCTION

Although ferries have been operating in Halifax Harbour for many years, the use of higher speed ferries for longer trips has not been experienced or even considered until recently. It is beneficial, we believe, to examine the use of higher speed ferries in other cities where they have operated safely and effectively for many years.

As of early 2019, there were about 1,800 high-speed ferries operating in global markets by 600 operators. Sixty-two vessels were delivered in 2018 and 71 the previous year².

About 64% of fast ferries are catamarans or wave-piercing catamarans, 23% are monohulls and 12% are hydrofoils. Surface-effect, hovercraft and trimarans together account for 1%.

Of the 1,800 fast craft in operation, only 8% carried passengers and automobiles, including The Cat that has operated between Yarmouth and Maine.

Therefore, about 1,700+ are of a type that is being considered for Halifax. The technology is leading edge but not “bleeding” edge, with a very good track record. They also operate in all types of geography and climatic conditions, from tropical to the Norwegian coast.

In terms of the number of vessels in service, the United States leads the way, with 222, whether for commuting or sight-seeing. China is in second place, with 151, and Russia is in third place with 130. The top 10 is rounded out by Italy (117), Norway (116), Australia (115), Japan (105), Singapore (63), Greece (52) and Turkey (48).

The biggest fleets are employed by several companies shown in Table 2.

Table 2 Companies Operating High-Speed Ferries

Company	Country	# Vessels
TurboJet	Hong Kong	32
Liberty Lines	Italy	29
Istanbul Deniz Otobusleri	Turkey	28
NYC Ferry	US	27
Sealink	Australia and New Zealand	25
Norled	Norway	23
Boreal Sjo	Norway	22
Allen Marine Tours	US	20
Severrechflot	Russia	18
NY Waterway	US	17
Thames Clippers	UK	17
Zhuhai High-Speed	China	17

Source: Shippax Market 19, Shippax AB, Halmstad, Sweden

In the following sections, we present brief descriptions of several passenger-only, fast ferry operations. The sample includes large, medium and small markets, using vessels similar in size contemplated for Halifax. We examine nine ferry services in eight locations: Bermuda, Boston, New York, San Francisco, Seattle (2), Vancouver, and Auckland. They represent a mix of small (Bermuda), large (New York) and mostly medium-sized markets. They are also harbour

² Shippax Market 19, Shippax AB, Halmstad, Sweden

ferries, rather than linear, river ferry services such as London or Brisbane. We did not include Hong-Kong and Istanbul because of their sheer scale and size.

2.2 BERMUDA SEA EXPRESS

Bermuda has a ferry network that is government-owned and operated by their public transit agency. The network consists of a number of routes with shorter routes served by slower steel ferries and longer routes served by higher speed aluminum catamarans.

2.2.1 ROUTE DISTANCE AND TRAVEL TIME

Bermuda's network includes several ferry routes varying in length listed below and shown in Figure 2.

- Lower Ferry, Paget. Across the harbor and south east 0.4 km
- Salt Kettle, Paget. Across the harbor and south west 1.2 km
- Belmont, Warwick. Across the harbor and south west 2.0 km
- Rockaway, Southampton. Via the harbor and west 4.4 km
- Mangrove Bay, Sandys. Via the harbor and west 7.2 km
- Cavello Bay, Sandys. Via the harbor and west 9.6 km
- Dockyard, Sandys. Via the harbor and west 9.8 km
- St. George's. Via the harbor and west, then east 19.2 km

For comparison, the route between downtown Halifax and Mill Cove Bedford is approximately 10.8 km.



Figure 2 Bermuda Ferry Network

2.2.2 FARES, RIDERSHIP AND MODAL SHARE

Passenger fares for the Bermuda network are shown in Figure 3. They report their modal share to be 7% ferry, 13% transit bus and 65% driving.

Passes		Adult 1-Day		Adult Monthly Pass		Child 1-Day		Student Passes (Residents Only)	
Passes valid on all routes on both ferries and buses.		Adult 2-Day	\$31.50	Adult 3-Month Pass	\$169.00	Child 2-Day	\$16.00	All Students must present a Student Pass for free transportation.	
		Adult 3-Day	\$44.00			Child 3-Day	\$22.00	If Student Pass not presented, child (Age 5 - 15) or Adult (Age 16+) fares apply.	
		Adult 4-Day	\$48.50			Child 4-Day	\$24.50		
		Adult 7-Day	\$62.00			Child 7-Day	\$31.00		

Tickets/Tokens		BLUE / GREEN / ORANGE ROUTE		PINK ROUTE		Holders of Seniors and Special Persons Pass (Residents Only)	
Please ensure you have the correct fare before boarding.		Cash		Cash		Child under age 5	Free
		Adult	\$5.00	Adult	\$3.50		
		Child (Age 5 - 15)	\$2.75	Child (Age 5 - 15)	\$2.75		
		Tokens		Tokens			
		Adult	\$4.50	Adult	\$2.75		
		Child (Age 5 - 15)	\$2.75	Child (Age 5 - 15)	\$2.75		
				Tickets (Booklet of 15)	\$25.00		

Motor Cycles If paid by Cash or Token \$4.50
If paid by Pass Free
Tickets (Booklet of 15) \$37.50
Holders of Seniors and Special Persons Pass (Residents Only) Free
Child under age 5 Free

Passes, Tokens & Tickets available from the Hamilton Ferry & Bus Terminals, Visitors Information Centres, sub-post offices, hotels and guest houses.

Figure 3 Bermuda Passenger Fare Table

2.2.3 SERVICE SPAN AND FREQUENCY

Ferries operate on winter and summer schedules (see Figure 4), corresponding with the cruise and tourist seasons. In the summer, the Hamilton-Dockyard service (Blue Route) runs on the schedule shown. Transit times are 20-30 minutes depending on the time of day. The Rockaway route (Green Route) is more oriented to commuters. At the Rockaway terminal, there is a park-and-ride facility and transit times are twenty minutes.

Hamilton • Watford Bridge • Cavello Bay • Rockaway GREEN ROUTE					
MOTOR CYCLES NOT ALLOWED ON WATFORD BRIDGE AND CAVELLO BAY					
Monday - Friday	Leave Hamilton	Leave Watford Bridge	Leave Cavello Bay	Leave Rockaway	Arrive Hamilton
	6:40	7:00	7:10	7:20	7:45
	7:10	-	-	7:55	8:15
	7:45	8:00	8:10	8:20	8:45
	4:10	4:50	4:40	4:30	5:20
	5:20	6:00	5:50	5:40	6:20
	6:20	7:00	6:50	6:40	7:20

Figure 4 Sample Timetables

Hamilton • Royal Naval Dockyard BLUE ROUTE			
MOTOR CYCLES MAY EMBARK AT HAMILTON & DOCKYARD			
Monday - Friday	Leave Hamilton	Leave Dockyard	Arrive Hamilton
	7:30	7:30	7:50
	8:00	8:30	10:00
	8:45	Moves on to Orange Route at 8:30	-
	9:15	10:15	10:45
	10:15	11:00	11:30
	11:45	12:30	1:00
	1:30	2:15	2:45
	3:15	4:00	4:30
	5:00	5:45	6:15
	6:30	7:15	7:45
	7:30	8:15	8:45
	9:00	9:45	10:15
	10:30	-	-
Saturdays and Sundays	Leave Hamilton	Leave Dockyard	Arrive Hamilton
	9:00	9:45	10:15
	10:30	11:15	11:45
	12:00	12:45	1:15
	1:45	2:30	3:00
	3:15	4:00	4:30
	4:45	5:30	6:00
	Leave Hamilton	Leave Dockyard	Arrive Hamilton
	6:15	7:00	7:30

Times in Red are for Wednesdays Harbour Nights Only
Motorcycles not allowed on Harbour Nights • April - September

2.2.4 VESSEL TYPES AND FLEET SIZE

Bermuda substantially upgraded its ferry service about 15 years ago (see Table 3), by investing in new high-speed vessels and facilities. The oldest vessels, Serenety and Resolute were built by Hearn Duclos Corporation in Somerset, Mass in 2002 at a cost of US\$2.5 million each. They are capable of 23 knots. Two additional vessels, Tempest and Venturilla were built in 2004 by North West Bay Ships in Tasmania, for the same price, and they are capable of 34 knots.

The Bermuda government considers these high-speed vessels to be expensive to operate; they are heavy and use jet propulsion. An alternative they are considering is fast ferries which they believe to be lighter, propeller-driven and more fuel efficient.

Table 3 Bermuda High-Speed Ferry Fleet

Name	Builder	Year	Passengers	Speed (knots)
Serenity	Hearn Duclos	2002	205	23
Resolute	Hearn Duclos	2002	205	23
Tempest	North West Bay	2004	177	34
Venturilla	North West Bay	2004	177	34

2.2.5 TERMINAL INFRASTRUCTURE

A park-and-ride facility is located at Rockaway. The government is considering building more of them.

2.2.6 OPERATING COSTS

Ferries cost \$10,000 per day to operate between Hamilton and the West End, \$4,000 per day for the smaller Bermudian tenders, and \$13,000 per day for the high-speed ferry between the Dockyard and St. George's during the summer.

2.2.7 FUNDING MODEL

Costs are subsidized by the Bermuda government. Total revenue in 2017/18 for ferries was \$1.5 million with a total cost of \$8.6 million. The revenue/cost ratio was 17%³. The service from the Dockyard to St. George's was contracted to Rhode Island Ferry, but the Bermuda government "took it back" in 2018.

2.3 BOSTON MBTA

In the summer of 2018 there were 5 public ferry routes providing commuter and recreational service in Boston Harbor. The Massachusetts Bay Transportation Authority (MBTA) operates three year-round commuter services through contracts with Boston Harbor Cruises (BHC), which was sold to Hornblower Holdings in October 2019. The city of Salem also partners with BHC to provide seasonal service between Salem and Boston, and the town of Winthrop operates their own service to Central Wharf in Boston and two other locations on the waterfront. Maintenance is performed by Boston Harbour Cruises at their own facilities.

There are also privately-run services that connect Boston and Provincetown operated by BHC and Bay State Cruise Company (BSCC). There has been service to Lynn in past years, but it did not operate in 2018. This analysis will focus on the MBTA service. Other services provided access to Boston Harbor islands.

The MBTA runs three ferry lines in Boston Harbor, as described in the following sections. There are also several private sector services within the Boston area, such as to Winthrop and Salem.

³ Government of Bermuda, Ministry of Tourism and Transport, 2019 Transport Green Paper, p. 39.

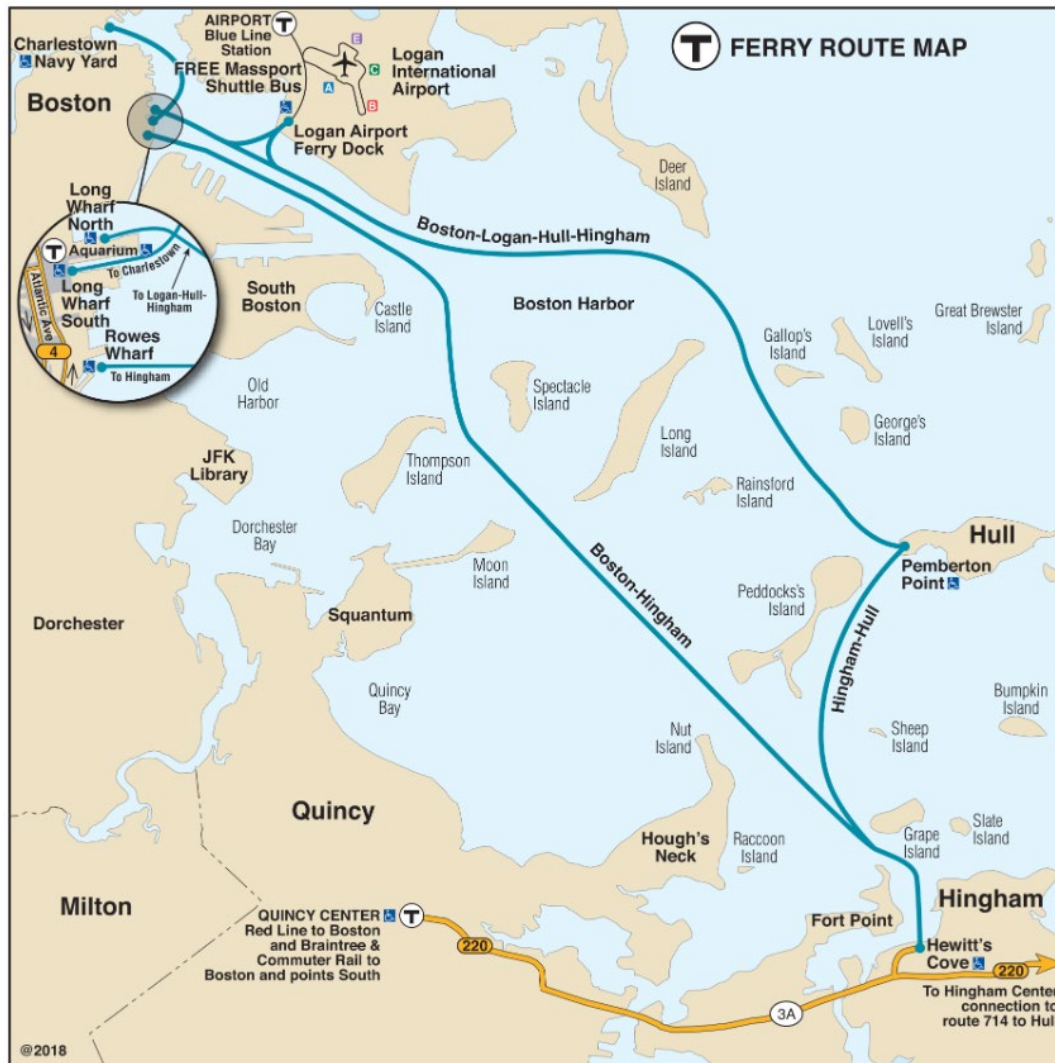


Figure 5 Boston Harbour Ferry Routes

2.3.1 ROUTE DISTANCE AND TRAVEL TIME

Travel times for the three ferry routes operated in Boston are shown in Table 4.

Table 4 Boston Ferry Routes

Route	Ferry Travel Time	Driving
Hingham to Boston	35 minutes	45-80 minutes
Hingham to Hull to Logan to Boston	23 (non-stop)-55 (multi-stop) minutes	55-100 minutes
Long Wharf to Charlestown	10 minutes	

Source: Pioneer Institute, 2017

2.3.2 FARES, RIDERSHIP AND MODAL SHARE

The three main services have the fare structure and ridership shown in Table 5.

Table 5 Boston Fares and Ridership

Route	Single fare	Monthly pass	Annual Passengers
Hingham to Boston	\$9.25	\$308	827,397
Hingham to Hull to Logan to Boston	\$9.25	\$308	337,499
Long Wharf to Charlestown	\$3.50	\$84.50	317,355

2.3.3 SERVICE SPAN AND FREQUENCY

Weekday schedules for all three MBTA routes are shown in Figure 6.

2.3.4 VESSEL TYPES AND FLEET SIZE

MBTA operates two vessels and Boston Harbour Cruises provides eleven. We have data on seven of those vessels, which is shown in Table 6.

Table 6 Boston Ferry Vessels

Name	Builder	Year	Passengers	Speed (knots)
Aurora	Gladding Hearn	1998	350	33
Nora Vittoria	Gladding Hearn	1998	350	33
Salacia	Gladding Hearn	2000	597	36
Sanctary	Gladding Hearn	1999	325	31
Sterling	Aluminum Boats	1980	150	26
Champion	Gladding Hearn	2017	149	26
Glory	Gladding Hearn	2018	149	26

Source: Shippax Hi-Speed Register

WEEKDAY F1 Hingham – Boston

Monday to Friday To Boston		
	Hingham Hewitt's Cove	Boston Rowes Wharf
AM	6:00	6:35
	6:30	7:10
	6:50	7:30
	7:15	7:50
	7:45	8:20
	8:00	8:40
	8:20	9:00
	8:45	9:20
	9:15	9:50
	11:00	11:40
PM	2:30	3:10
	4:10	4:50
	4:45	5:25
	5:05	5:35
	5:45	6:25
	6:10	6:45
	6:40	7:15
	7:40	8:15

Monday to Friday From Boston		
	Boston Rowes Wharf	Hingham Hewitt's Cove
AM	6:50	7:30
	7:15	7:55
	7:35	8:10
	8:00	8:35
	8:30	9:05
	10:00	10:40
	1:30	2:10
PM	3:25	4:05
	4:00	4:40
	4:30	5:05
	5:00	5:40
	5:20	5:55
	5:40	6:15
	6:00	6:40
	6:30	7:10
	7:00	7:35
	7:30	8:05
	8:30	9:05

WEEKDAY F4 Charlestown – Boston

Monday to Friday To Boston		
	Charlestown Navy Yard Pier 4	Boston Long Wharf
	6:45 AM	6:55 AM
	Every 15 minutes from 6:45 AM to 9:15 AM	
	9:15 AM	9:25 AM
	Every 30 minutes from 9:15 AM to 3:45 PM	
	3:45 PM	3:55 PM
	Every 15 minutes from 3:45 PM to 6:45 PM	
	6:45 PM	6:55 PM
	Every 30 minutes from 6:45 PM to 8:15 PM	
	Service ends with the 8:15 PM boat	

Monday to Friday From Boston		
	Boston Long Wharf	Charlestown Navy Yard Pier 4
	6:30 AM	6:40 AM
	Every 15 minutes from 6:30 AM to 9 AM	
	9:00 AM	9:10 AM
	Every 30 minutes from 9 AM to 3:30 PM	
	3:30 PM	3:40 PM
	Every 15 minutes from 3:30 PM to 6:30 PM	
	6:30 PM	6:40 PM
	Every 30 minutes from 6:30 PM to 8 PM	
	Service ends with the 8 PM boat	

Figure 6 Boston Ferry Schedules

One of MBTA's newest vessels is Champion, a high-speed catamaran built in 2017 and capable of carrying 149 passengers (see Figure 7).



Figure 7 One of MBTA's Newer Vessels

Source: Inner Harbour Connector Study, 2018

2.3.5 TERMINAL INFRASTRUCTURE

The MBTA operates seven terminals and all such infrastructure including maintenance facilities are owned and managed by outside contractors. There are 1,726 parking spaces available at Hingham and 200 at Hull. None of the other terminals provide parking. The daily fee at Hingham is \$2 while a monthly pass is \$35.

2.3.6 OPERATING COSTS

From 2003-2015, the average annual subsidy has been \$3.78 million. The highest was \$4.97 million in 2014 and the lowest was \$2.39 million in 2007. Since 2010, it has fluctuated between \$4-5 million. By comparison, Boston's bus operating subsidy was \$224 million⁴.

MBTA fare revenue versus total operating costs is shown in Figure 8. Farebox recovery on the whole ferry system is 68%. One study noted that the ferry system has both comparatively low ridership and the highest farebox recovery compared with subway, bus and train⁵. Broken down by route, farebox recovery is shown in Table 7.

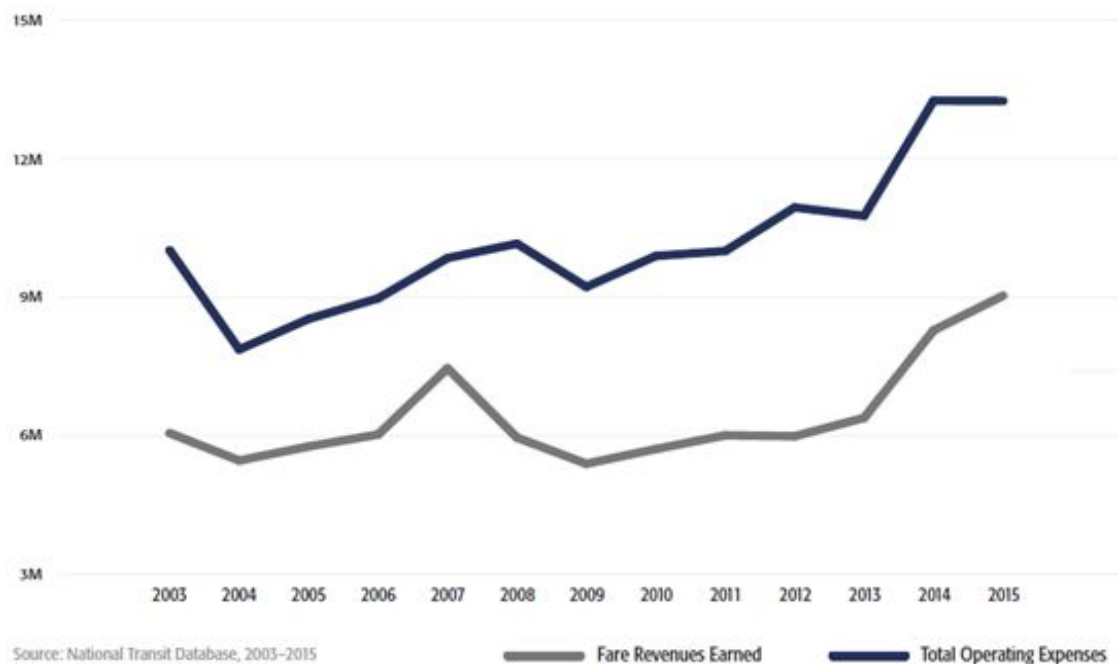


Figure 8 MBTA Revenue and Expense History

The MBTA's farebox recovery ratio is 4th best in the US, behind NY Waterway, BilleBey Ferry (now merged with NY Waterway), and the Port Authority Trans-Hudson Corporation⁶.

⁴ Matthew Blackburn and Gregory W. Sullivan, "Is it time to expand water transportation in Greater Boston", Pioneer Institute, white paper, September 2017.

⁵ New York (NYC Ferry <https://www.ferry.nyc/>)

⁶ Ibid., p. 20

Table 7 Farebox Recovery

Route	Farebox Recovery
Hingham to Boston	72%
Hingham to Hull to Logan to Boston	74%
Long Wharf to Charlestown	58%

2.3.7 FUNDING MODEL

Funding is provided by MBTA and the farebox. MBTA owns two vessels while BHC owns 11. BHC manages the MBTA's vessels on their behalf.

BHC operates all ferry services, insures and maintains all vessels and is paid a monthly subsidy based on a formula of fixed cost per trip multiplied by number of trips in a given month⁷.

2.4 NEW YORK NYC FERRY

Besides the Staten Island ferry, which operates large double-ended ferries between Staten Island and the tip of Manhattan, there are four passenger-only ferry service companies operating in New York Harbor. They are:

- NYC Ferry (ferry.nyc/)
- New York Water Taxi /Yellow Line (nywatertaxi.com)
- NY Waterway (nywaterway.com)
- Seastreak (seastreak.com)

For these purposes, we profile the newest service, NYC Ferry, which has seen substantial investment since 2017. The other three are private companies and it is not clear whether they receive any subsidy. The Staten Island ferry is operated by the city's Department of Transportation and is provided free of charge.

NYC Ferry took over services previously operated by NY Waterway on the East River. It has been vastly expanded under the Bill DeBlasio mayoralty. The service was announced in 2015 and commenced in 2017.



Source: Metal Shark Boats

Figure 9 Newer NYC Ferry

2.4.1 ROUTE DISTANCE AND TRAVEL TIME

NYC Ferry's routes stretch over a 60-mile length. Within it are six separate routes and 20 "landings". The present routes are shown in Figure 10. There are plans to further expand the service reach to include Staten Island and the Hudson River.

⁷ Ibid.

2.4.2 FARES, RIDERSHIP AND MODAL SHARE

One-way fares are \$2.75; one-way with a bike is \$3.75 and 30-day passes are \$121 and \$141 respectively, with children under 44" riding free. Daily ridership is about 10,000, or 3.7 million passengers per year. By 2023 ridership is projected to be 9 million per year. (This compares with the 5 million people who ride the subway on a daily basis).

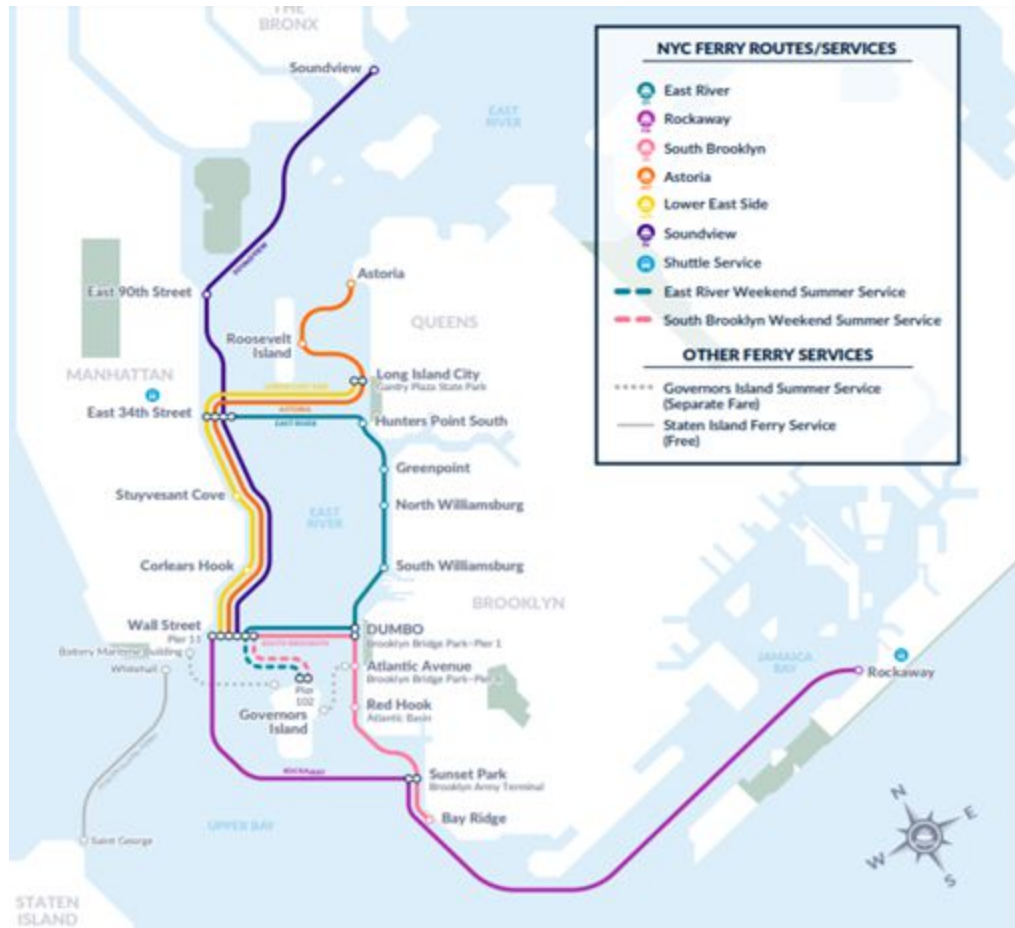


Figure 10 NYC Ferry Routes

2.4.3 SERVICE SPAN AND FREQUENCY

Data on the number of stops and vessel headways are shown in Table 8.

Table 8 NYC Ferry Stops and Travel Time

Route	Stops	Travel Time (minutes)
East River	7	43
Rockaway	3	57
South Brooklyn	6	41
Astoria	6	45
Lower East Side	4	46
Soundview	4	46

2.4.4 VESSEL TYPES AND FLEET SIZE

NYC Ferry operates 27 vessels, most of which were series built to Incat Crowther designs by Metal Shark Marine in Louisiana (see Figure 11). One version carries 150 passengers and the other one carries 350. There are 18 and nine of these respectively. The smaller ones cost approximately USD \$4.0 million.



Source: Metal Shark Boats

Figure 11 Metal Shark Shipyard

Table 9 NYC Ferry Vessels

Name	Builder	Year	Passengers	Speed
Standard River Boat	Metal Shark	2016 x 9	150	26 knots
Rockaway Vessel	Metal Shark		150-250 expandable	25 knots
Standard River Boat	Metal Shark	2016 x 6	150	
Rockaway Vessel	Metal Shark	2019 x 11	350	

Source: Wikipedia

2.4.5 TERMINAL INFRASTRUCTURE

Since 2017, 21 new terminals have been built for the service. They are designed to be accessible by foot and to connect with the bus and subway network.

2.4.6 OPERATING COSTS

The new service is very expensive to operate. In April 2019, the average subsidy was estimated to be \$10.73 per passenger⁸.

2.4.7 FUNDING MODEL

Vessels are operated by Hornblower marine under contract to the city of New York Economic Development Corp. (The Staten Island Ferry is operated by the city's Department of Transportation). Hornblower receives about \$30 million annually from the city, under a six-year contract.

2.5 SAN FRANCISCO WETA

The San Francisco Bay Area Water Transit Authority (WTA) was created by the California State Legislature in 1999 and tasked with planning new and expanded ferry service. In 2007, the San Francisco Bay Area Water Emergency Transportation Authority (WETA) (<https://weta.sanfranciscobayferry.com/>) was created to replace WTA and add the emergency response element to the agency's mission.

At the direction of the Legislature, WETA then developed a plan to absorb ferry services then run by the Cities of Alameda and Vallejo. Alameda-Oakland and Harbor Bay ferry services transitioned to WETA in 2012, and those routes in addition to a new route connecting the East Bay to South San Francisco began operating under the San Francisco Bay Ferry brand (<https://sanfranciscobayferry.com/>). All of WETA's vessel operations are managed by Blue and Gold fleet (<https://www.blueandgoldfleet.com/about/>). WETA opened a maintenance facility at North Bay in Vallejo, in 2016.

In 2016, WETA operated 12 vessels, and seven terminals on four routes, with an annual operating budget of \$33 million. By 2035 it envisions having 44 vessels, 16 terminals, operating 12 routes, with an operating budget of \$144 million.

Another company, Golden Gate Ferry (<https://www.goldengate.org/ferry/riding-the-ferry/>) operates four vessels from three terminals located north of the Golden Gate Bridge to downtown San Francisco as well as Oracle Park when major league baseball games are taking place.

2.5.1 ROUTE DISTANCE AND TRAVEL TIME

The WETA / San Francisco Bay Ferry routes are shown in Figure 12.

Golden Gate Ferry operates on three additional routes:

- Larkspur- San Francisco – 30 minutes
- Sausalito- San Francisco – 30 minutes
- Tiburon- San Francisco – 30 minutes

⁸ Tom Fox, "How to get ferry service right", Crain's New York Business, 1 April 2019.



Figure 12 San Francisco Ferry Routes

2.5.2 FARES, RIDERSHIP AND MODAL SHARE

Adult passenger fares on the WETA / San Francisco Bay Ferry service range from \$7.20 to \$15.10 one-way, depending on the distance travelled. Most routes cost \$9.40. The Golden Gate Ferry service charges \$12.50 from Larkspur and \$13.00 from the other two locations.

The WETA / San Francisco Bay Ferry system carries about 3 million passengers per annum. Their ridership has doubled since 2012 and has increased 46 percent since 2015. Golden Gate carried 2.47 million passengers in FY 2019 and 2.57 million in FY 2018. The Larkspur route is the busiest at 1.64 million in FY 2019; next is Sausalito with 629,954 and Tiburon with 195,467 passengers.

Between the two ferry systems, close to five million passengers are transported every year.

2.5.3 SERVICE SPAN AND FREQUENCY

For the main WETA / San Francisco Ferry routes, transit times and frequencies are shown in Table 10. The same data for Golden Gate Ferries is shown in Table 11.

Table 10 WETA Ferry Transit Time and Frequencies

Service	Transit Times to SF Ferry Terminal	Frequency
Alameda / Oakland	35 / 20 minutes	Every 35 minutes
Mare Island / Vallejo	90 / 70 minutes	Varies / peak service
Alameda / South San Francisco	55 / 40 minutes	3 per day each direction
Harbor Bay	25 minutes	Every 30 minutes peak
Richmond	35 minutes	4 sailings peak

Source: San Francisco Bay Ferry

Table 11 Golden Gate Ferry Transit Times and Frequencies

Service	Transit Times to SF Ferry Terminal	Frequency
Larkspur	30 minutes	17 per day; every 30 minutes
Sausalito	30 minutes	9 per day: every 35 minutes
Tiburon	30 minutes	7 per day: every 75 minutes peak

2.5.4 VESSEL TYPES AND FLEET SIZE

WETA / San Francisco Bay Ferry vessels range in size from 267 to 445 passenger capacity (see Table 12). Service speeds range from 25-34 knots. Eight vessels are propeller driven and five are driven by water jets. Golden Gate Ferry operates four catamarans and three monohulls shown in Table 13.

Table 12 WETA/San Francisco Bay Fleet

Name	Builder	Year	Passengers	Service Speed (knots)
Peralta	Nicholls Brothers	2002	331	25
Encinal	Nicholls Brothers	1985	395	23
Bay Breeze	Nicholls Brothers	1994	250	26
Intintoli	Dakota Creek	1997	349	34
Mare Island	Dakota Creek	1997	330	34
Solano	Dakota Creek	2004	320	34
Vallejo	Gladding Hearn	1994	267	34
Gemini class 4 vessels	Kvichak / Nicholls	2008-09	225; 199	26
Hydrus	Vigor	2017	400	27
Cetus	Vigor	2017	400	27
Central Bay 3&4	Vigor	2018-19	400	27
North Bay high speed	Dakota Creek	2018-19	445	34

Source: WETA

Table 13 Golden Gate Ferries

Name	Builder	Year	Passengers	Service Speed (knots)
Marin	n/a	1976-77	750	n/a
San Francisco	n/a	1976-77	750	n/a
Sonoma	n/a	1976-77	630	n/a
Del Norte	Dakota Creek	1997	400	36
Golden Gate	Dakota Creek	1998	450	36
Mendocino	Nicholls Bros	2001	450	36
Napa	Dakota Creek	1999	450	37

Source: Wikipedia and Shippax Hi-Speed Register 19

2.5.5 TERMINAL INFRASTRUCTURE

Most terminals serving the WETA / San Francisco Bay Ferry have free parking, as shown in Table 14.

Table 14 Parking at San Francisco Area Ferry Terminals

Terminal	Parking Spaces
Alameda	250
Oakland	Free parking up to 12 hours in 7-storey garage
Oracle Park	some
Richmond	362
SF Ferry Building	None, BART and buses close by
San Francisco Pier 41	Some hourly parking
South San Francisco	35
Mare Island	none
Vallejo	In city waterfront parking garage

Source: <https://www.sanfranciscobayferry.com/terminals>

Table 15 shows parking available at terminals operated by Golden Gate Ferry.

Table 15 Golden Gate Ferry Terminals

Terminal	Parking Spaces
Larkspur	1,800 – first come, first serve, \$2 per day
Sausalito	Pay for parking adjacent to terminal
Tiburon	Pay for parking downtown

Source: <https://www.goldengate.org/ferry/riding-the-ferry/terminal-locations-parking/>



Source: <https://www.goldengate.org/golden-gate-fleet/>

Figure 13 Larkspur Ferry Terminal

2.5.6 OPERATING COSTS

WETA's operating budget in 2016 was \$33 million and farebox recovery was about 50%. The operating cost per passenger is approximately \$12.20.

2.5.7 FUNDING MODEL

WETA's farebox recovery rate varies by route but systemwide it is currently 64% year to date. Its operating subsidy for the current fiscal year is approximately \$26 million. Of that, \$22 million from bridge tolls and the other \$4 million from county transportation tax contributions.

The Golden Gate Ferry is supported by farebox revenue and Golden Gate Bridge tolls.

2.6 SEATTLE KITSAP TRANSIT

Washington State Ferries (WSF) is the main ferry operator in the Seattle area and is one of the largest such operators in the world, carrying 24.7 million passengers and 10.8 million vehicles annually. It operates large double-ended car/passenger ferries on 13 routes.

Of interest to this project, however, are two passenger-only services which have been established to compete with or supplement WSF. One of these services is Kitsap Transit which launched fast-ferry service on the Bremerton/Seattle route in July 2017 and on the Kingston/Seattle route in November 2018. The Southworth route is under development and is expected to open in 2020. Kitsap Transit also operates shorter routes which they consider "foot ferries".

2.6.1 FERRY ROUTE DISTANCE AND TRAVEL TIME

The Kingston-Seattle route is 30 minutes and Bremerton-Seattle is 40 minutes. The new Southworth route will take 22 minutes. By car, the trip from Kingston to downtown Seattle would take 90 minutes using a conventional ferry and 70-90 minutes driving from Bremerton. From Southworth, the conventional ferry takes 60 minutes. Routes are shown in Figure 14.

2.6.2 FARES, RIDERSHIP AND MODAL SHARE

The fare structure is quite unique. It is far more expensive to travel westbound than eastbound i.e. it is less expensive to travel to Seattle than to return from Seattle (see Table 16).



Figure 14 Kitsap Ferry Network

Table 16 Fare Structure

	One-Way Cash		Kitsap Transit Monthly Trip Passes	
	Eastbound	Westbound	Fast Ferry Only	Bus & Fast Ferry
Full Fare	\$2.00	\$10.00	\$168.00	\$196.00
Reduced Fare	\$1.00	\$5.00	\$84.00	\$98.00

Thus far, the Kitsap fast ferry has about and 8% share of the transit market, as shown in Figure 15.

RIDERSHIP BY SERVICE & CHANGE FROM 2017

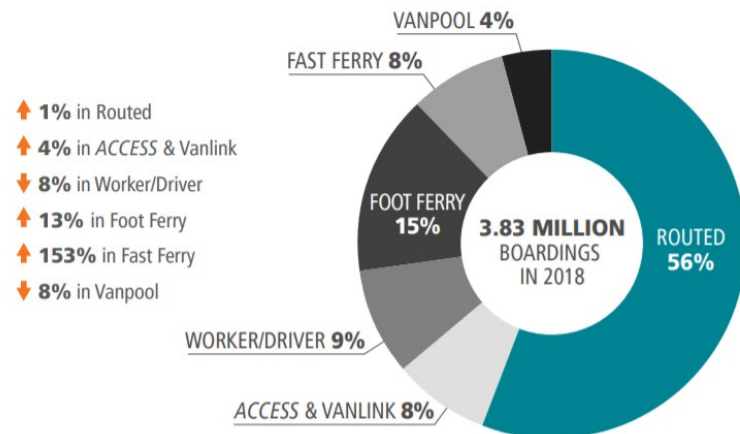


Figure 15 Kitsap Ferry Modal Share

2.6.3 SERVICE SPAN AND FREQUENCY

Generally, the two services only operate at peak times, as shown in Figure 16.

Bremerton/Seattle

Weekdays			
Bremerton to Seattle (Eastbound)		Seattle to Bremerton (Westbound)	
Depart Bremerton Ferry Dock	Arrive Pier 50 Seattle Ferry Dock	Depart Pier 50 Seattle Ferry Dock	Arrive Bremerton Ferry Dock
AM 5:25	AM 5:55	AM 6:05	AM 6:35
6:45	7:15	7:25	7:55
8:05	8:35	8:40	9:10
PM 2:05*	PM 2:35	PM 2:40*	PM 3:10
3:15	3:45	3:55	4:25
4:30	5:00	5:10	5:40
5:45	6:15	6:25	6:55
7:05*	7:35	7:40*	8:10

Kingston/Seattle - Weekdays

Weekdays			
Kingston to Seattle (Eastbound)		Seattle to Kingston (Westbound)	
Depart Kingston Ferry Dock	Arrive Pier 50 Seattle Ferry Dock	Depart Pier 50 Seattle Ferry Dock	Arrive Kingston Ferry Dock
AM 5:25	AM 6:04	AM 6:15	AM 6:54
7:05	7:44	7:55	8:34
8:45	9:24	10:45	11:25
PM 2:35	PM 3:14	PM 3:25	PM 4:04
4:15	4:54	5:05	5:44
5:55	6:34	6:45	7:24

Figure 16 Kitsap Route Schedules

2.6.4 VESSEL TYPES AND FLEET SIZE

Kitsap Transit operates five vessels (see Table 17), three of which currently operate on the fast ferry routes. These vessels have been designed with a high sensitivity to reducing wake wash because of the shorelines and marinas along the route.

Table 17 Kitsap Fleet Vessels

Name	Builder	Year	Passengers	Speed (knots)
Finest	Derecktor	1996	350	35
Melissa Ann	Nicholls	1988	172	28
Rich Passage I	All American	2010	118	37

Source: Kitsap Transit



Figure 17 MV Finest

2.6.5 TERMINAL INFRASTRUCTURE

Kitsap Transit operates and maintains a series of free park and ride facilities that serve Kitsap County's four WSF terminals, the Kitsap foot ferry, and the fast ferry service. They range in size from 14 to 462 cars. It operates shuttle buses to and from the two fast ferry terminals.

2.6.6 OPERATING COSTS

The average fare per passenger is \$3.99 for the fast ferry. The subsidy per passenger is \$12.15 and the farebox recovery percentage is 24.7%. Figure 18 provides a graphic representation of revenues and expenses.

2.6.7 FUNDING MODEL

The funding model is quite unique. In 2016 voters approved a ballot proposition for a dedicated sales tax to support Kitsap Transit's plan for passenger-only ferry service to downtown Seattle from Bremerton, Kingston and Southworth (2020).

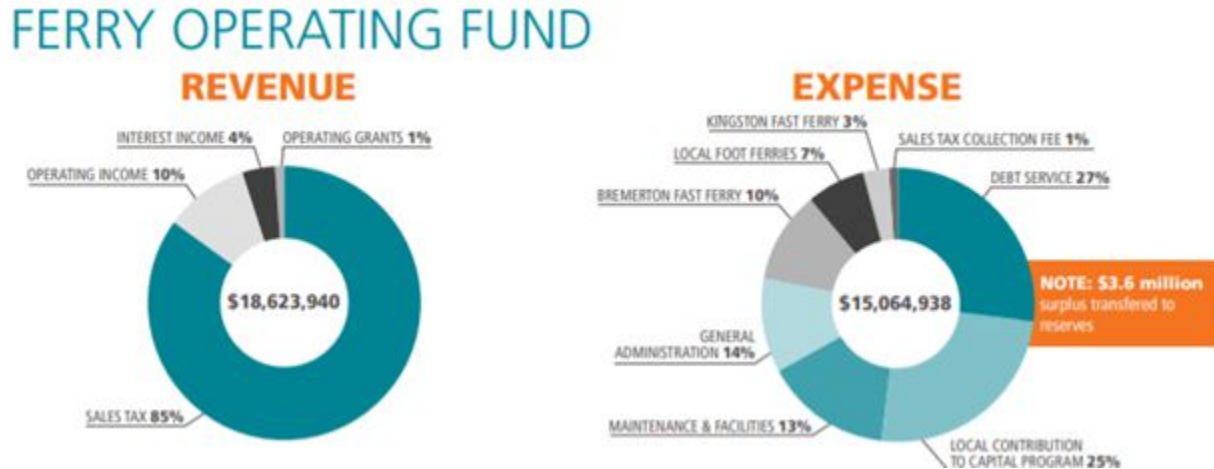


Figure 18 Kitsap Ferry Revenue and Operating Costs

2.7 KING COUNTY WATER TAXI

The second Seattle-area ferry service is provided by King County Marine Department. They operate two passenger-only water taxis in the Seattle region. They are the Vashon Island water taxi and the west Seattle water taxi.

2.7.1 ROUTE DISTANCE AND TRAVEL TIME

The Vashon Island route is 16 kilometres long and takes 22 minutes. The West Seattle route is approximately 3 kilometres long and takes 10-15 minutes, depending on docking time at the terminal in Seattle.

From Vashon Island there is an alternative WSF service to Fountleroy, which connects to the regional highway network. To get to the ferry dock in downtown Seattle would take 75 minutes.

From West Seattle there is a drive through an industrial area which would take 15 minutes with no traffic.

2.7.2 FARES, RIDERSHIP AND MODAL SHARE

The adult one-way fare on the Vashon service is \$6.75 while the West Seattle service costs \$5.75.

In 2018, the Vashon Island service carried 249,398 passengers. The West Seattle service carried 414,967 passengers; the system carried 664,365 passengers altogether.

The Vashon Island service operates six round trips per day, while the West Seattle service operates twelve round trips during November-March and 12-21 during the rest of the year. Schedules are shown in Figure 19.

Weekdays only

Does not operate on **holidays***.
Crossing time: about 22 minutes.

Leave Vashon	Leave Seattle
---	5:30 AM
6:10 AM	6:38 AM
7:10 AM	7:40 AM
8:15 AM	---
---	4:30 PM
4:58 PM	5:30 PM
5:58 PM	6:30 PM
6:58 PM	---

Departs Pier 50	Departs West Seattle
5:55 AM	6:15 AM
6:30 AM	6:50 AM
7:05 AM	7:25 AM
7:40 AM	8:00 AM
8:15 AM	8:35 AM
8:50 AM	9:10 AM
---	---
3:25 PM	3:45 PM
4:05 PM	4:25 PM
4:45 PM	5:05 PM
5:25 PM	5:45 PM
6:05 PM	6:25 PM
6:45 PM	7:05 PM

Figure 19 King County Water Taxi Schedules

2.7.3 VESSEL TYPES AND FLEET SIZE

The King County Marine Department operates two sister ships on its routes (see Table 18).

Table 18 King County Ferry Fleet

Name	Builder	Year	Passengers	Speed (knots)
Sally Fox	All American Marine	2015	278	28
Doc Maynard	All American Marine	2015	278	28

2.7.4 TERMINAL INFRASTRUCTURE

Parking is available about a block away from the terminal on Vashon Island. The terminal is linked to local bus routes. There are also park and ride facilities on the island.

There is limited short term parking at the Seacrest Park terminal in West Seattle.

2.7.5 OPERATING COSTS

In 2018, operating costs were \$7.1 million and revenues \$3.2 million. The farebox recovery percentage was 45%. The service's operating costs are shown in Figure 21.



Figure 20 Vessel docked at West Seattle Terminal

2.7.6 FUNDING MODEL

The Vashon service was WSF funded and operated from 1994-2008. The West Seattle service was operated by Argosy Cruises from 1998-2009.

In April 2007 the county formed the special-purpose King County Ferry District to take over operations of both the West Seattle and Vashon Island passenger-only ferries. The district is funded through a property tax levied on all property in the county. The ferry district took over operation of the West Seattle/Downtown Seattle route from King County Metro on April 27, 2008.

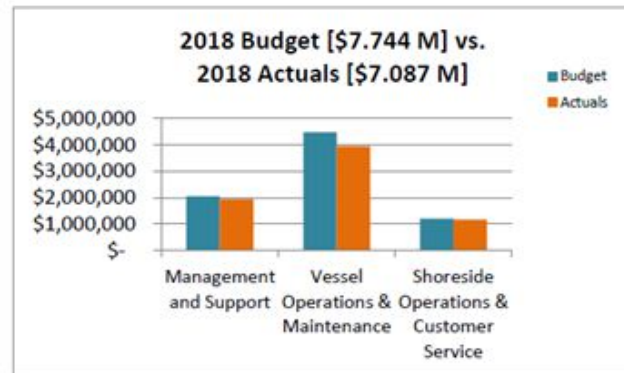


Figure 21 Kings County Transit Operating Costs

2.8 VANCOUVER SEABUS

Vancouver's passenger-only ferry service (SeaBus) is almost identical in concept to Halifax's cross-harbour ferries. It is operated by TransLink, which also operates the bus, Skytrain and some commuter rail. SeaBus is not a fast or high-speed ferry service.

There have been some ongoing discussions regarding ferry service along the Fraser River as well as between Nanaimo and downtown Vancouver, but these have not yet materialized.

2.8.1 DISTANCE AND TRAVEL TIME

The SeaBus route crosses Burrard Inlet and is 2.8 kilometres long (see Figure 22). The crossing takes 10-12 minutes at a cruising speed of 11.5 knots. To drive the 10-kilometre distance would take 26 minutes with no traffic. The route map clearly shows how the ferry is integrated into other components of the regional transit network.



Figure 22 SeaBus Route

2.8.2 FARES, RIDERSHIP AND MODAL SHARE

Similar to the SkyTrain, the SeaBus require a 1-, 2-, or 3-Zone fare, depending on the time of day and number of geographical zone boundaries crossed during the trip. Those fares are shown in Figure 23.

In 2018, the service carried 6.6 million passengers, up from 6.2 million the year previous⁹.

2.8.3 SERVICE SPAN AND FREQUENCY

SeaBus schedules are shown in Figure 24. TransLink is moving towards sailings every 10 minutes because demand is very strong.

Fare Product	Zones	Adult	Concession
Single/Cash Fares (Tap to Pay)	1	\$3	\$1.95
	2	\$4.25	\$2.95
	3	\$5.75	\$3.95
Stored Value (Compass Card)	1	\$2.40	\$1.95
	2	\$3.45	\$2.95
	3	\$4.50	\$3.95
Monthly Pass (Compass Card)	1	\$98	-
	2	\$131	-
	3	\$177	\$56

Figure 23 SeaBus Fare Structure

Departing Waterfront			Departing Lonsdale Quay		
Day/s	Times	Frequency	Day/s	Time	Frequency
Monday to Friday	6:16 a.m. to 7:15 a.m.	15 mins	Monday to Friday	6:00 a.m. to 7:00 a.m.	15 mins
	7:15 a.m. to 9:46 a.m.	10 mins		7:00 a.m. to 9:30 a.m.	10 mins
	9:46 a.m. to 3:15 p.m.	15 mins		9:30 a.m. to 3:00 p.m.	15 mins
	3:15 p.m. to 6:45 p.m.	10 mins		3:00 p.m. to 6:30 p.m.	10 mins
	6:45 p.m. to 9:16 p.m.	15 mins		6:30 p.m. to 9:00 p.m.	15 mins
	9:16 p.m. to 12:46 a.m.	30 mins		9:00 p.m. to 12:32 a.m.	30 mins
	1:22 a.m.	Last sailing		1 a.m.	Last sailing
Saturday	6:16 a.m. to 7:16 a.m.	30 mins	Saturday	6:02 a.m. to 7:02 a.m.	30 mins
	7:16 a.m. to 9:16 p.m.	15 mins		7:02 a.m. to 9:02 p.m.	15 mins
	9:16 p.m. to 12:46 a.m.	30 mins		9:02 p.m. to 12:32 a.m.	30 mins
	1:22 a.m.	Last sailing		1 a.m.	Last sailing
Sunday/ Holidays	8:16 a.m. to 9:16 p.m.	15 mins	Sunday/Holidays	8:02 a.m. to 9:02 p.m.	15 mins
	9:16 p.m. to 11:16 p.m.	30 mins		9:02 p.m. to 11:02 p.m.	30 mins
	11:16 p.m.	Last sailing		11:02 p.m.	Last sailing

Figure 24 SeaBus Schedules

⁹ Shippax Market19, p. 260.

2.8.4 VESSEL TYPES AND FLEET SIZE

SeaBus operates three double-ended catamaran sisterships, which are constructed out of aluminum (see Table 19). A fourth is under construction in the Netherlands and is expected to enter service in 2020. The latter vessel is expected to cost \$32.2 million.

Table 19 SeaBus Fleet

Name	Builder	Year	Passengers	Speed (knots)
Burrard Beaver	Yarrows	1976	385	13.5
Burrard Pacific Breeze	Victoria	2009	385	13.5
Burrard Otter II	Damen	2014	385	13.5
Burrard Chinook	Damen	2020	385	13.5

In late 2019, TransLink recently issued an RFP seeking to identify and investigate potential vessel propulsion options to be used in the design of the next generation of SeaBus vessels. They want to examine battery-powered vessels, autonomous vessels, and potential designs as well as builders.

2.8.5 TERMINAL INFRASTRUCTURE

The Waterfront terminal is located downtown adjacent to Canada Place and the Vancouver Convention Centre. It has a direct link to the Skytrain and the West Coast Express commuter rail line.

Lonsdale Quay in North Vancouver is a busy marketplace and transit hub, with at least twelve bus lines converging there. The transit hub is being upgraded. There is parking at the Quay but is limited to three hours maximum. The terminal is set up to encourage riders to take transit for their whole trip.

2.8.6 OPERATING COSTS

In 2017, TransLink's overall cost recovery ratio was 55.8%. SeaBus was not broken out separately in the Annual Report.

2.8.7 FUNDING MODEL

Besides farebox revenue, TransLink receives money from a property tax and a parking tax on property within its operating area, as well as commercial opportunities.

2.9 AUCKLAND, NEW ZEALAND

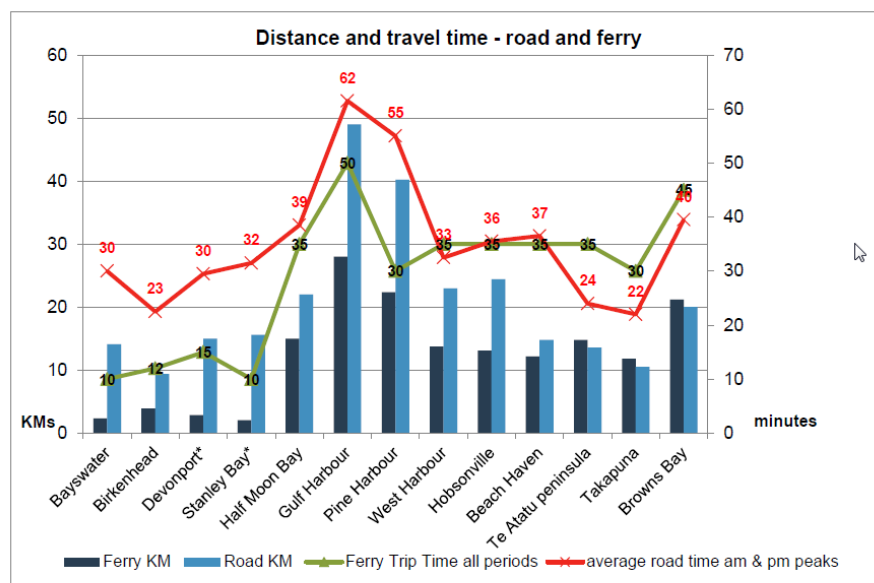
Auckland is the largest city in New Zealand, with a metro population of 1.4 million. The central city is clustered around Waitemata Harbour, which opens up onto the Haurakai Gulf, akin to Halifax Harbour opening joined to St. Margaret's Bay. There are suburbs to the north, west and east of the city which are accessible by road, rail and water. Congestion in the central city is a major issue.

2.9.1 ROUTE DISTANCE AND TRAVEL TIME

Auckland's ferry system is illustrated in Figure 25. Auckland's ferry services are very competitive with road alternatives, both in terms of driving distance and driving times, as shown in Figure 26.



Figure 25 Auckland Ferry Network



Note: road distance based on Google distance by fastest route. Road travel time supplied by Travel Demand Management team. * Exempt services - Waiheke Island excluded.

Source: Ferry Development Plan, Auckland Transport, 2014

Figure 26 Ferry/Road Time Comparison

2.9.2 FARES, RIDERSHIP AND MODAL SHARE

The fare structure varies according to the distance travelled. For illustrative purposes, we have chosen three routes to compare (see Figure 27): Half Moon Bay (15 km), Gulf Harbour (28 km), and Birkenhead (5 km).

Half Moon Bay

TO/FROM AUCKLAND	CASH FARE	AT HOP FARE
Adult fare	\$10.50	\$7.60
Child fare*	\$6.00	\$4.50
Accessible fare*	\$6.00	\$4.50
Tertiary fare*	\$10.50	\$5.90
AT HOP Ferry Mid Monthly pass	-	\$260.00

Gulf Harbour

TO/FROM AUCKLAND	CASH FARE	AT HOP FARE
Adult fare	\$15.00	\$11.10
Child fare	\$8.00	\$6.00
Accessible fare	\$8.00	\$6.00
Tertiary fare	\$15.00	\$8.40
AT HOP Ferry Outer Monthly pass	-	\$330.00

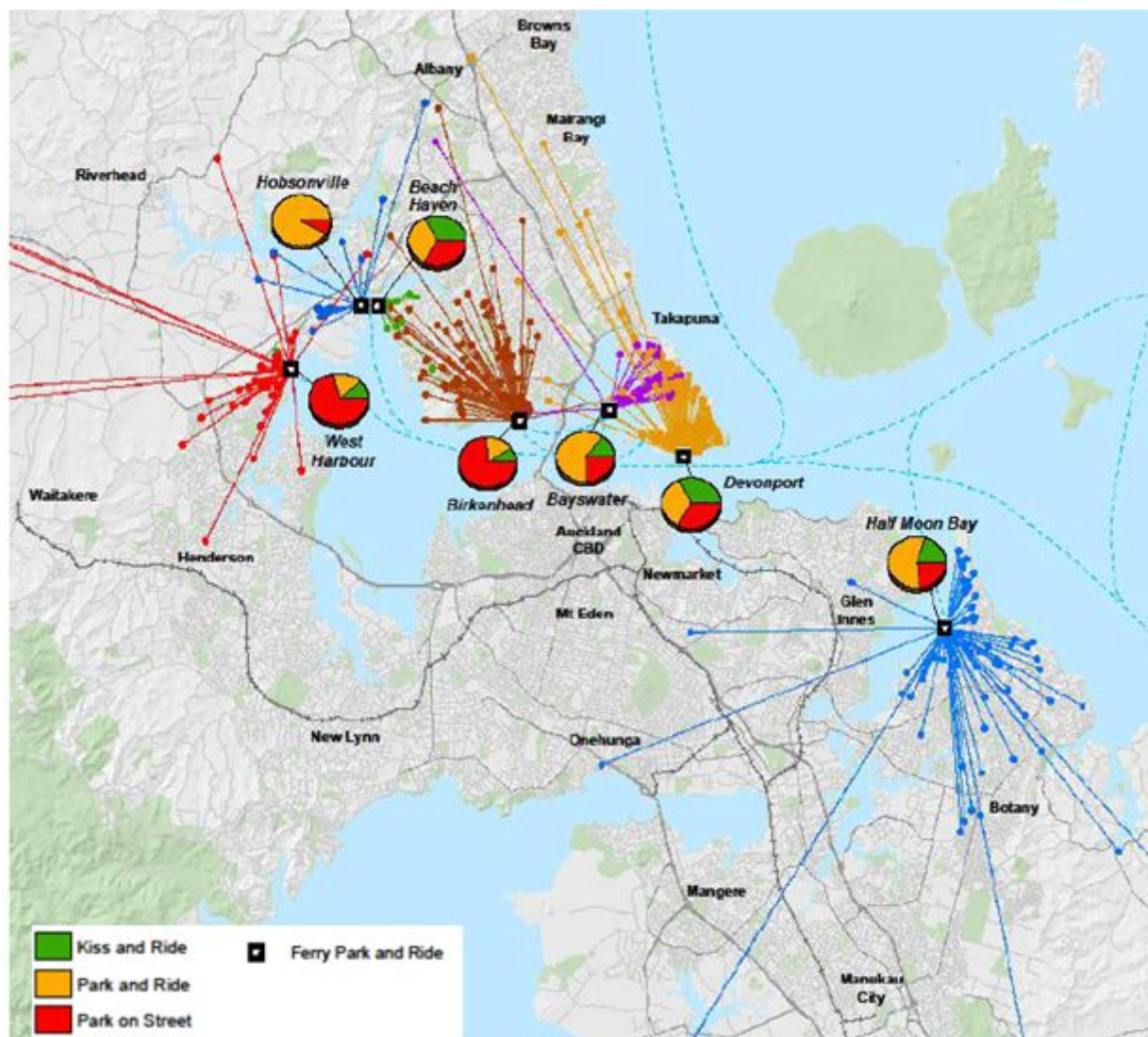
Birkenhead

TO/FROM AUCKLAND	CASH FARE	AT HOP FARE
Adult fare	\$7.50	\$5.00
Child fare*	\$4.00	\$2.95
Accessible fare*	\$4.00	\$2.95
Tertiary fare*	\$7.50	\$3.80
AT HOP Day Pass	-	\$19.00
AT HOP Ferry Inner Monthly pass	-	\$160.00

Figure 27 Auckland Fare Structure

Auckland ferries carried 6.3 million passengers in 2018. Modal share is 7%. About 77% of ferry passengers were carried on Devonport and Waiheke services.

The map in Figure 28 illustrates the relative shares of “kiss and ride”, “park and ride”, “park on street” and “ferry park and ride locations.”



Source: Ferry Development Plan, 2014

Figure 28 Park and Ride Catchments

2.9.3 SERVICE SPAN AND FREQUENCY

The shortest route is across the Waitemata Harbor to Devonport. It is akin to the two Halifax Harbour routes. More relevant are the services to Half Moon Bay and West Harbour. Schedules are shown in Figure 29. The longest route is Gulf Harbour, with travel time of 50 minutes, as shown in Figure 30.

Half Moon Bay to City

HRS	MON TO FRI MINUTES	SATURDAY MINUTES	SUNDAY & PUBLIC HOLIDAYS* MINUTES
06	55	-	-
07	30	-	-
08	15	30	30
09	15	-	-
10	15	45	45
11	-	-	-
12	15	-	-
13	-	15	15
14	15	-	-
15	15	45	45
16	15	-	-
17	00	-	-
18	00 30	-	-
19	30	00	00
20	-	-	-
21	00fo	-	-
22	30fo	-	-
23	-	-	-

fo = Friday only
No service on Christmas Day

West Harbour Schedule

Monday to Friday only (excluding public holidays)			
Depart West Harbour	Arrive Downtown Pier 4	Depart Downtown Pier 4	Arrive West Harbour
06:50	07:20	07:20	07:55
07:20	07:50	07:50	08:25
07:40	08:10	08:10	08:45
08:10	08:40	08:45	09:15
08:40	09:10	09:15	09:45
09:20	09:50	-	-
11:00	11:30	12:45	13:15
14:30	15:00	15:05	15:35
15:55	16:25	16:30	17:00
16:15	16:45	16:50	17:20
16:45	17:15	17:20	17:50
17:15	17:45	17:50	18:20
17:55	18:25	18:30	19:00
18:25	18:55	19:00	19:30

Arrival times are approximate only and are subject to weather and other unplanned circumstances
For more information on fares and fare products visit AT.govt.nz/fares

Figure 29 Short Route Ferry Schedules

Monday to Friday only(excluding public holidays)			
Depart Gulf Harbour Marina Pier Z	Arrive Downtown Pier 4	Depart Downtown Pier 4	Arrive Gulf Harbour Marina Pier Z
*06.30	07.20	*07.30	08.20
*07.00	07.50	*09.30	10.20
*07.30	08.20	*10.30	11.20
*08.30	09.20	*12.30	13.20
*10.30	11.20	*14.45	15.35
*11.30	12.20	*16.45	17.35
*13.30	14.20	*17.15	18.05
*15.45	16.35	*17.45	18.35
*17.45	18.35	*18.45	19.35
19:45	20:35	20:45	21:35

*Connecting bus service to/from The Plaza
Arrival times are approximate only and are subject to weather and other unplanned circumstances
For more information on fares and fare products visit AT.govt.nz/fares
This service is provided by Fullers360

Figure 30 Gulf Harbour Schedule

2.9.4 VESSEL TYPES AND FLEET SIZE

Fullers and Fullers360 operate the most routes, and at over 5 million, carry the most passengers. They have the largest number of vessels and are summarized in Table 20.

Table 20 Fullers Group Vessels

Name	Year	Passengers	Speed (knots)
Adventurer	2002	246	28
Jet Raider	1990	400	
Quickcat	1986	650	27
Quickcat II	1985	195	27
Seabus	1989	411	
Seaflyte	1994	199	25
Starflyte	1999	306	27
Superflyte	1996	650	26
Wanderer II	1996	158	28
Takahe	2011	197	26

Sources: Shippax Market 19; Shippax Hi-Speed Annual Register of Ferries

2.9.5 TERMINAL INFRASTRUCTURE

Auckland Transport provides the terminal infrastructure. Some have park and ride features, while some just provide a dock. The latest strategic plan envisions some expansion of parking facilities as shown in Table 21. A new park and ride and bus turnaround facility recently opened at Half Moon Bay and is shown in Figure 31.

Table 21 Proposed Park and Ride Projects for Ferry Terminals

Location	Year	Estimated cost	Existing spaces	New spaces
West Harbour	2015-2025	\$0.429M	38	50
Hobsonville extension	2015/16	\$0.859M	31	100
Half Moon Bay	2018/19 onwards	New project (est 2 levels) \$6.0M	305	305 - replace existing parking; potential public-private partnership
Birkenhead	2018/19	New project (\$0.429M)	150	50 additional spaces depending on feasibility

Source: Ferry Development Plan, Auckland Transport, 2014



Source: Google Images

Figure 31 Half Moon Bay Ferry Terminal

2.9.6 OPERATING COSTS

Auckland's ferry services are subsidized by about NZ\$10 per passenger, or NZ\$60 million per year.

2.9.7 FUNDING MODEL

Services are provided by six companies, under contract to Auckland Transport (see Table 22). The largest is Fullers, which operates as Fullers and Fullers 360. Service providers are listed below. Fullers and others operate commuter-type services and tourist services.

Table 22 Auckland Ferry Service Providers

Fullers Group Limited	Scheduled passenger services between Downtown and Birkenhead, Northcote Point, Bayswater, and Half Moon Bay Exempt scheduled services to Stanley Bay, Devonport, Waiheke Island Tourist services and charters, holiday period passenger services to Great Barrier Island.
360 Discovery Cruises	Scheduled passenger services between Downtown and Gulf Harbour, Hobsonville and Beach Haven and Downtown Tourist services and charters Inter-regional service to Coromandel via Orapiu
Belaire Ferries Limited	Scheduled passenger services between Downtown and West Harbour Marina Scheduled service to Rakino Island Charters
Sea Link Pine Harbour Limited	Scheduled passenger services between Downtown and Pine Harbour Marina
Sea Link Travel Group	Exempt scheduled vehicular and foot passenger ferry service between Half Moon Bay and Kennedy Point (Waiheke Island); passenger, freight and vehicular ferry services between Wynyard Quarter and Great Barrier Island and weekend services between Wynyard Quarter and Kennedy Point; charters
Explore Group Limited	Exempt scheduled services between Downtown and Waiheke Island (Matiatia) Tourist services including weekend sailings to Motutapu Island (summer only)

Source: Ferry Development Plan

2.10 CONCLUSIONS AND TAKEAWAYS

2.10.1 PASSENGER FARE STRUCTURE

Except for NYC Ferry, most services seem to be more expensive than alternative forms of transit. In the case of one of the Seattle services, the headhaul was much less expensive than the backhaul. (We endeavoured to get an explanation for this but were unsuccessful in this regard). Fares also tended to vary by distance travelled. Other than Vancouver, services are not well-integrated with other elements of the transit network.

Figure 32 shows a sample of one-way undiscounted adult fares versus travel distance for a selection of routes that we reviewed. For context, the travel distance from the Halifax Ferry Terminal to Shannon Park and Mill Cove are provided.

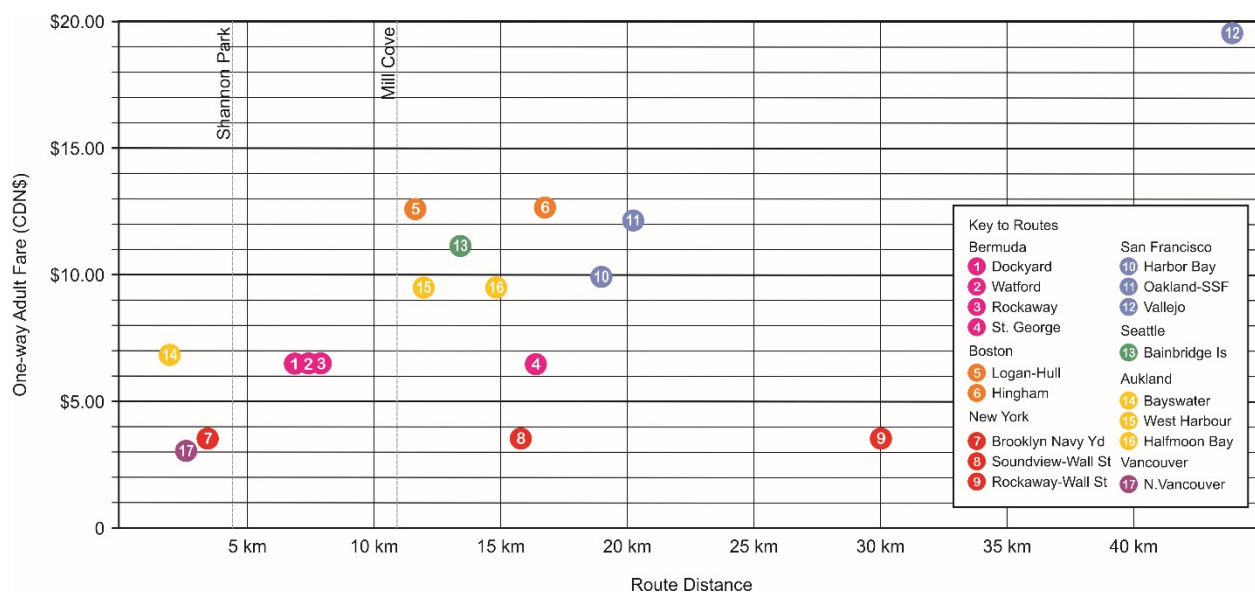


Figure 32 Fares Versus Travel Distance on Selected Ferry Routes

2.10.2 RIDERSHIP AND MODAL SHARE

We were unable to obtain very detailed modal share data. It was usually included in “transit” data versus other modes like auto, active etc.

2.10.3 VESSEL TYPES AND FLEET SIZE

Most of the vessels reviewed were designed by Incat Crowther, an Australian designer and builder. US yards have built their vessels under license. There is also some design expertise in the Seattle area, and New Zealand.

Vessel size varies quite extensively. NYC Ferry and NY Water Taxi before it, settled on 149-seat capacity, at least initially. NYC Ferry has recently built 350-passenger capacity vessels to respond to increased demand. The Kitsap “foot ferries” in Seattle are 149 passenger vessels, but the fast ferries are as high as 350 passengers.

San Francisco’s expanding WETA system has increased their vessel sizes from about 330-350 passengers to 445 on recent new additions.

Bermuda has found its first- and second-generation waterjet propelled vessels to be too heavy and expensive to operate. They are looking for lighter and faster vessels. The current vessels travel at 28-34 knots.

Except for Vancouver, most of the vessels reviewed travel at speeds varying from 25-37 knots. Vancouver's vessels are an old 1970's design; a recent RFP suggests they are at least going to examine the potential for an alternative approach, but the main emphasis of that RFP seems to be on propulsion systems and types of fuel.

2.10.4 TERMINAL INFRASTRUCTURE

None of the services we examined provide parking at their main terminals. NYC Ferry provides no parking at its 21 terminals as they are all in very urbanized parts of the city and linked to other parts of the transit system.

One of Bermuda's terminal sites has a park and ride and they are examining the potential for more. The suburban terminal in San Francisco have extensive park and ride facilities.

Seattle's two fast ferry operators have park and ride facilities, but not necessarily adjacent to the ferry terminals. One of them has park and rides throughout the community and provides shuttle buses to connect with the ferry service.

The two terminals in Vancouver do not have parking but have extensive connections to other forms of transit.

2.10.5 MAINTENANCE INFRASTRUCTURE

San Francisco seems to have the most extensive maintenance facilities. Most others are provided by the contracted vessel operators i.e. Hornblower and Boston Harbor Cruises.

2.10.6 OPERATING COSTS

The best cost recovery ratio amongst the services scanned was Boston at over 65% and the worst was Bermuda at about 25%. Other data on ridership and operating costs is provided in Table 23. Caution should be exercised in comparing operating costs from service to service as not all components of operation are consistently accounted for by each agency.

Table 23 Operating Cost and Ridership Comparison

Name	Annual Operating Cost (\$US million)	Annual Revenue (\$US million)	Annual Ridership	Approx. Operating Cost per Passenger
Dockyard Route (Bermuda)	1.7	0.9	101,397	\$16.70
King County Water Taxi (Seattle)	7.1	3.2	664,365	\$10.68
WETA (San Francisco)	33.0	n/a	2,700,000	\$12.20

2.10.7 FUNDING MODEL

There is a mix of different approaches to funding. Some services are operated by government (Bermuda, Seattle (2), Vancouver), while others contract out the operation of vessels to private companies (New York, Boston, San Francisco). Either approach could work in Halifax.

The two Seattle-area fast ferry operations have the most unique and imaginative funding models. King County water taxi is funded by a legislated property tax and Kitsap Fast Ferries are funded by a voter approved sales tax.

2.10.8 OTHER

Other research¹⁰ suggests that ferry services can spur Transit Oriented Development (Ferry Oriented Development) and help revitalize urban waterfronts or new waterfront development.

System integration is another important facet of a successful ferry service. Moreover, successful ferry services with high ridership are easy to use and should be integrated into the overall transportation network of roadways and transit.

It is interesting to note that in San Francisco, ferries are integrated into their emergency response planning. Although the imminent threat of earthquake is not present here, there may be some value to being able to evacuate more people by water with more ferries available.

¹⁰ Tanko, Michael, Matthew I. Burke & Harsha Cheemakurthy (2018), Water Transit and Ferry-Oriented Development in Sweden: Comparisons with System Trends in Australia, Transportation Research Record, 2672, 890-900

3 EXPANDING THE FERRY NETWORK

3.1 RECOMMENDED VESSEL FEATURES

3.1.1 VESSEL CHARACTERISTICS

The potential choices for a new passenger vessel for expanded ferry service in Halifax Harbour are virtually limitless. Any new class of ferry should offer Halifax Transit the ability to use its full existing crewing resource interchangeably across its entire fleet including the existing ferries. This requires that certification levels for operators, both deck and engine should be the same; in the case of the deck department a 150 tonne Master's License and for the engine department a Small Vessel Machinery Operator Certificate. Operational, regulatory and crewing factors lead us to believe that the "ideal" vessel will have the following characteristics:

MULTI-HULL DESIGN, MOST LIKELY A CATAMARAN.

- A smaller water plane, displacement and wetted hull surface for a given deck area, when compared to a monohull vessel, offering better hull efficiency and reduced fuel consumption.
- Better wake characteristics.
- Less sensitivity to passenger movements on board the vessel.

A SINGLE DECK WITH BOW LOADING

- A single deck offers more efficiency for loading and discharge of passengers, a critical factor in the vessel maintaining schedule. Ideally passengers will load and discharge over the bow, however experience on the existing HRM ferries indicates that side load and discharge can be accomplished relatively efficiently if this is dictated by terminal design.
- In accordance with the Marine Personnel Regulations, one crew member is required to assist in passenger management in an emergency situation for each passenger carrying "compartment" including open decks. A second passenger deck would increase the required crew complement by one person.

A LENGTH OVER ALL OF LESS THAN 24 METRES

- A 24m overall length is the threshold at which a number of construction regulations begin to apply.
- Exceeding this criterion will likely require the vessel to be built to class and add dramatically to the construction cost of the vessel.
- For comparison, the existing ferries are approximately 24 metres long.

AN INSTALLED POWER OF LESS THAN 1499 KW

- The Marine Personnel Regulations (Section 219) dictate that on a "sheltered waters voyage" if a number of other criteria are met that the vessel may carry a crew member with a Small Vessel Machinery Operator certificate rather than a 4th Class Marine Engineer certificate. This corresponds with HRM's current crew certification requirement for the existing ferries.

PROPELLER OR AZIMUTHING THRUSTER DRIVE

- The expected transit speeds for the new service are such that jet drives would be unlikely to offer an efficient propulsion option and that the added complexity and operating cost of jets would not be justified.
- Conventional shaft/propeller drive would offer a noticeable cost advantage and simplicity of operation.

- Azimuthing Thruster or “Pod” drive would offer the potential of significantly enhanced fuel efficiency if a contra rotating propeller drive (two contra rotating propellers per drive) was selected and may be able to be exchanged without removing the vessel from the water. Azi Drive would also offer enhanced manoeuvrability.

It is evident from experience in other cities that a catamaran design is a given for higher speed operation in areas where wake needs to be minimized. We believe that, for operation in the Halifax Harbour, a propeller drive is preferable to a jet drive due to the presence of debris in the harbour and the reduced requirement for maintenance.

Beyond those two features, there are other design considerations such as aluminum body versus composite and diesel power versus alternative hybrid and electric/solar technologies. We believe these decisions will not affect the determination of system feasibility and are best left for later evaluation or may even be left open going into an Expression of Interest or Tendering process.

We recommend that the vessel be a single passenger deck with the bridge above. This type of design may reduce the crewing requirement and, from experience voiced by the Halifax Transit ferry staff, substantially reduces vessel unloading time.

Space should be provided to accommodate bicycles and strollers. While space onboard the vessel is preferred, many vessels we have seen can accommodate a large number of bicycles on the exposed bow of the vessel, to the side of the passenger loading/unloading corridor.

Catamaran ferries typically load and unload from the bow of the vessel and docking is done by nosing in to the dock. Although this is a departure from the existing method of loading and unloading passengers (from the side) we recommend this method as it will improve docking as well as loading and unloading times.

To optimize the route operating schedules it is important to reduce the time that the ferry is docked and for that reason it will be important to have a crew washroom onboard.

3.1.2 VESSEL CREWING

Crewing typically represents either the largest or second largest expense in vessel operations. Minimization of crew numbers, always within the bounds of safe operation of the vessel and in conformance with the applicable regulations, is critical to operation of a financially viable service.

After reviewing the applicable regulations, it would appear that a 24m single deck catamaran with remotely operated machinery could be safely operated with a crew of three persons, a Master, a Mate, and a Deckhand or Deckhand/Engineer. Ideally any new vessel will require the same crew certification requirements as the existing Halifax Transit fleet to allow mobility of crew members through all vessels in the fleet.

The expected crew would consist of:

- A Master.

This would require a 150-ton Master’s License, suitable for any vessel under 500 GRT operating on a sheltered water voyage.

Marine Personnel Regulations (212) Table 1 Item 12.

- A Second person on deck watch.

A person holding an Able Seafarer or Bridge Watch rating. Marine Personnel Regulations 216(2).

- A person in charge of Machinery.

It is fully expected that a vessel of this size will have less than 1499 kW installed propulsive power, and as a result of meeting the other criteria in the Regulations should be able to be operated with an Engineer with a Small Vessel Machinery Operator’s certificate.

MARINE PERSONNEL REGULATIONS 219 (2)

The configuration of the vessel chosen will dictate whether any more than three crew members are required in order to deal with any emergency situation.

For example:

Under the Marine Personnel Regulations 207 (4d) (i) aside from the Master of the vessel, there must be one person available to fight fire and simultaneously under 207 (4d) (iv) one person to deal with passengers in each passenger compartment or deck (hence the preference for a single deck)

Under the same section there must be one person for each Muster Station and one person for every 150 passengers (hence the preference for a vessel with a total complement of 150 persons)

Under the Life Saving Appliance Regulations the suggested design will be described as a Class V vessel and under part 66(1) (a) the vessel must carry suitable life rafts for the full complement

Under the Marine Personnel Regulations 210 (a) (i) there must be one crew member for every two life rafts.

This should then dictate that no more than two life rafts should be specified.

Reviewing the above to operate safely within the “Sheltered Waters” limits of Halifax Harbour then all requirements would be met with a crew of three persons.

If the vessel:

- Has a single passenger compartment.
- Has a remotely operated propulsion system.
- Has a total complement of up to 150 passengers.
- Has two life rafts or inflatable rescue platforms.

3.1.3 PASSENGER CAPACITY

The 2006 Fast Ferry Cultivation Study developed scenarios that considered both a 350-passenger vessel and a 206-passenger vessel and found that, with their demand projections, the larger vessel delivered optimal results. Despite this finding, we are recommending a vessel with a passenger capacity of 150. This capacity is a regulatory threshold in both Canada and the United States and capacity above that number requires additional crewing and other requirements. For this reason, a 150-passenger capacity is a standard design for many ferry vessels built in North America.

We believe that procuring a smaller vessel for the first of what may be several new ferry routes will provide scalability and reduce the risk to HRM of not meeting passenger demand projections. If the 150-passenger capacity of the ferry is routinely exceeded by high demand, then the Municipality will likely be eager to seek additional routes, even if the demand projections are lower. The Municipality could then consider acquiring higher capacity vessels for the initial route and shift the original vessels to new routes. Alternatively, additional 150-passenger capacity vessels could be procured and the departure frequency increased. If the service does not meet demand projections, service frequency could be reduced with one of the ferries being redeployed to a second route.

3.1.4 SPEED

The overarching requirement for the Master of any vessel operating in Canada is defined under the Canada Shipping Act 2001, specifically, the Collision Regulations, Schedule 1: International Rules for Preventing Collisions at Sea, 1972 with Canadian Modifications and more specifically Rule 6 of those Regulations:

Safe Speed — International

Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

In determining a safe speed the following factors shall be among those taken into account:

(a) By all vessels:

- (i) the state of visibility,
- (ii) the traffic density including concentrations of fishing vessels or any other vessels,

- (iii) the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions,
 - (iv) at night the presence of background light such as from shore lights or from back scatter of her own lights,
 - (v) the state of wind, sea and current, and the proximity of navigational hazards,
 - (vi) the draught in relation to the available depth of water.
- (b) Additionally, by vessels with operational radar:
- (i) the characteristics, efficiency and limitations of the radar equipment,
 - (ii) any constraints imposed by the radar range scale in use,
 - (iii) the effect on radar detection of the sea state, weather and other sources of interference,
 - (iv) the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range,
 - (v) the number, location and movement of vessels detected by radar,
 - (vi) the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity.

Safe Speed — Canadian Modifications

- (c) In the Canadian waters of a roadstead, harbour, river, lake or inland waterway, every vessel passing another vessel or work that includes a dredge, tow, grounded vessel or wreck shall proceed with caution at a speed that will not adversely affect the vessel or work being passed, and shall comply with any relevant instruction or direction contained in any Notice to Mariners or Notice to Shipping.
- (d) For the purpose of paragraph (c), where it cannot be determined with certainty that a passing vessel will not adversely affect another vessel or work described in that paragraph, the passing vessel shall proceed with caution at the minimum speed at which she can be kept on her course.

For the purposes of this study and the proposed routes, visibility, other traffic and particularly pleasure boat traffic and other harbour operations will have the greatest impact on what will constitute “Safe Speed”.

We believe that the ferry travel speeds used in the report *An Operational and Life Cycle Cost Analysis of Transit Service Alternatives in the Bedford-Halifax Corridor* are unjustifiably low and stand in the way of ferry expansion being feasible. From our analysis of ferry systems in other cities (see Section 2) and our interviews with key harbour stakeholders, we believe that higher travel speeds are appropriate for Halifax Harbour and will be supported.

The Halifax Port Authority advises that a harbour speed limit of ten knots has been used in the past, but that this is only used as a control for wake generation. Knowing that catamaran designs can greatly limit wake generation at higher speeds, they acknowledge that this type of a vessel will require unique consideration of safe operation speeds. As a starting point, we recommend proposing a maximum speed of 26 knots in Bedford Basin and 20 knots from the MacKay Bridge southward. Travel speed is critical to the scheduling of the ferry routes and, thus, the number of ferries needed to service those routes. It is critical that agreement be reached with regulators such as Halifax Port Authority, Transport Canada and Halifax Vessel Traffic Management as well as other stakeholders like the Department of National Defense regarding safe operating speeds prior to any investment in ferries.

3.1.5 WASH WAKE REQUIREMENTS

As suggested in the previous sections, wake generated by new ferry vessels should be the controlling criteria and not travel speed. The Fast Ferry Cultivation Study suggested a maximum wake height of 25 cm and a maximum wash energy of 2000 joules/metre be used when setting specifications for a vessel tender. We believe these criteria could be increased for Halifax Harbour to 30 cm and 2200 joules/metre. Table 1 (section 1.4.4) has shown that several vessels that operate in the Harbour at lower speeds generate a wake in excess of 35 cm and the existing ferries generate a wash energy above 2200 joules/metre.

3.1.6 MANOUVRABILITY AND PERFORMANCE IN ADVERSE WEATHER

Most vessels with a catamaran design can come from top speed to a complete stop in a relatively short distance as a result of their power-to-weight characteristics. The vessels can also manoeuvre well and turn very sharply.

The operating speeds we have proposed for service using new ferries will clearly need to be reduced in situations of limited visibility and heavy harbour traffic. It is very difficult to establish for planning purposes what those speeds will be. Suffice to say that, on occasion, ferries will not be able to keep their set schedule. This is akin to regular transit buses having to switch to a “snow schedule” when winter conditions reduce their operating speed.

New and emerging technologies, such as LIDAR, can assist bridge personnel in detecting objects obscured by fog and can be of benefit in maintaining needed operating speeds. LIDAR is analogous to Radar (Radio Detection and Ranging) but uses laser light rather than radio waves to detect targets. The newer versions of this technology have proven useful in reduced visibility and can be integrated into an ECDIS system.

FLIR is a different technology which is used to detect infra red and allows the operator to see anything that has a different heat signature from the ambient surroundings. These technologies, in combination with the existing onboard radar systems and the monitoring that is provided from shore by Halifax Traffic Services, will improve overall safety and should allow sufficient mitigation of risk as to minimizing time losses arising from reduced visibility.

3.2 RECOMMENDED TERMINAL FEATURES

3.2.1 FERRY DOCK

As noted in section 3.1.1, catamaran ferries are normally designed to “nose-in” to a wharf and load and unload passengers over the bow of the vessel. We believe the simplest approach is to construct new floating docks and to drop a gangway from the dock to the bow of the vessel once it is firmly pushing against the dock and tied. The gangway and wharf system should be designed so that its slope never exceeds five percent over the range of tide heights.

An example of a ferry dock in the San Francisco area is shown in Figure 33 (although the vessel is side-loading). Note that there is a glass/metal covered queueing area, but the majority of the gangway is uncovered. A similar dock in New York with a vessel more typically nosing-in to dock is shown in Figure 34.

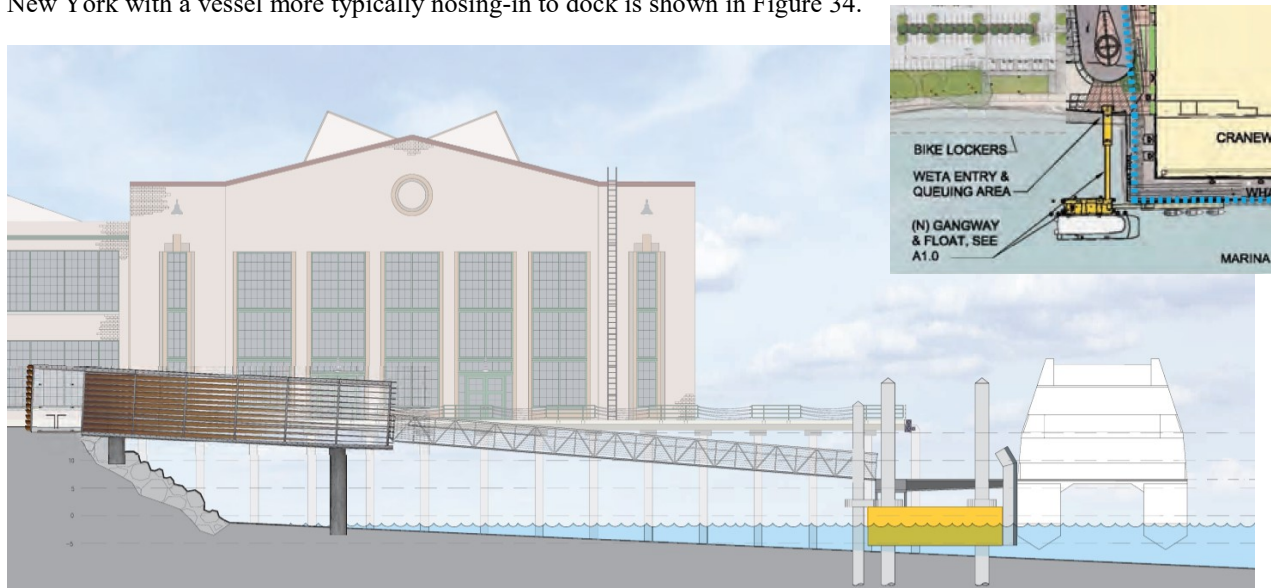


Figure 33 Planned Ferry Dock in Richmond, CA



Figure 34 Example of Nose-In Docking in New York

While this approach may be common in other cities, current ferry passengers have become accustomed to sheltered access to board a ferry. While interim wharfs may be designed as uncovered for the Halifax network, permanent terminal facilities should include sheltered gangways.

All wharfs at new terminals should be designed to moor all vessels required for that route during non-operational times. The wharfs will also need to accommodate ferry refueling and maintenance activities unless a dedicated facility is built (see section 5.1.10).

3.2.2 PASSENGER ACCOMODATION

The vast majority of urban ferry systems that we have examined use the same principle for managing passengers that a bus system does. A waiting area (normally sheltered) is provided at the ferry dock and passengers board the ferry when it arrives and pay their fare onboard. Although ferry passengers currently pay their fare at a staffed entry point at the ferry terminal, we believe that expansion of the ferry network opens an opportunity to re-examine the requirement and need for staffing at terminals. Fare technology being developed by Halifax Transit should make the collection of fares from passengers as they board the ferries straightforward.

Our interpretation of the ISPS code is that it should not apply to ferries operation in Halifax as indicated in section 201(2)(b) below:

- 201 (1) This Part applies to vessels in Canada, and Canadian ships outside Canada, that are SOLAS ships or non-SOLAS ships.
- (2) This Part does not apply to
 - (a) a pleasure craft, a fishing vessel, a vessel that is owned or operated by a government and used only on government non-commercial service, a vessel without a crew that is in dry dock, dismantled or laid-up, or a vessel that is subject to a security arrangement concluded between the Government of Canada and a contracting government in application of Regulation 11 of Chapter XI-2 of SOLAS; or
 - (b) a vessel that is entitled to fly the Canadian flag and that is engaged on a voyage between marine facilities in Canada, except when the vessel has an interface with a SOLAS ship or non-SOLAS ship that is entitled to fly the flag of a foreign state that is not subject to a security arrangement referred to in paragraph (a).

Even if it determined that staffing at a terminal is not required to meet the ISPS code, it will be an essential feature of the facility if vessels frequently reach their passenger capacity and a staff person is needed to ensure that only one vessel's capacity of passengers can enter the waiting area at one time to ensure orderly boarding. HRM staff has also indicated that a staffed terminal building will aid in customer service and has become an expectation of the ferry service. Accordingly, our operational cost estimates will include the presence of a security person at each of the new ferry terminal buildings during operating times.

3.2.3 TRANSIT ORIENTED DEVELOPMENT

In some locations, particularly Mill Cove and Shannon Park where site planning and development is ongoing, there may be an opportunity to integrate future development around a ferry terminal site. When new residential units are constructed with higher density and well-connected for walking and biking to a transit terminal that already has high level transit service, it can be expected that buyers intending to use transit to commute to work will be most attracted to locating there. New development also brings an opportunity to integrate a passenger waiting area into a new public (or possibly private) building on the waterfront.

The areas surrounding the Larry Uteck and Birch Cove sites are close to fully-developed with reasonably high density within walking distance. We believe there is some opportunity, however, to use underdeveloped or lower density commercial lands to create some small-scale transit-oriented development.

3.2.4 BUS CONNECTIONS

Many of the potential ferry terminal sites are on a major bus corridor and creating a strong transfer link between buses and the ferries can play a critical role in reducing bus loading entering the urban core and maximizing the ferry ridership. In some locations, buses can be brought off-corridor to within close proximity of the ferry dock, but in other locations, buses will need to stay on their corridor and transferring passengers will need to walk to the ferry dock. The corridor bus stops should be located as close to a signalized intersection as practical and a wide concrete walkway or multi-use trail should be built between the intersection and the passenger waiting area at the dock. For locations on the west side of the Bedford Basin, a crossing of the CN main line will be required. Although, with proper design features, approval can be obtained for an at-grade crossing, it is suggested that grade separated crossings be considered due to the high volume of pedestrians and the speed of passing trains.

Some ferry services we have reviewed (Seattle, in particular) will shuttle passengers from an “inland” parking lot to the ferry terminal. Although this type of a feature is not part of our basic service model, it could be explored in the future.

3.2.5 PASSENGER DROP-OFF AND PICK-UP

The act of a driver stopping at a transit terminal to drop off or pick up a passenger is in evidence at many of Halifax Transit's major transit terminals. This can also be an important element of a ferry terminal, but will require some off-street space to accommodate this activity. Space sufficient for 15-25 vehicles to wait for passengers arriving on the ferry should be the minimum provided.

3.2.6 PARK-AND-RIDE

Park-and-ride has proven to be a valuable resource in building ridership for transit services like MetroLink and MetroX as it allows residents who do not have bus service in their neighborhood or community to still take advantage of public transit within the urban service area. Park-and-ride can also be used to increase the market potential for ferries, but the inherent issue for ferries is that the terminals require valuable waterfront land and parking (particularly surface parking) can be prohibitively expensive to provide. In many instances, the land used for parking might better be used for transit-oriented development.

The provision of park-and-ride parking for the terminals will need to be considered on a case-by-case basis. At already developed sites, like Birch Cove and Larry Uteck Boulevard, a parking lot will be nearly impossible to provide. At developing sites, like Mill Cove and Shannon Park, a parking facility may be a consideration. There may, for example,

be a strategic opportunity to share a parking space between daytime ferry commuters and a commercial or institutional use with a higher night-time parking demand.

One opportunity that might be considered for locations where only limited parking might be provided is to develop a program of registering drivers as a carpool and designing parking only for a registered carpool driver.

3.2.7 ACTIVE TRANSPORTATION CONNECTIONS

Active transportation (AT) can also be an important method for passengers to reach the ferry terminal. Because the terminals are at sea level, bicycle and walking trips to the terminal will always be downhill and the deterrent of “being sweaty at work” is reduced. Ongoing work to establish the Bedford Highway as an AT corridor can be built upon to create connections to the ferry waiting area.

Connections from the roadway/AT network to the ferry terminal, could be enclosed and integrated into the building fabric of site development. This will be particularly important when crossing the rail line parallel to the Bedford Highway. These connections must be accessible for wheelchairs and other mobility aids and may require an elevator in locations where grade differences are substantial.

Bicycle parking and bicycle lockers should be a part of the waiting area design. Bicycles, scooters, and wheelchairs should be accommodated on all new ferries.

3.2.8 CREW FACILITIES

There is limited or no space available at the existing ferry terminals for vessels to be berthed overnight or when out of service. For this reason, vessels will need to be berthed at the new terminals. Since this will be the location where crew shifts begin, it may be necessary to construct a building (or integrate into an existing building) where the crews will have lockers and a washroom. Consideration should be given to constructing 6-10 parking spaces reserved for crew.

3.3 POTENTIAL FERRY DESTINATIONS

A cursory examination of the five potential terminal sites within the study area was undertaken and described in the following sections. More detailed examination of siting issues will be undertaken once the highest priority locations are determined.

3.3.1 BEDFORD MILL COVE

Mill Cove in Bedford has been undergoing a substantial transformation over the past 20 years. Under the direction of Develop Nova Scotia (formerly Waterfront Development Corporation), infilling has been used to create lands for development. Although conceptual plans for phased development have been created, little progress has been made in the past few years.

Details of how a passenger waiting area and passenger pickup/dropoff area would be designed and located would be best established as part of a development plan. One benefit of establishing a ferry terminal on a developing site like this is the ability to integrate elements like a passenger waiting area and dropoff/pickup into the new community to gain synergies.

The CN main rail line would need to be crossed to provide an active transportation connection between the terminal and the Bedford Highway. Further examination would be required to determine whether an overpass or underpass of this line would be more appropriate.

3.3.2 LARRY UTECK BOULEVARD

Over the past several years, the area surrounding the Larry Uteck Boulevard and the Bedford Highway has seen significant residential densification and this intersection has become an important urban hub. With high existing population in close proximity to the waterfront, this is an interesting site for a ferry terminal. The downside of establishing ferry service here is that limited developable space remains, although much of the frontage of the Bedford Highway in this area is underutilized with low density commercial and surface parking.

Creating a connection between the Bedford Highway/Larry Uteck intersection and a ferry dock would require acquisition of an existing commercial lot and construction of a pedestrian overpass across the CN main line. Creation of a passenger dropoff/pickup area would likely require a structure due to grades and the constrained space available.

3.3.3 BIRCH COVE

Birch Cove is located near the intersection of Kearney Lake Road and the Bedford Highway. Two docks have been located on the waterfront area here in the past, but have recently been removed. Both the dock area and the access road to it are privately owned. An existing single-lane underpass of the rail line is adequate for low volumes of vehicle traffic, but would require modification to create a safe passage for pedestrians alongside vehicles. There is an existing parking lot that could potentially be reconfigured for passenger dropoff/pickup. There is very little density nearby and limited opportunity for development, particularly when sea level rise is taken into account. As this location is closer to downtown, fewer passengers may feel an advantage to transferring from their bus to a ferry.

3.3.4 WRIGHT'S COVE

Wright's Cove is a sheltered inlet adjacent to the Burnside Business Park. This location is of particular interest as it is located on municipally-owned land and is near to a transit node intended to serve as an entryway to the business park. Adding a dock, passenger waiting area, passenger pickup/dropoff area and pedestrian connection to the transit stop would require much less capital cost than any of the other sites being considered. Although the transit stop is currently some walking distance away, consideration may be given to relocating it closer to the ferry docking area.

On the marine side, however, there are some channels to navigate and nearby commercial wharfs and a marina that may be impacted. In fact, a study of the Wright's Cove area¹¹ suggests that the channel to the municipal waterfront is not navigable at low tide. Some channel alteration may be required.

3.3.5 SHANNON PARK

Shannon Park is a decommissioned DND residential site. The land has been cleared and is now being considered for redevelopment through the Canada Lands Corporation. Policy has already been created through the Centre Plan, a Development Agreement application has been received, and negotiations are underway.

Like Mill Cove, specific locations for ferry-related infrastructure are best left to development plans for the full site.

¹¹ Wright's Cove Transportation and Land Use Plan, Cantwell & Associates, 2006

3.4 POTENTIAL FERRY ROUTES

Several routes and route combinations using the existing and potential ferry terminal locations identified in Section 1.3 have been developed for operational evaluation.

We have created seven routing schemes and have provided time-space diagrams to show how a vessel, or multiple vessels, would provide service between a pair of destinations or multiple destinations. A schematic diagram of the seven route plans is provided in Figure 35 and each is described in the following sections.

The routing plans concentrate on point-to-point trips during the commuting peak periods, as the time taken to dock and load and unload passengers on multi-stop trips will make travel times unattractive to those boarding the ferry first. Furthermore, a vessel may fill to capacity at its first stop meaning that no more passengers can be picked up at the intermediate stop(s). During off-peak periods, travel time is less critical and demand has been reduced, making multi-stop routing more practical.

Although we have shown vessels departing on the hour and regular intervals, a multi-route network would necessitate staggering the departures so that vessels arrive at the Halifax Ferry Terminal at offset times. Route travel profiles are shown only for the morning commuter peak and the beginning of the off-peak period. It can be assumed that the afternoon profile would be a reflection of the morning profile.

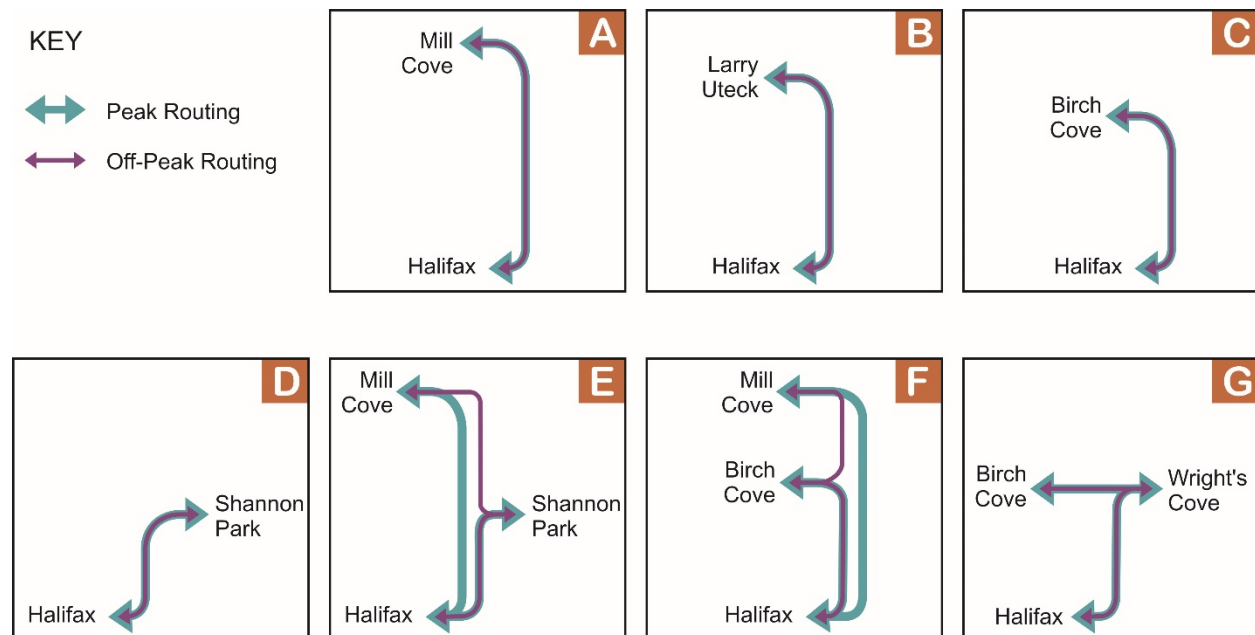


Figure 35 Route Plan Schematics

The following criteria have been used in determining operating time for each route. Much of this has been set based on measurements taken of the existing ferries, although most, if not all, of these times can be reduced through vessel and terminal design. Accordingly, our assumed operating criteria can be taken as being conservative.

LEAVE DOCK AND ACCELERATE

With bow loading, the vessels will “back out” of their berth to depart. Acceleration to operating speed is very quick. We have assumed a total of 30 seconds (0.5 minutes) to leave the dock and accelerate to operating speed.

TRAVEL TIME AT OPERATING SPEED

Travel time at operating speed is a simple calculation from the travel speed and dock-to-dock distance. For all routes we have used two different operating speeds. A lower speed is used in the Harbour (within 5.0 km of the Halifax Ferry Terminal – to a point just to the north of the MacKay Bridge) and a higher speed in Bedford Basin.

DECELERATION AND DOCKING

Ferries will have to drop from their operating speeds to dead slow to allow them to manoeuvre into the dock. We have assumed this to be accomplished in 2.0 minutes. This time has been extended to 2.5 minutes for the terminal at Wright's Cove due to the presence of a marina and a negotiating a narrower channel to reach the dock. Further investigation may determine this docking time for Wright's Cove may need to be increased even further.

DOCKED TIME

Time is required to be stationed at the dock for passenger loading and unloading. We believe that this process can be completed in 2-3 minutes even with capacity loads. We have aimed to have a minimum docked time of four minutes to allow for some flexibility in re-establishing schedule compliance in cases where vessels may be delayed traveling between docks.

To confirm the soundness of the terminal timing assumptions, segment times were measured for fourteen ferries arriving at Halifax Ferry Terminal during the highest loading periods in both the morning and afternoon peak (see Appendix A and summary in Table 24). The two minute deceleration/docking time is greater than the equivalent time for the existing ferries, but appropriate given the higher approach speeds. The existing ferries have a higher total docked time, but the planning value is a minimum that may be able to be extended in the detailed planning phase.

Table 24 Terminal Timing for Ferries

Timing Segment	Planning Assumption	Average Measured Value
Deceleration/Docking	2:00	1:38
Total Docked Time	4:00	5:48

3.4.1 SERVICE A: MILL COVE TO HALIFAX

This will be a direct trip from Mill Cove in Bedford to the Halifax Ferry Terminal (see Figure 36). It can be completed in a 40-minute cycle, allowing for two vessels to provide departures every 20 minutes. Achieving a 40-minute cycle, however, requires speeds higher than desired (27 knots) and a short docking time (3.5 minutes) at terminals.

A more comfortable plan is realized when the cycle is extended to 45 minutes (Figure 37). With this cycle, three vessels could provide departures every 15 minutes.

Should off-peak service be desired, it can be run comfortably with a single vessel departing every 60 minutes.

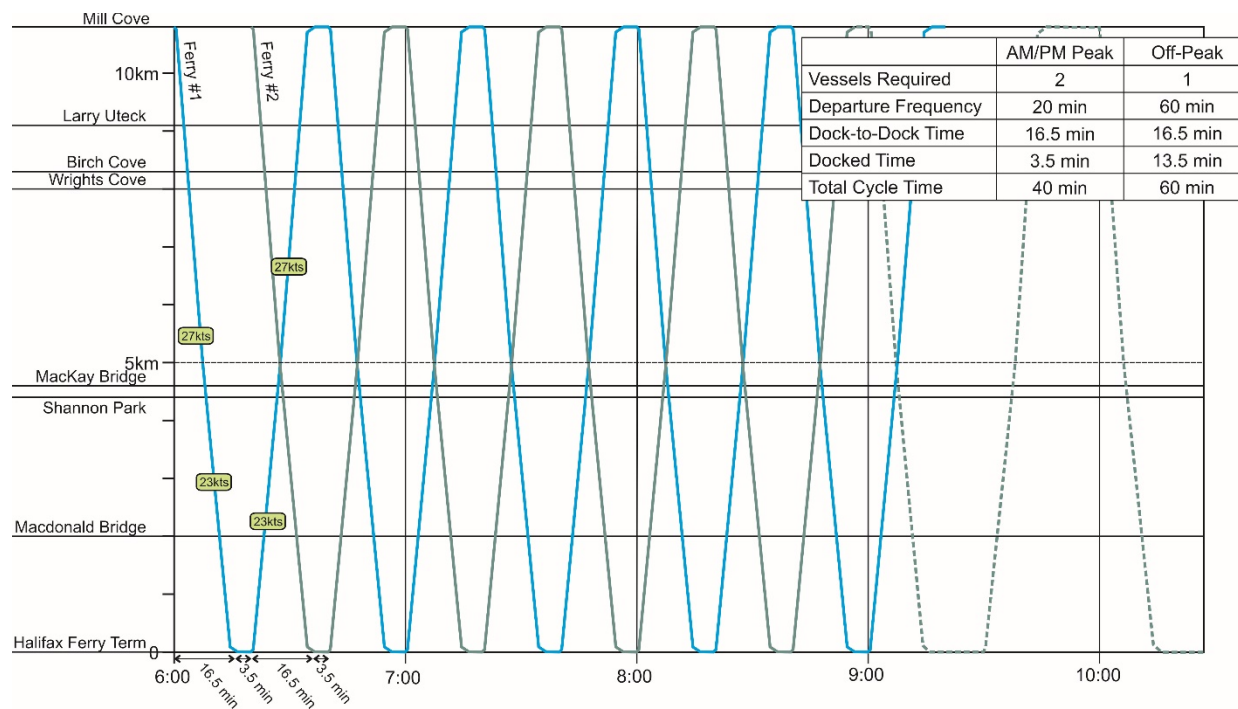


Figure 36 Service A1: Mill Cove to Halifax (40-minute cycle)

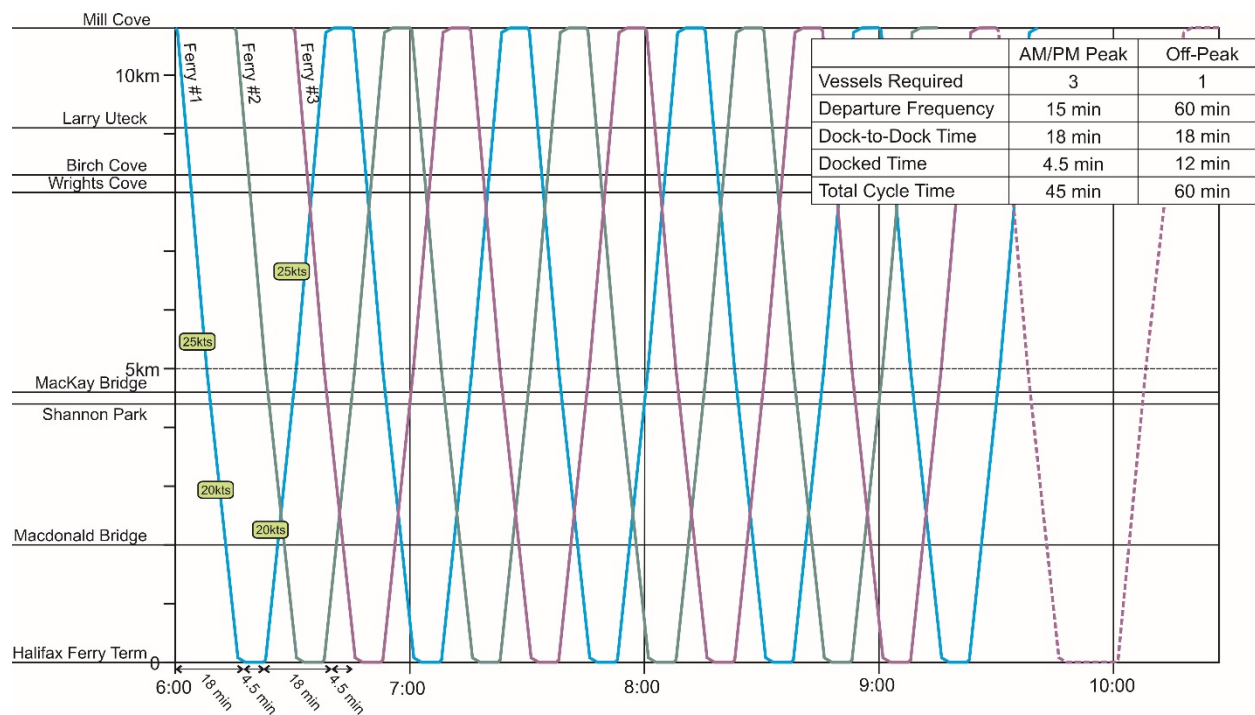


Figure 37 Service A2: Mill Cove to Halifax (45-minute cycle)

3.4.2 SERVICE B: LARRY UTECK TO HALIFAX

This is similar to the Mill Cove service, although the shorter travel distance allows this route to be completed comfortably in a 40-minute cycle offering the same twenty-minute frequency using two vessels (Figure 38).

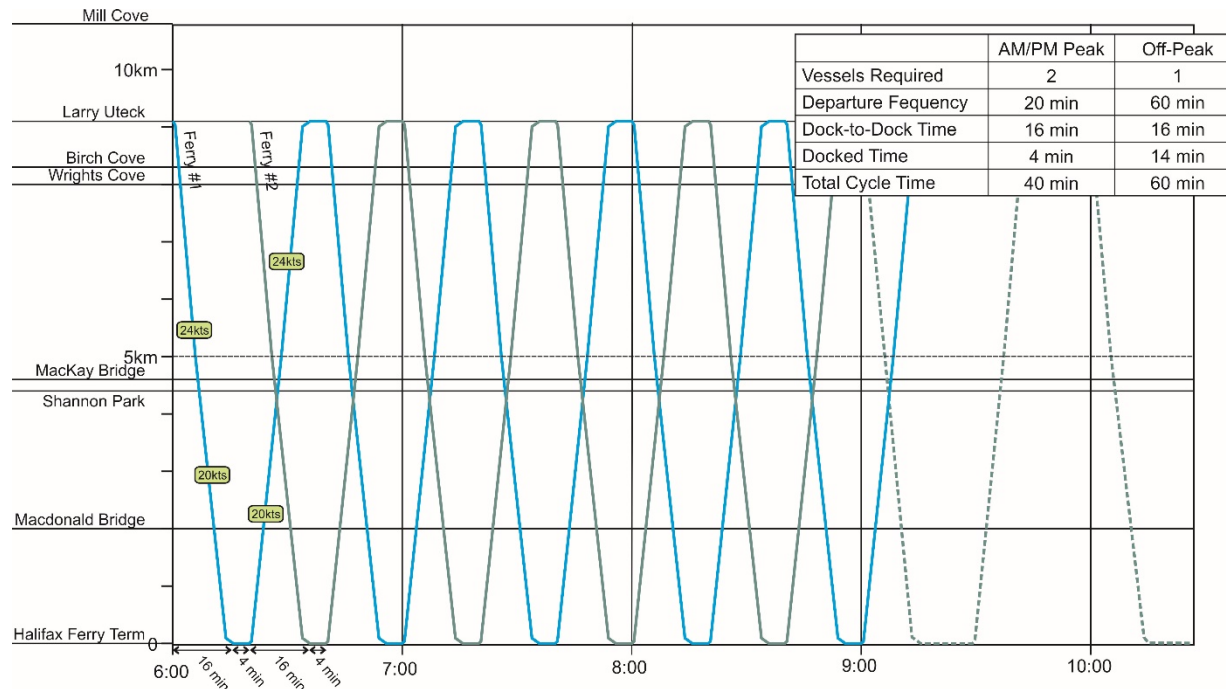


Figure 38 Service B: Larry Uteck to Halifax

3.4.3 SERVICE C: BIRCH COVE (OR WRIGHT'S COVE) TO HALIFAX

Birch Cove and Wright's Cove are nearly identical in distance to the Halifax Ferry Terminal and so have been shown with the same service schedule (Figure 39). Like the two previous routes, they can be serviced in a 40-minute cycle, although the shorter travel distance allows for longer docked times (or additional manoeuvring time in the case of Wright's Cove).

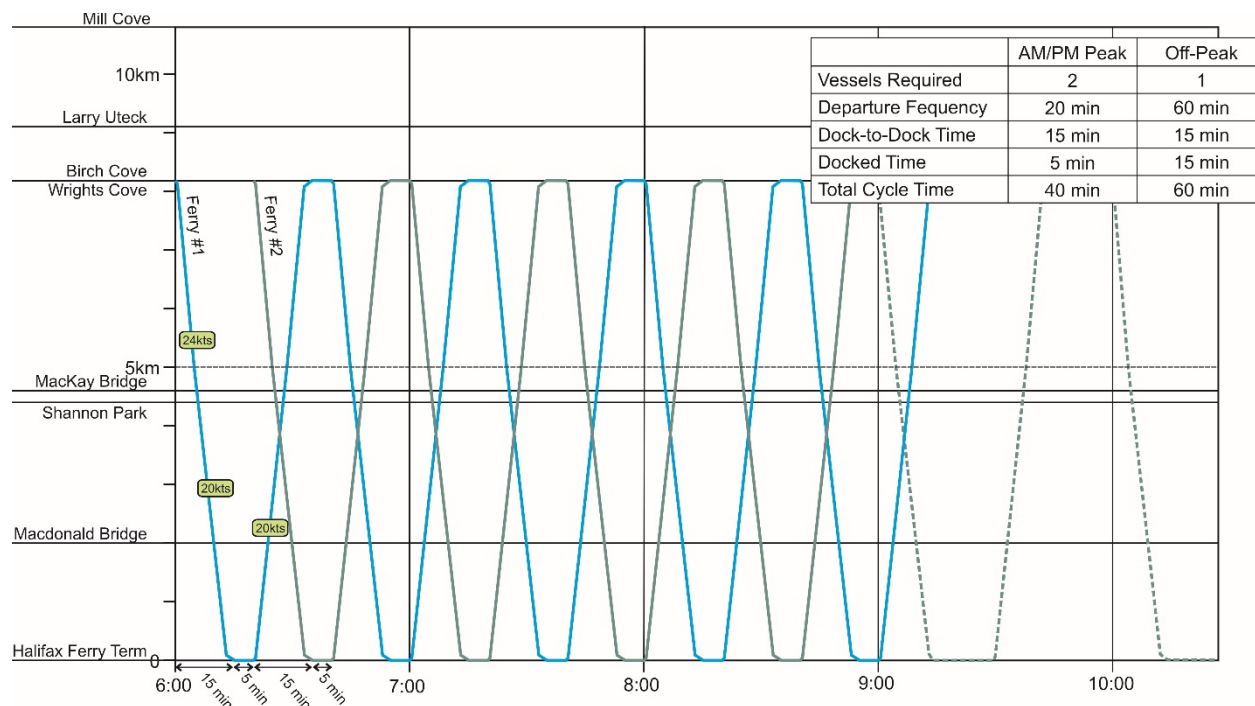


Figure 39 Service C: Birch Cove to Halifax

3.4.4 SERVICE D: SHANNON PARK TO HALIFAX

A shorter travel distance allows for Shannon Park to be serviced with a shorter cycle length of 30 minutes (Figure 40). We have suggested that this route would be served by one vessel although two vessels could be used to increase departures to one every fifteen minutes.

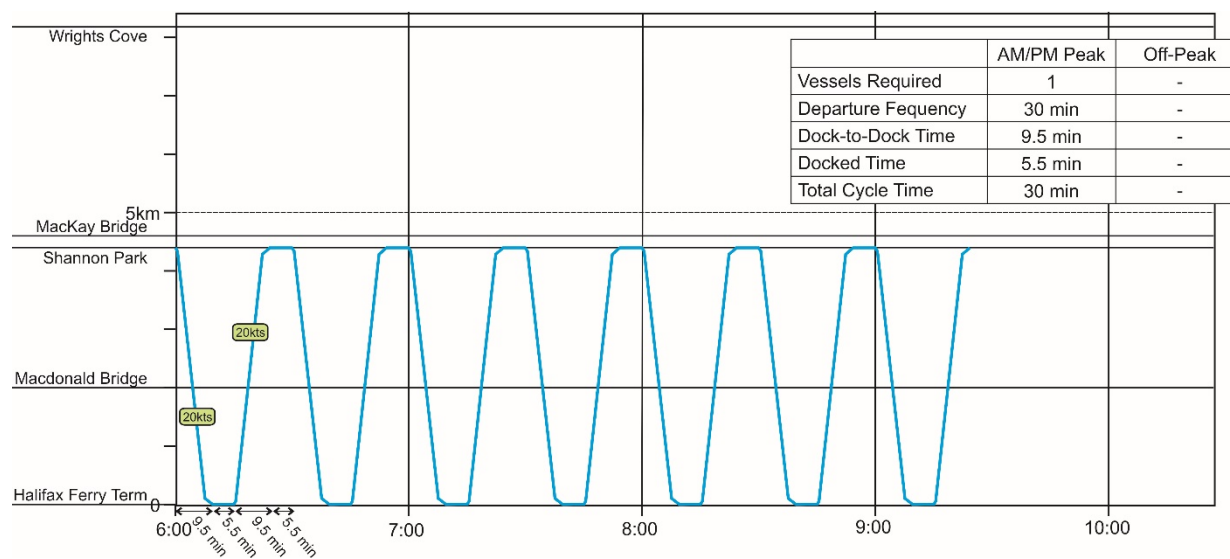


Figure 40 Service D: Shannon Park to Halifax

3.4.5 SERVICE E: LARRY UTECK-HALIFAX-SHANNON PARK

Rather than traveling back and forth between a pair of destinations, a ferry's operating cycle might be optimized by alternating the destinations it travels to from the Halifax Ferry Terminal. In the off-peaks, both destinations might be served in a multi-stop route. Although we have used Larry Uteck combined with Shannon Park here (Figure 41), other combinations of multiple destinations may be considered.

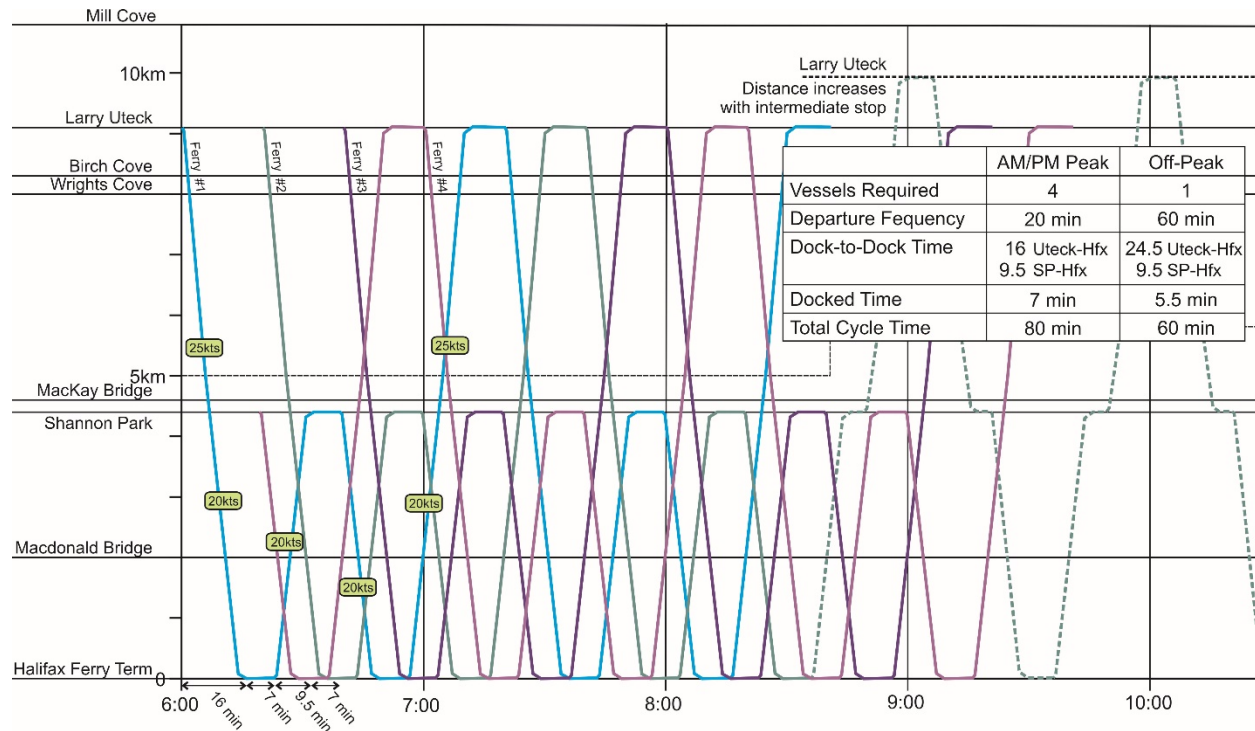


Figure 41 Service E: Mill Cove to Halifax to Shannon Park

3.4.6 SERVICE F: MILL COVE-HALIFAX-BIRCH COVE

Similar to Service E, Service F combines two destinations with the downtown Halifax Ferry Terminal (Figure 42). Since a 40 second cycle time is difficult to achieve with Mill Cove and easily achieved with the shorter travel distance to Birch Cove, alternating the two destinations helps to even out the shortfall and surplus in time. This results in a service frequency of 20 minutes during the peak and 60 minutes in the off-peak where a switch is made to a single vessel doing a multi-stop route.

The Larry Uteck destination could be substituted for Birch Cove or Mill Cove. Pairing Larry Uteck and Mill Cove results in a slightly longer travel distance than what is shown in the Service E profile so a minute would need to be cut from the docking time.

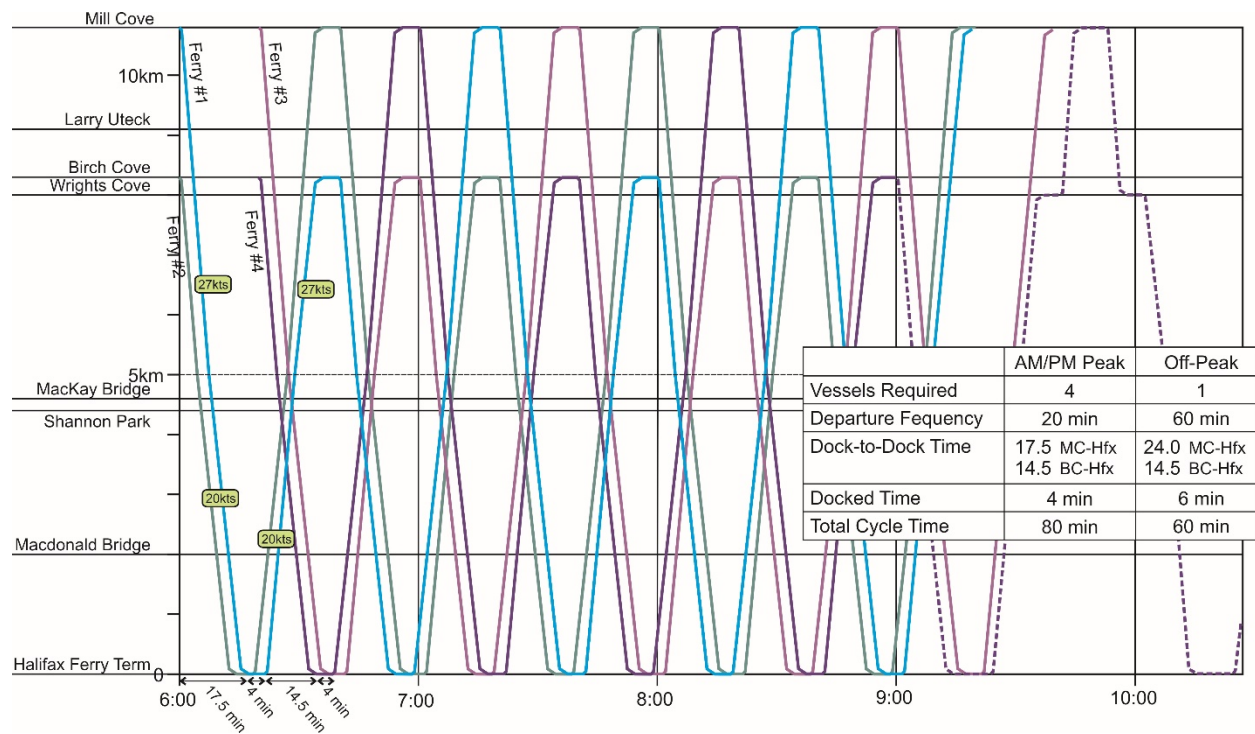


Figure 42 Service F: Mill Cove to Halifax to Birch Cove

3.4.7 SERVICE G: BIRCH COVE-WRIGHT'S COVE-HALIFAX

Wright's Cove is different from other destinations being considered in this exercise because it is more an "attractor" of trips (going to work) than it is a "producer" of trips (leaving home). A ferry route that crosses Bedford Basin to Wright's Cove would very distinctly shorten the travel distance for people who live on the Halifax mainland and work in Burnside. The routing shown (Figure 43) provides connections to Wright's Cove both from Birch Cove (or alternatively Larry Uteck which is an equivalent distance from Wright's Cove) and downtown Halifax. The route could also be used for travel from Birch Cove to the Halifax Ferry Terminal, although the time taken with the Wright's Cove stopover increases the time and lessens the attractiveness.

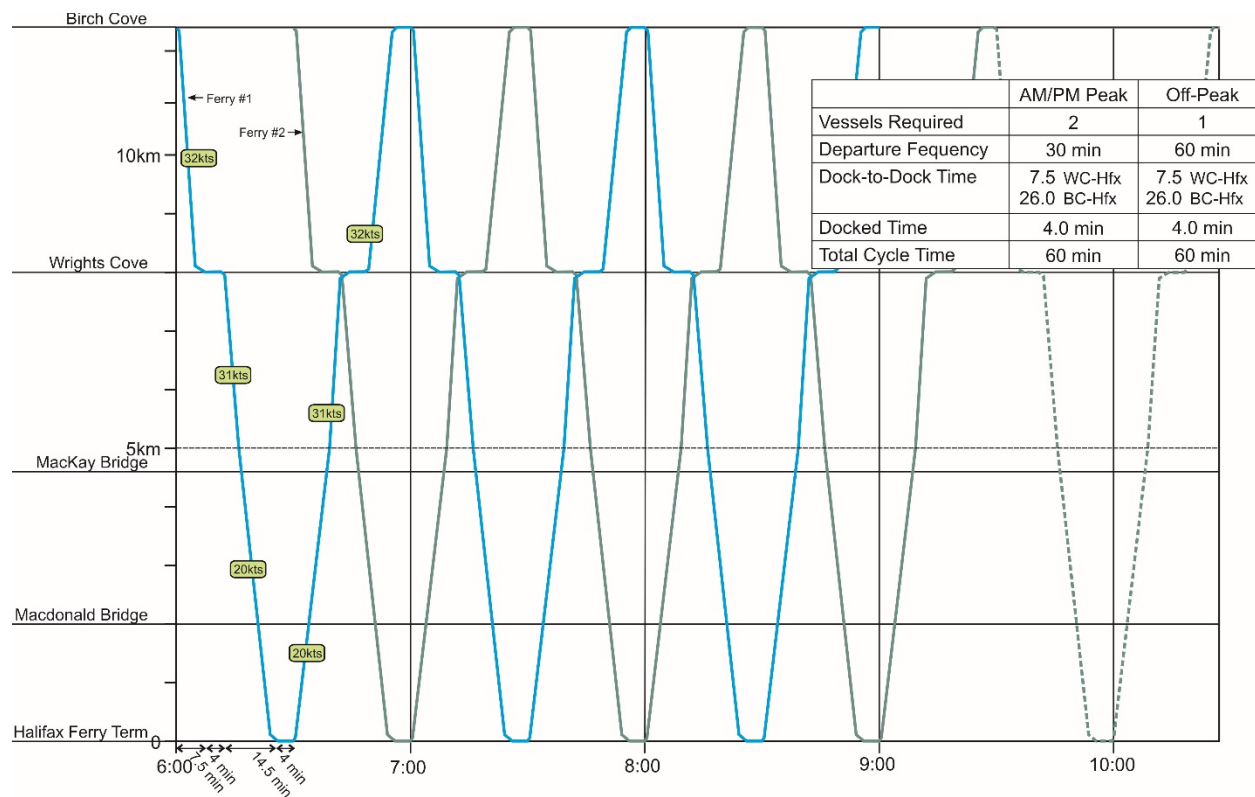


Figure 43 Service G - Birch Cove to Wright's Cove to Halifax

3.5 RIDERSHIP POTENTIAL

3.5.1 BACKGROUND TO MODELING

The ferry ridership modelling for this study relies on the NovaTRAC Halifax Survey 2018 (Habib, 2019) and the Halifax Travel Demand Model (HTDM) developed in Bela and Habib (2019). Following is a brief description of the zonal system, predicted ridership, model development process and data used in predicting the ridership. The full modeling process is described in Appendix B.

3.5.2 ZONAL SYSTEM

The study delineates super-zones around each ferry station proposed in this study. Two types of super-zones are considered: Catchment A and Catchment B. Catchment A refers to the adjacent traffic analysis zones (TAZ) that are within two kilometers, convenient for walking, biking and/or kiss-and-ride possibilities. Catchment Area B refers to the potential hinterland within 10 kilometers that may generate ferry trips. The study considers four super zone areas corresponding to the station area considered: 1) Mill Cove, 2) Larry Uteck, 3) Birch Cove and 4) Shannon Park. We have adjusted the inclusion of a few TAZs from the initial sets for Catchment A and B for each area depending on network considerations (such as highway location) and proximity to Downtown Halifax. The destination super-zone is identified as Destination Area A, that includes areas within 2 km of the downtown ferry terminal (meaning that at least the centroid of the TAZ falls within 2 km). Figure 44 uses Mill Cove to show how the TAZs are identified for each super-zone. A similar chart was developed for each of the potential terminal sites (see Appendix B).

3.5.3 PREDICTED RIDERSHIP

The predicted ferry ridership for each super-zone is shown in Table 25. The Daily Trip Potential is the total number of trips that originated from each Origin super-zone and destined to the Destination super-zone of Downtown Halifax. The O-D paired trips for each TAZ is obtained from the Halifax Travel Demand Model (HTDM). The Capture Rate is the estimated mode share that utilizes a 2011 Stated Preference Survey and Logit Modeling methods.

It should be noted that these projections are relevant for each ferry terminal as a stand-alone. Due to the proximity of the potential terminal sites, there is some overlap of the catchment zones. This means that if, for example, ferry service is provided at both Mill Cove and Larry Uteck, the ridership projection numbers would not be as high as shown in Table 25 as there would be some “double counting” of passengers originating in overlapping catchment areas.

These ridership projections consider only the two surrounding catchment areas. Additional ridership may be realized from park-and-ride, passenger drop-offs, and transfers from pass-by buses by customers who live outside of these catchment areas. Furthermore, this data comes from 2016 population data and doesn’t consider growth within the catchment areas. Both considerations result in ridership projections that will be on the conservative side.

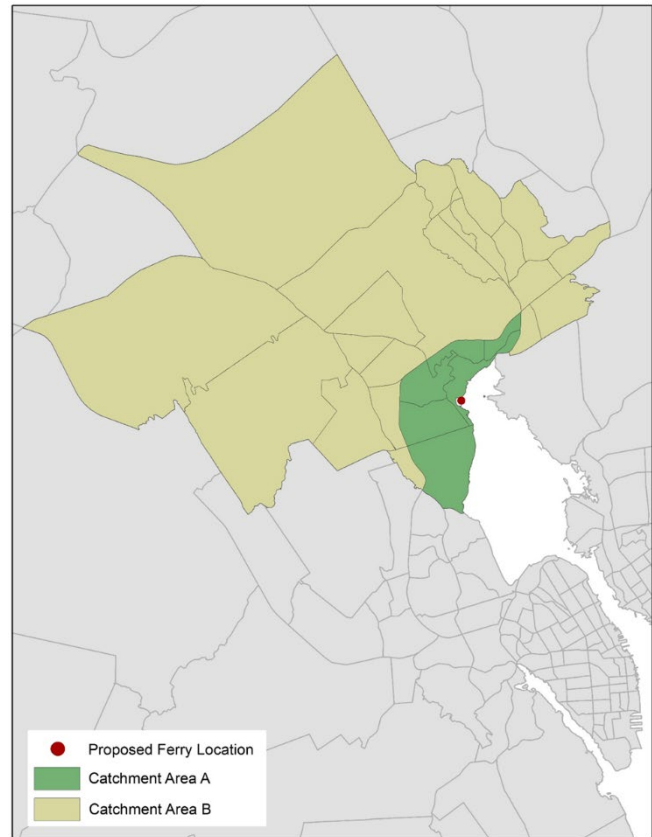


Figure 44 Catchment Areas for Mill Cove

Table 25 Predicted Ferry Ridership by Super-zone

Predicted Ferry Ridership							
	Catchment A			Catchment B			Total Daily Ridership
	Daily Trip Potential	Capture Rate (%)	Daily Predicted Ferry Trips	Daily Trip Potential	Capture Rate (%)	Daily Predicted Ferry Trips	
Mill Cove	4890	13.1	644	7396	11.1	818	1460
Larry Uteck	3598	10.6	383	7324	8.8	647	1030
Birch Cove	4413	10.3	455	8021	8.5	684	1140
Shannon Park	521	13.2	69	2353	9.7	228	300

3.6 COMPARISON OF TERMINAL LOCATIONS

3.6.1 OVERVIEW

To perform a comparative matrix evaluation of the potential ferry terminal sites, several evaluation criteria were developed. These criteria are described below. Each of the criteria was given a relative weighting based on discussion with HRM staff.

The application of these criteria to the potential terminal locations is provided in Tables 26 to 28.

3.6.2 MARINE OPERATIONS CRITERIA

EXPOSURE – To what degree is the proposed ferry dock exposed to the elements? A location protected from the wind would be the most desirable for daily operations, whereas an unprotected location would be the least desirable.

HARBOUR TRAFFIC IMPACT – To what degree will the proposed terminal impact existing harbour traffic? A terminal isolated from frequent harbour traffic would be considered most desirable and a terminal that is located near areas of frequent traffic would be the least desirable.

WATER DEPTH – Does the proposed location have sufficient water depth to accommodate a ferry dock? A terminal with a lack of water depth will require a longer, more expensive wharf, while a terminal with ample water depth would be less expensive for wharf construction and more easily navigated.

VESSEL MANEUVERING – How difficult would it be for a ferry to navigate an entry channel to the proposed location? A terminal with nearby obstructions would be the most difficult to maneuver around and would be considered the least desirable location. A terminal with no nearby obstructions that is easily accessible would be considered the most desirable location.

WAKE IMPACT – To what degree will the wake generated by the ferry impact harbour users? Locations with the most potential to cause impact would be considered the least desirable.

NOISE IMPACT – To what degree will the noise generated by the ferry impact nearby residents or harbour users? Locations with the most potential to cause impact would be considered the least desirable. Having existing residents near to the ferry dock will be judged as less desirable than areas where future residents are expected.

3.6.3 MANAGING AND CONNECTING PASSENGERS CRITERIA

RIDERSHIP POTENTIAL – This criterion compares the relative potential ridership demand from the study projections (see Section 3.5).

FERRY TRIP IMPEDANCE AS A PERCENTAGE OF CAR TRIP IMPEDANCE – Travel impedance is, in theory, a measure of what influences a person's choice of travel mode. It considers not only the travel time, but out-of-pocket costs (transit fares, bridge tolls, etc) and out-of-vehicle time (walking to/from transit and waiting for or transferring between buses or other transit modes). For each ferry terminal site we have compared the impedance of a direct ferry trip to downtown with the equivalent driving trip. Only the best transit services can surpass a car trip for impedance (a relative impedance of 100% or less). A relative ferry trip impedance between 100% and 150% makes a desirable location and a relative impedance higher than 150% makes a less desirable location. Details on this calculation are provided in Appendix C.

TRANSIT CONNECTIONS – How well is the proposed terminal connected to the existing transit route system? A terminal that is located amongst existing transit routes and where the walking distance is short between bus stop and dock would be considered the most desirable. A terminal that is separated from existing transit routes or would require an expensive rail crossing would be considered the least desirable.

PARK-AND-RIDE – How difficult would accommodating a Park-and-Ride facility be at the proposed terminal? The least difficult or expensive terminal location to provide a Park-and-Ride facility would be considered the most desirable, whereas the most difficult or expensive terminal would be the least desirable location.

KISS-AND-RIDE – How difficult would accommodating a Kiss-and-Ride facility be at the proposed terminal? Evaluation considerations are the cost to construct, the ability for vehicles to enter and exit the roadway network and the proximity of the kiss-and-ride area to the dock.

3.6.4 SITE CHARACTERISTICS CRITERIA

POTENTIAL AS A TOURIST/OFF-PEAK DESTINATION – What degree of potential does the proposed terminal have as a future tourist destination or for attracting off-peak trips in general? These trips can help to increase off-peak ridership and create better two-way flow. The location with the most potential for a future tourist destination would be considered the most desirable, whereas the location with the least potential would be considered the least desirable.

POTENTIAL FOR TRANSIT-ORIENTED DEVELOPMENT – How much potential does the proposed terminal have to accommodate a transit-oriented development? A location that allows development to grow and integrate with the presence of a ferry commuting option will attract residents for whom transit is already a desired choice. A terminal that is displaced from existing or future planned transit hubs would be considered the least desirable. The terminal that has the most potential to accommodate existing and future planned transit would be considered the most desirable.

PROXIMITY TO WORKPLACE OPPORTUNITIES – How close is the proposed terminal to nearby workplaces? An area that can both produce and attract workplace commuting trips will help to create two-way flow on the ferry routes. The terminal with the most opportunity to accommodate workplace commuters would be considered the most desirable location. The terminal with the least opportunity to accommodate workplace commuters would be considered the least desirable location.

MULTI-PURPOSE FACILITY INTEGRATION – How easily can a passenger waiting area be integrated with a multi-purpose public facility (e.g. aquarium, library, museum, etc.)? The easiest location to integrate the terminal with a multi-purpose facility would be considered the most desirable, whereas the most difficult location would be considered the least desirable.

PROPERTY OWNERSHIP OF SHOREFRONT AND WATER LOT – This is a determination of the need for property acquisition to construct a wharf and waiting area. Sites that require the most property acquisition would be considered the least desirable location, whereas the site that requires the least property acquisition would be considered the most desirable.

Table 26 Terminal Site Comparison: Total Score and Marine Operations Ratings

	MILL COVE	LARRY UTECK	BIRCH COVE	WRIGHT'S COVE	SHANNON PARK
TOTAL WEIGHTED SCORE	94	73	66	67	88

MARINE OPERATIONS

CRITERIA	WEIGHT	MILL COVE	LARRY UTECK	BIRCH COVE	WRIGHT'S COVE	SHANNON PARK
Exposure	2	Little protection	Highly Exposed	Little Protection	Protected by a wharf and islands	Some protection within a cove
Harbour Traffic Impact	2	Nearby activities at Bedford Yacht Club, some activity at public wharf	Negligible	Small amount of activity at existing private wharfs	Close proximity to Dartmouth Yacht Club and commercial wharves	Negligible
Water Depth	2	Ample depth near shoreline	Ample depth near shoreline	Ample depth near shoreline	Navy Island Cove may require some dredging for sufficient depth	Good depth near shoreline
Vessel Maneuvering	2	No difficulty	No difficulty	No difficulty	Narrow channel to negotiate	No difficulty
Wake Impact	2	Minimal impact to users of the existing wharf	None expected	None expected	Wake may impact nearby marina and wharf activity	None expected
Noise Impact	1	Nearby residences (future) may be impacted by noise	Existing residences may be impacted by noise	Existing residences may be impacted by noise	Nearby residences (future) may be impacted by noise	Nearby residences (future) may be impacted by noise

More positively supports the criteria

4

3

2

1

0

Less positively supports the criteria

Table 27 Terminal Site Comparison: Managing and Connecting Passengers Ratings

MANAGING AND CONNECTING PASSENGERS

CRITERIA	WEIGHT	MILL COVE	LARRY UTECK	BIRCH COVE	WRIGHT'S COVE	SHANNON PARK
Transit Connections	2	190m walk from Bedford Highway transit corridor. Distance includes ramps for a new pedestrian overpass/underpass.	140m walk from Bedford Highway transit corridor. Distance includes ramps for a new pedestrian overpass.	180m walk from Bedford Highway transit corridor. Would require an existing underpass to be modified to accommodate pedestrians.	150m walk from transit stop and 260m from Windmill Road transit corridor. Minimal infrastructure required.	Not near to any transit corridors
Park-and-Ride	2	An opportunity may arise to integrate a new parking lot near to the terminal with site development.	Little apparent opportunity, although limited parking may be integrated into a redevelopment plan.	Little apparent opportunity, although limited parking may be integrated into a redevelopment plan.	Some opportunity, although less applicable as this is location is a trip destination as opposed to a trip origin.	An opportunity may arise to integrate a new parking lot near to the terminal with site development.
Kiss-and-Ride	2	Little opportunity for anything on the Bedford Highway. Future integration into site development is possible, although would be a detour from major commuting corridors.	Can be created as a fourth leg to the Larry Uteck/Bedford Highway intersection with acquisition of a commercial property. Would still be a 70-100m walk from the terminal.	Surplus parking lot space or a small lot expansion may be available near the terminal. Adding traffic to the existing single lane rail underpass may be problematic, however.	Adequate amount of municipal land with good proximity to the terminal and connections to the roadway network.	Can be integrated into the site development, although it will require some "offtracking" from the regional roadway network.

More positively supports the criteria

4	3	2	1	0
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Less positively supports the criteria

Table 28 Terminal Site Comparison: Characteristics Ratings

SITE CHARACTERISTICS

CRITERIA	WEIGHT	MILL COVE	LARRY UTECK	BIRCH COVE	WRIGHT'S COVE	SHANNON PARK
Ridership Potential	3	Projected daily two-way trips: 1400 Potential to increase with high density site development.	Projected daily two-way trips: 1000	Projected daily two-way trips: 1100	Not a significant trip generator. Further high density residential development (Harbour Isle) is possible.	Projected daily two-way trips: 300 Potential to increase with high density site development.
Ferry Trip Impedance as a Percentage of Car Trip Impedance	2	120%	110%	100%	160%	160%
Potential as a Tourist Destination	1	Potential for site development to create some commercial/cultural attraction is high.	No opportunity apparent.	No opportunity apparent.	No opportunity apparent.	Potential for site development to create some commercial/cultural attraction is moderate.
Potential for Transit-Oriented Development	3	Good potential for future development to orient around a ferry terminal.	Small amount of vacant and underutilized land between the Bedford Highway and the rail line may create an opportunity.	Small amount of vacant and underutilized land between the Bedford Highway and the waterfront may create an opportunity.	Some opportunity for further residential development.	High potential for future development to orient around a ferry terminal.
Proximity to Workplace Locations	1	Some current employment and significant future opportunities within walking distance.	Minimal employment within walking distance.	Minimal employment within walking distance.	Significant employment within walking or short bus shuttle distance.	Minimal current employment but some future opportunities within walking distance.
Multi-Purpose Facility Integration	2	Excellent opportunity to construct a public multi-purpose waterfront facility.	Little opportunity apparent.	Little opportunity apparent.	Little opportunity apparent.	Excellent opportunity to construct a public multi-purpose waterfront facility.
Property Ownership of Water Lot and Shorefront	3	Water lot and shorefront are publicly (provincial) owned.	Water lot and shorefront are privately owned.	No water lot. Shorefront is privately owned.	No water lot. Shorefront is publicly (municipal) owned.	Water lot and shorefront are publicly (federal) owned.

More positively supports the criteria

4	3	2	1	0
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Less positively supports the criteria

4 HALIFAX FERRY TERMINAL

4.1 CURRENT CAPACITY

With eight ferry arrivals per hour during the commuting peak, the existing Halifax Ferry Terminal can see very high use of the passenger waiting area. On days when special events are on, the capacity can be exceeded and passengers can be seen queuing outside of the building. The waiting areas for both of the existing ferry routes is at least as great as the capacity of one ferry.

The total number of passengers in the waiting area of the Halifax Ferry Terminal on a typical weekday afternoon is shown in Figure 45. This graph clearly shows the fluctuation in occupancy as the ferries come and go every 7.5 minutes. We believe this leaves a small amount of waiting capacity between arrivals of the Alderney Ferry. This assumes that a new ferry route would arrive every 15 minutes or every 30 minutes to keep in sequence. If an arrival frequency of 20 minutes for a new service was selected, an overlap of arrivals could not be prevented and capacity would become an issue.

From a passenger waiting area perspective, it may be minimally possible to accommodate another four ferry arrivals per hour at the Halifax Ferry Terminal by shifting to arrivals every five minutes. Any additional ferry arrivals, however, would clearly exceed the capacity.

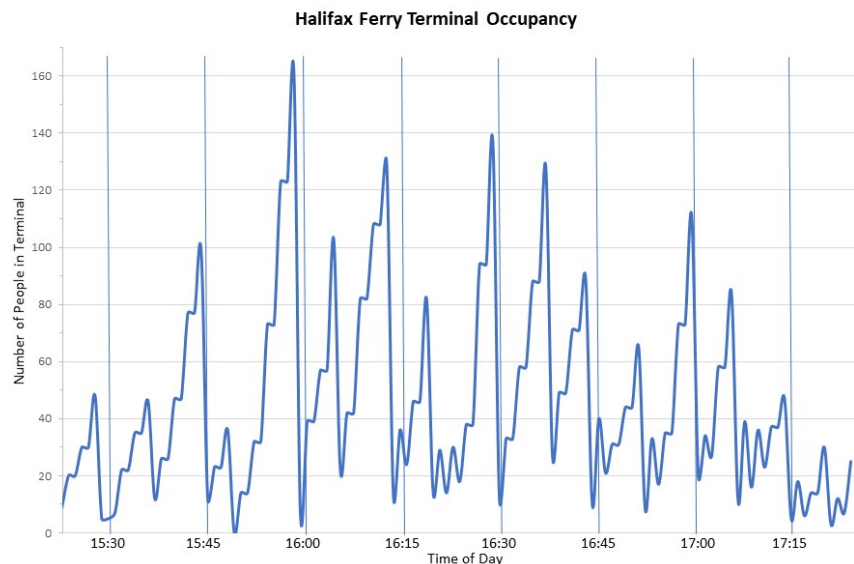


Figure 45 Halifax Ferry Terminal Passenger Waiting Area Occupancy

4.2 ACCOMODATING MORE FERRIES IN DOWNTOWN HALIFAX

We believe there are three options available for accommodating additional passengers and ferry arrivals in downtown Halifax. These options are discussed in the sections following.

4.2.1 EXPAND THE EXISTING HALIFAX FERRY TERMINAL

Figure 46 shows the layout of the existing Halifax Ferry Terminal. Although a detailed analysis has not been undertaken, we believe that there is an opportunity to expand the footprint of the ferry terminal building either to the north or to the south by a small amount to increase the passenger waiting area and to create a gateway to a new gangway. We believe that it may also be practical to convert all of the current “non-secure” area within the building to be “secure”.

We see two potential options for locating a gangway to service two new “nose-in” catamaran ferries (see Figure 46). Option One places a gangway parallel to the seawall at Nathan Green Square. Option Two uses a wharf parallel to the existing ferry wharf, leaving sufficient space for ferries to navigate into their existing berth. From the ExploreHRM mapping, these all appear to be within the land and water lots owned by the Municipality.

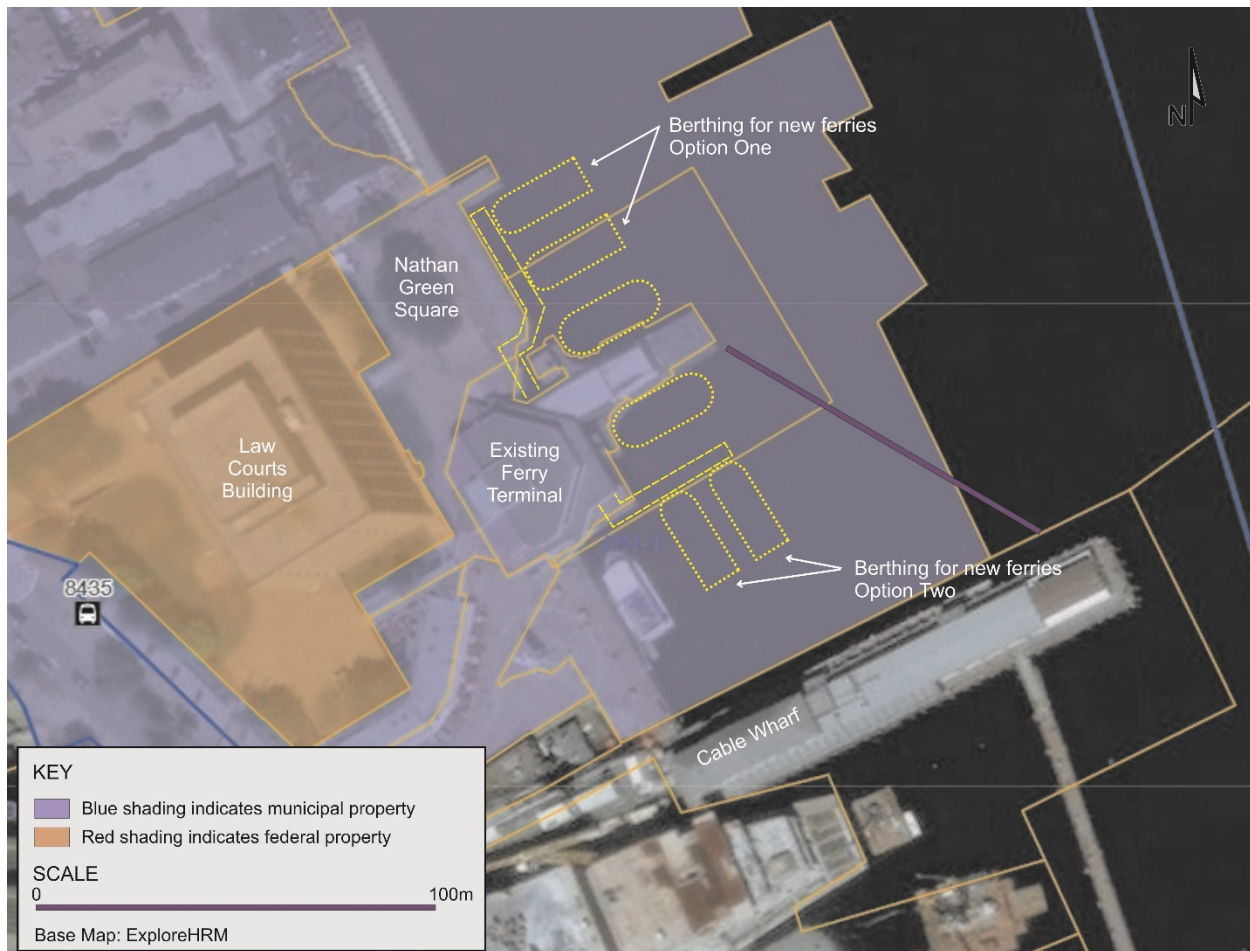


Figure 46 New Berthing Options for Halifax Ferry Terminal

Option One has the benefit of eliminating the crossing of paths between the new ferry routes and the existing ferry routes. It also avoids the frequent commercial traffic using Cable Wharf.

4.2.2 BUILD A NEW, LARGER FERRY TERMINAL FERRY

This option would see a new, larger ferry terminal built to handle both the existing ferry service and any new services planned both in the short and longer terms. The existing ferry terminal would need some renovation work to provide a new wharf to serve the new ferries and a building renovation to create access to that gangway from the ferry terminal

waiting room. Expanding the passenger waiting area, as discussed in Section 4.1, is desirable with the addition of one new route and a must with any route expansion beyond that.

The existing building is showing its age and not, as ferry management staff have indicated, fully providing its intended function. Therefore, strong consideration must be given to a building replacement over a building renovation.

With good design, there may be sufficient space on the existing property to construct a new “super-terminal”. This would take advantage of the existing wharf infrastructure and avoid the challenge of finding new space on an already active waterfront. The existing Ferry Boat Lane transit area is an important companion to the ferry terminal and a terminal relocation would add the challenge of relocating bus connections.

Nevertheless, discussion with Develop Nova Scotia has brought forward the idea of conducting a comprehensive review of waterfront lands of the Halifax Ferry Terminal and Chebucto Landing. Developing a plan for land ownership and rationalization of an assortment of marine uses could pay dividends for the Municipality, the Province and the private sector. An exercise like this may identify an opportunity for a ferry terminal to be integrated into another building, with either a public or a commercial ownership.

4.2.3 BUILD A NEW TERMINAL AS A COMPANION TO THE EXISTING HALIFAX FERRY TERMINAL

This option would see the retention of the existing ferry terminal for the servicing of the existing ferry routes and construction of a new ferry terminal for any expansion routes. Implementing this option would encounter the same site location issues discussed in the previous section, although some simplification may be realized as a smaller building would be required. As there is not expected to be significant value in passengers transferring between existing and new ferries, the companion terminal need not be that close to the existing terminal. It would, however, need to be close to the heart of downtown employment and easily connected to downtown bus service.

5 THE PREFERRED OPPORTUNITY

5.1 SERVICE COMPONENTS

Following a review of the service and routing options with the Municipality's stakeholder group, it was determined to focus on direct service between the Halifax Ferry Terminal and three destinations: Mill Cove, Larry Uteck and Shannon Park. These services will be assessed as three separate point-to-point routes operating during the commuter peaks, although mid-day service using multi-stop routes may be considered.

It is these services that will be more thoroughly defined and assessed in the following sections. Of the three routes, it is assumed that service to Mill Cove will be the first to be delivered.

Of the three options examined for the Halifax Ferry Terminal, it was decided that using the existing site to construct a new and expanded terminal for all ferry services was preferred. A minor renovation, capable of handling additional passengers from a single new route could also be considered as an interim measure.

5.1.1 ROUTE TIMING

The route plan recommended for Mill Cove is Service A2 shown in Figure 37. The service will be provided during morning (06:00 to 09:00) and afternoon (15:00 – 18:00) commuter peaks. Using three vessels operating a 45-minute cycle will result in departures every 15 minutes. Consideration may also be given to operating one vessel on a 60-minute cycle during mid-day, evening and/or weekend hours, although this additional service has not been evaluated in the financial analysis.

The plan for Larry Uteck is Service B (two vessels with 20-minute headways) and for Shannon Park is Service D (one vessel with 30-minute headways). If these routes are operated in off-peak hours, consideration should be given to using one of the multi-stop routing plans shown in section 3.4 or a variation thereof.

To model a realistic timing plan, timing of terminal segments was taken from fourteen ferry arrivals at Halifax Ferry Terminal (see Table 29 and Appendix A). These were used to determine the time normally taken to decelerate and pull into the dock and load and unload passengers. The minimum loading time is for all passengers to unload from the ferry and all passengers in the waiting area ready at the time of boarding commencing being aboard the ferry. The minimum loading time will be used when the ferry is behind schedule or close to that point and is normally referred to as "load-and-go". A higher loading time is assumed for the Mill Cove route due to the higher expected passenger volumes.

Table 29 Timing Measurements and Planning Assumptions

Timing Segment	Average Measured Value (Current Ferries)	Planned Value		
		Mill Cove	Larry Uteck	Shannon Park
Deceleration/Docking	1:38	2:00	2:00	2:00
Minimum Loading Time	2:09	2:30	2:00	2:00
Normal Loading Time	5:48	4:30	4:00	6:30

If it desired to increase frequency of the Shannon Park route, it is recommended that Service Plan E be implemented to provide 20-minute frequency to both Larry Uteck and Shannon Park using four ferries in an 80-minute cycle.

Although off-peak and weekend service has not been considered in the project costing, it can best be delivered with two vessels. One vessel would do a 60-minute cycle from Mill Cove to Halifax (Service A) and the second vessel would do a 60-minute cycle from Larry Uteck to Halifax with an intermediate stop at Shannon Park (Service E).

5.1.2 SCHEDULE RELIABILITY WITH REDUCED VISIBILITY

The 2010 Delphi MRC study, *An Operational and Life Cycle Cost Analysis of Transit Service Alternatives in the Bedford-Halifax Corridor*, assumed a maximum travel speed of 14 knots in low visibility conditions. The study also quoted fog data from Shearwater to predict the frequency by which ferry speeds would need to be reduced. We believe that newer navigational technologies will allow for better confidence in higher speed operations and that fog presence in Bedford Basin and the inner harbour will not be as frequent as would be experienced at Shearwater.

Restricted visibility is likely to have the greatest impact on the potential to safely operate at the speeds necessary to assure an economically viable and marketable service. This will be less critical in the autumn, winter and spring months when there is little to no recreational traffic on the harbour.

Halifax Harbour is affected, on occasion, by extremely heavy fog and notwithstanding the use of the best possible equipment on the new vessels there will be occasions when they are unable to operate safely at full speed. From empirical observation, very heavy fog extends only infrequently into the Bedford Basin past the Narrows and the MacKay Bridge and, in most cases, vessels should be able to operate at full speed up to that point.

We looked at hourly data collected by Environment Canada for the Halifax Dockyard weather station over a five year period from 2015 to 2019 inclusive.

Most Nova Scotians will be familiar with the existence of what is sometimes described as the “fog line”, the point at which fog is frequently encountered as one approaches the coast. The Halifax Dockyard weather station is more representative to the actual conditions likely to be experienced by the ferry operation than is Shearwater, being farther inland and less exposed to the lower temperatures and more severe conditions closer to the open sea.

The criteria for assuming that visibility would be reduced was a relative humidity greater than 99% and a difference between the air temperature and the dew point of less than 0.2 degrees celsius. This assumption was discussed with a meteorologist from Environment Canada¹². He advised that these assumptions were reasonable but that due to numerous other variables such as the state of the tide, that are not tracked by Environment Canada, there was no certainty that should our selected conditions be encountered that visibility would be reduced, or that in certain other situations that visibility would not be affected. For the purposes of this study, however, he felt that our parameters were reasonable.

It should also be noted that meeting our criteria for restricted visibility does not necessarily mean that service speed will be affected. Our analysis does not distinguish between rain, snow and fog. Any of these conditions could be encountered under the selection criteria and not all of them will affect service speed. Once a final design is selected, operating guidance will need to be established in accordance with the criteria laid out in the Collision Avoidance Regulations, most particularly as applies to visibility conditions, traffic and stopping distance. So, for example, all other things being equal, visibility of less than one kilometer may not necessarily affect the vessel’s service speed.

Our analysis was limited to “peak hour” operations, that is between the hours of 0600 and 0900 in the mornings and 1500 and 1900 in the evenings as we expect that operations, if any, outside of these hours will be less critically affected by a change in schedule as there is additional terminal buffer time built into the operating schedule. The results of this modeling are shown in Table 30.

As might be expected, due to warming temperatures in the afternoon, there is a greater likelihood of encountering restricted visibility in the mornings.

As stated, not all of these occurrences of limited visibility will be of sufficient magnitude to require a reduction in speed. Furthermore, not all occurrences of speed reduction will result in the inability of the ferry to maintain its schedule. Our proposed commuting peak operating plan for Mill Cove has each ferry docked for a total of 4.5 minutes

¹² Personal communication, Russell Emery, Senior Program Meteorologist - Client Service Operations Atlantic, Meteorological Service of Canada, Environment and Climate Change Canada

at both ends of its run. We expect loading and unloading to take a maximum of two-and-a-half minutes leaving two minutes of “schedule buffer time”. If ferries were to reduce their travel speed by 20% in the inner harbour and narrows

Table 30 Expectation of Precipitation Modeling Results

Precipitation Occurrences (Hours) by Year and Month (AM Peak)							Precipitation Occurrences (Hours) by Year and Month (PM Peak)						
Month	2015	2016	2017	2018	2019	Monthly Average	Mon	2015	2016	2017	2018	2019	Monthly Average
Jan	5	6	10	5	0	5	Jan	2	2	6	6	0	3
Feb	3	10	28	31	0	14	Feb	3	4	13	11	0	6
Mar	14	8	13	18	1	11	Mar	1	3	5	13	0	4
Apr	15	8	22	32	2	16	Apr	3	7	11	21	1	9
May	10	21	15	15	0	12	May	2	2	9	3	0	3
Jun	8	13	0	2	1	5	Jun	1	1	0	0	0	0
Jul	13	6	0	0	0	4	Jul	4	0	0	0	0	1
Aug	23	0	0	0	0	5	Aug	5	0	0	0	0	1
Sep	19	2	0	0	0	4	Sep	10	0	0	0	0	2
Oct	1	0	0	2	0	1	Oct	2	1	0	0	0	1
Nov	1	6	4	0	0	2	Nov	2	2	0	0	0	1
Dec	21	8	3	0	1	7	Dec	18	9	0	0	1	6
Annual Total	133	88	95	105	5		Annual Total	53	31	44	54	2	

(and maintain speed in the basin where fog expectation is lower) or by 10% for the entire route, they would still be able to meet their schedule by reducing the buffer time to zero.

The requirement for a ferry captain to independently determine the speed at which the vessel is operated during limited visibility conditions is not unlike the requirement for a bus driver to determine travel speed during winter icing conditions. Given the nature of this decision-making, it is not possible for us to definitively project how frequently, and to what degree, ferry captains will deem it necessary to reduce speed.

However, to gain a degree of confidence in how the ferry service would be expected to comply with its planned operating schedule, we suggest that the following assumptions for speed adjustment during the precipitation occurrences modeled in the table above:

No reduction in travel speed required	65% of hours
Modest reduction in speed required but able to maintain schedule	20% of hours
Significant reduction in speed required and adherence to schedule is discontinued	15% of hours

Using these assumptions, it might be expected that the ferry service will fail to maintain schedule between 1 and 20 hours every year during the mornings and between one and eight hours during afternoons. Three timing plans corresponding to each of these three ranges of visibility-limiting occurrence are provided in Table 31. In the Moderately Low Visibility Plan, speed is reduced in the Harbour where fog is more likely and water traffic is higher and this time is made up by minimizing the loading time so that the ferries are able to stay on schedule. In the Very Low Visibility Plan, speeds are reduced on the entire route and additional time is allocated for docking. With this plan, Mill Cove ferries require an additional 15 minutes to complete their cycle with the result being a change to 20-minute headways instead of the 15-minute headways delivered in normal conditions. The Larry Uteck route is modified from 20-minute headways to 30-minute headways. There is enough extra loading time for the Shannon Park route that schedule adjustments are not required regardless of visibility conditions by reducing buffer time to zero.

The reduced level of service experienced with the Very Low Visibility Plan is clearly better than occasions when buses are delayed due to snow events or roadway collisions. In other words, ferry system slow-downs due to fog may be more frequent than bus slow-downs due to snow and major collisions, but the impact will be far less.

Table 31 Alternative Service Plans with Lessened Visibility Occurrences

MILL COVE	Normal Plan		Moderately Low Visibility Plan		Very Low Visibility Plan	
	Speed (knots)	Cum. Time	Speed (knots)	Cum. Time	Speed (knots)	Cum. Time
Depart Mill Cove Dock		0:30		0:30		0:30
Travel in Basin (5.8 km)	25	8:00	25	8:00	19	10:30
Travel in Harbour (5.0 km)	20	16:00	16	18:00	11	25:00
Decelerate/Dock		18:00		20:00		27:30
Load/Unload Halifax		22:30		22:30		30:00
Leave Dock/Accelerate		23:00		23:00		30:30
Travel in Harbour (5.0 km)	20	31:00	16	33:00	11	45:00
Travel in Basin (5.8 km)	25	38:30	25	41:00	19	55:00
Decelerate/Dock		40:30		43:00		57:30
Load/Unload Mill Cove		45:00		45:00		60:00
LARRY UTECK	Normal Plan		Moderately Low Visibility Plan		Very Low Visibility Plan	
	Speed (knots)	Cum. Time	Speed (knots)	Cum. Time	Speed (knots)	Cum. Time
Depart Larry Uteck Dock		0:30		0:30		0:30
Travel in Basin (4.1 km)	25	6:00	25	6:00	19	7:30
Travel in Harbour (5.0 km)	20	14:00	16	16:00	10	24:00
Decelerate/Dock		16:00		18:00		26:00
Load/Unload Halifax		20:00		20:00		30:00
Leave Dock/Accelerate		20:30		20:30		30:30
Travel in Harbour (5.0 km)	20	28:30	16	30:30	10	47:00
Travel in Basin (5.8 km)	25	34:00	25	36:00	19	54:00
Decelerate/Dock		36:00		38:00		56:00
Load/Unload Larry Uteck		40:00		40:00		60:00

We believe this analysis gives the best projection possible given data availability and the uncertainty of the ferry captain's reactions to reduced visibility conditions. If it is determined that this level of schedule adherence may be a "deal-breaker" in developing an expanded ferry network, consideration should be given to undertaking a route-specific visibility data collection program over the next year.

5.1.3 CREWING AND TRAINING

We have considered that the vessels' primary function will be for the transport of commuters, similar to the features provided by the bus system, rather than for tourist development or other non-core functions. Transport Canada has provided a pro-forma Minimum Crewing document in accordance with the vessel characteristics criteria provided in this report. These criteria do not include outdoor seating or an additional deck as these would not be required for a transit function and would almost certainly require an extra crew member. It is improbable that these features could be used on an optional basis, as if they were included in the vessel design, the public would likely insist that they be useable in all operations and this would in turn give rise to a requirement for a fourth crew member.

There will be additional training costs for any vessels purchased for this service because the service will be fundamentally different from the existing ferry service, both in type of vessel, propulsion system and operating speed. This will most likely include simulation training, either PC based or full simulator based, or both, but it is difficult to quantify the costs of this additional training without having a final equipment selection. We point out that additional training will be required, but given the speed of evolution of electronic technologies and the probable lead time between submission of this report, an RFP for vessels, and the subsequent specification of equipment, any estimate of training costs is likely to be at best grossly inaccurate and at worst misleading.

5.1.4 VESSELS

Our discussions with various designers indicate that vessels of the type described in section 3.1.1 should have a capital cost in the region of USD \$5 million each or approximately \$6.5 million per vessel. Given the numerous options available for financing municipal capital projects, we have not attempted to estimate the annual costs related to the capital purchases involved for the vessels.

The ferries proposed for use on this service have been selected using the current certification levels of the existing fleet as a primary selection criterion. A low-wake design will be an essential aspect.

We have assumed that three vessels will be acquired initially to operate the Mill Cove service with no spare vessel. When one ferry needs to be taken out of service, the schedule would be adjusted, similar to the way the existing ferry service operated until recently. Once additional routes are added, and the fleet of ferries exceeds three, a spare vessel should be acquired.

The initial expectation is that the ferries would most likely be powered by Caterpillar prime movers as are the existing ferries. Caterpillar provides various levels of service up to and including a full maintenance with operating hours monitored by them. Caterpillar has a very strong presence in the HRM and maintains a significant inventory of spares on site. It is our experience that the longest delay for spares experienced to date (after a considerable period of purchasing spare for another client) has been two days.

In the event that another prime mover was selected, spares and maintenance arrangements would need to be addressed however, the size and complexity of the engines needed to operate vessels of this size makes most maintenance tasks fairly simple. Life cycle cost analysis and spares and technical support availability will be critical evaluation criteria in selection of the engine packages for any new vessels.

An important feature of this design is its ability to come to a complete stop quickly from its design operating speed. While there is no question that a propeller or azimuth thruster driven vessel has a longer stopping distance than a jet drive, our discussions with an operator of a High Speed Ferry service as well as with the designer of one of the types of vessels considered, indicate that a stopping distance of between three and six ship lengths, in this case between 100m and 150m should be achievable using conventional gearbox and fixed pitch propeller propulsion if the system is specified as being fitted with a shaft brake. The ability to stop the vessel from 25 knots (46 kms/hr) in one and a half ship lengths or in this case 36m as might be provided by a jet drive system, would create its own set of challenges for passenger safety.

Other vessel features will need to be considered when preparing a vessel procurement process, such as the need to store bicycles and strollers and how to secure mobility assistance devices. Features such as on-board public washrooms, vending machines and other customer amenities should also be evaluated. As these features have negligible impact on vessel cost, they have not been examined further in this study.

5.1.5 FARES

In discussion with Halifax Transit staff, it was felt that the fare for using the ferry should be consistent with the current fare structure. Halifax Transit has recently switched from a three-tier fare structure to a two-tier structure as shown in Table 32.

Table 32 Halifax Transit Fare Structure

Service Type	Adult Cash Fare	Adult Monthly Pass
Conventional	\$2.75	\$82.50
Regional Express	\$4.25	\$127.50

The 2006 *Bedford-Halifax Fast Ferry Cultivation Study* used market research data on fare elasticity and modelled an optimal fare of \$4.00 to \$5.00 (in 2006 dollars) for a Mill Cove ferry service. That analysis was based on data collected from a 2005 telephone market survey of 741 persons over the age of 18 in the primary and secondary markets for Mill Cove. That data is summarized in Table 33. Similarly, the 2011 Stated Preference Survey used to produce the ridership projections described in Section 3.5 used a one-way cash fare of \$4.00 as a baseline.

Table 33 Demand for Mill Cove Ferry Service by Fare Price

One-way Adult Fare	Fraction of Population 18+ that Would Use the Ferry
\$0.00	0.672
\$1.00	0.669
\$2.00	0.656
\$2.50	0.571
\$3.00	0.433
\$4.00	0.237
\$5.00	0.121
\$6.00	0.022

We believe that the fare rates used for Regional Express service are appropriate for the Mill Cove and Larry Uteck ferries given the length of the route and the high level of service that it provides. For reference, Figure 32 (section 2.10.1) has shown that a \$4.25 fare for the approximately 11 km distance to Mill Cove is at the low end of fares for other services. The shorter length of the Shannon Park route may warrant consideration for its passengers being charged the conventional ferry fare even though it has the features of the regional higher speed services.

5.1.6 MILL COVE FERRY TERMINAL

The land upon which a Mill Cove ferry facility would be built is owned by Develop Nova Scotia. Potentially developable areas around the site are also owned by Develop Nova Scotia along with other property owners with smaller lots. The Mill Cove 2014 draft concept contemplates developing on the existing infill footprint (with minor additional hardening of the edges) versus the full infill scenario originally proposed. The current plan now estimates that there could be the possibility of providing approx. 1,200 residential units, 54,000 square feet of commercial space, an unknown amount of institutional space to be discussed with HRM (with the idea that this could be a site for the new Bedford Library), and approximately 50% open space. There is also some thought that the adjacent Sobey's Shopping Plaza may be a candidate for redevelopment. There is a huge potential upside to establishing ferry service at the outset of development so that the site can grow with an orientation towards the transit service. Existing employment in the area coupled with additional employment resulting from development will help optimize the ridership with a higher degree of two-way travel.

This development concept, or any other development plan for this site, will not be advanced until the Municipality completes additional study of traffic in the area. Concern has also been expressed about the feasibility of establishing a second roadway connection to the site.

Two scenarios have been developed for accommodating ferries at Mill Cove. The first is a permanent facility that is integrated into the development of the Mill Cove site. The second allows for a quick implementation of ferry service in advance of development and assumes the use of currently vacant land intended for future development.

PERMANENT FACILITY

We believe that the best result for a Mill Cove Ferry Terminal is to integrate it into a new multi-use public building on the waterfront. The secure and staffed passenger waiting area and the ferry crew office/locker room would simply be part of this building. A new wharf purpose-built for the ferry would be needed so that the planned capacity of the existing South Jetty is not lessened. The gangway/walkway and dock will need to be designed to suit Canadian climatic conditions. This will likely include a covered gangway and dock as well as potentially a heated deck. The wharf would need to accommodate three vessels at one time, as they would be berthed here when not in service. A passenger pickup/dropoff area would be part of the site planning and parking for park-and-ride customers could be part of an overall plan for the development site. With a road entry at both ends of the development, transit buses currently on the Bedford Highway could be diverted to a transit loading area close the ferry boarding area.

The siting and design of this infrastructure needs to be carefully coordinated with the development of the remainder of the site. The new terminal and wharf should be sited in as close proximity to the Bedford Highway as possible. The grade of the rail line is approximately three meters below the grade of the Bedford Highway and about three metres above sea level. As a pedestrian overpass would require a 6.7 metre clearance above the rail, it may be more prudent to construct the crossing as an underpass which could be built as an extension of a new building on the Mill Cove site creating an indoor connection between the Bedford Highway and the ferry terminal. A parkade near to the terminal should be considered, although its footprint should be minimized. This need not be an exclusive facility for the ferry and might more appropriately be a shared facility for a number of uses in the locale.

Determining the number of park-and-ride spaces to provide at the terminal is challenging. From our jurisdictional scan, the majority of terminals provide zero parking while a few provide over a thousand spaces. There is also nothing in the local transit network that can provide a parallel to base a number on. From a planning perspective, a large footprint for parking, even structured parking, can take away land that might better be used for transit-oriented development. As a starting point, we suggest providing parking for 25% of one-way daily trips which would be a total of 310 spaces at Mill Cove. A fee should be charged for parking at this lot to recognize the value of the facility and to moderate its use. Parking revenue is not, however, considered in the financial analysis.

The terminal would require a footprint of approximately 2,800 square feet including a passenger waiting area, washrooms and a ferry crew room. Comparatively, the Woodside Ferry Terminal has approximately 5,000 square feet of space but is designed to accommodate double the loading of the ferries planned for Mill Cove.

The parcel for the facility (if it is stand-alone) would need to be approximately 9,000 square feet (not including water lot) to accommodate a passenger dropoff area, landscaping and a setback from the shoreline. If a supporting parking structure is included, it would require a footprint of approximately 20,000 square feet.

QUICK START FACILITY

With the uncertainty of development timing, we have also proposed a “quick start” plan for implementing ferry service in advance of development or construction of a public multi-use building. The plan would use the existing South Jetty with some modifications to accommodate passenger loading to the bow of the vessel. Like virtually all of the docking facilities we have seen in similar climate locations (New York and Boston) and consistent with public expectations at transit terminals, we recommend that this dock be secured, but not enclosed. We recommend that a facility be constructed with an enclosed connection up to the jetty that will double as a secured and staffed passenger waiting area and a ferry crew office/locker room. As this facility can be expected to be replaced as the service is integrated into future development, it can be designed as temporary in nature, possibly even with the use of portable trailers. A pedestrian overpass across the CN main line and a covered walkway could be used to connect passengers to the terminal from the Bedford Highway.

Further investigation and discussion would be required if this Quick Start option were to be considered for implementation. It is unclear whether a ferry loading area enclosed by fencing and not a structure would be deemed as providing sufficient security by Transport Canada. HRM staff has expressed concern that this type of facility, even if temporary in nature, is well below the level of service its customers have become accustomed to and would require additional operating costs to clear snow and ice. Furthermore, it is unclear whether Develop NS would allow the use of a portion of its South Jetty, given that its intended purpose is for public use.

5.1.7 LARRY UTECK FERRY TERMINAL

The lands upon which the facilities for the Larry Uteck Terminal would be built, including the water lot for the wharf, are all privately owned. Like Mill Cove, there is opportunity to redevelop the terminal site and the abutting lands from existing parking lots and low density commercial development into higher density residential and commercial uses with an orientation to the ferry service. Where this site surpasses Mill Cove is the presence of existing high density residential development within easy walking distance of the terminal. As there is limited land available for transit-oriented development, parking for park-and-ride is not appropriate. A transit stop and passenger drop-off area, possibly below grade, might be integrated into a future commercial building.

The terminal building would be constructed between the shoreline and the rail line. It would require an enclosed pedway connection across the rail line that would be approximately 500 square feet. Like Mill Cove, the terminal building would occupy a footprint of approximately 2,800 square feet including passenger waiting area, washrooms, ferry crew room, and stairway and elevator.

5.1.8 SHANNON PARK FERRY TERMINAL

The Shannon Park site consists of lands owned by Canada Lands Company and the Millbrook First Nation. Now vacant, the 85-acre Canada Lands site is intended to be developed into a compact, mixed use community of approximately 7,000 residents.¹³ These lands are currently undergoing a Development Agreement process.

Like the Mill Cove and Larry Uteck sites, Shannon Park has the potential for its development to be oriented around a ferry terminal and other transit connections. The exact location of a ferry would need to be determined in concert with the overall site development planning. The location selected should minimize the walking distance to transit routes on Windmill Road, while avoiding the planned public waterfront area and potential marina at the southern tip of the lands. A small structured or surface parking area should be considered. Like the Mill Cove site, it is suggested that this be planned for 25% of the projected one-way daily ridership or 70 spaces. A fee should be charged for parking at this lot to recognize the value of the facility and to moderate its use. Parking revenue is not, however, considered in the financial analysis.

Millbrook First Nations could be a valuable partner in developing a ferry terminal and the water-based infrastructure and should be engaged in the site selection and planning process. This partnership could also support opportunities to create a unique cultural destination and tourism attraction for this ferry route.

A terminal here would require a footprint of 2,500 square feet including washrooms, passenger waiting area and ferry crew room. The parcel for the facility (if it is stand-alone) would need to be approximately 9,000 square feet (not including water lot) to accommodate a passenger dropoff area, landscaping and a setback from the shoreline. If a parking lot or parking structure is included, it would occupy an additional parcel of approximately 15,000 square feet.

5.1.9 HALIFAX FERRY TERMINAL

The existing ferry terminal in Halifax is generally acknowledged to be near the end of its effective life and exceeding the limit of its ability to manage passenger loading. Finding a new site on the Halifax waterfront, and one with strong connections to the rest of the transit network, is unlikely. This will limit a new terminal to being located on the same site as the existing one. We have examined two scenarios for this facility, a new permanent building with more

¹³ *Regional Centre Secondary Municipal Planning Strategy (Package B)*; Halifax Regional Municipality

features and more capacity to handle additional vessels and passengers, and a simple renovation and construction of a new wharf that will allow for addition of a single new route.

PERMANENT FACILITY

From the two options for expanding docking capacity for the Halifax Ferry Terminal identified in Section 4.2.1, adding a docking area to the north side of the existing building is preferred. This side of the building has less marine activity than what would be experienced being next to Cable Wharf and it would allow for the three ferry routes to operate without crossing paths.

Without knowing the specific design of the vessels, it may be possible to adapt one of the existing ferry docking areas to accept nose-in loading from a catamaran vessel. However, for the purpose of this analysis, we have assumed that a new wharf will be required specifically for the Mill Cove route.

A rough sketch of what the proposed docking area would look like is provided in Figure 47. It includes a fixed walkway extending tangentially from the existing ramp with overhead glassed cover. A 20-metre long ramp extends from the walkway down to a floating dock. The top of the ramp will be designed to be level with high tide and the length of the ramp will be sufficient to span the tidal fluctuation while retaining a maximum 1:15 slope for accessibility. The height of the floating dock above the water will be designed to match the freeboard height of the bow of the ferry. The ramp and the floating dock have been left unsheltered both to save cost and to prevent blockage of harbour views from Nathan Green Square. Further examination may be required to determine if this can be designed to satisfy security requirements. Although the Alderney Ferry and the Mill Cove Ferry are shown to be berthed side-by-side, in reality they would be scheduled to arrive at different times and would never be berthed at the same time.

The facility would be designed to accommodate both the current conventional ferry routes plus up to three additional regional ferry routes. We have assumed that the same steps in boarding and unboarding passengers that are used currently will be implemented. Those steps are:

- Passengers enter the building; then
- Passengers pay their fare and are counted as they pass a staffed booth and enter a secure waiting area designated for one route; then
- Passengers gain exclusive entry to the ferry ramp to board their vessel; then
- Passenger debarking the vessel also have exclusive use of the ramp and their only exit is directly out of the building.

A sketch showing the proposed layout of the new building is provided in Figure 48. The ground floor footprint has been increased to 16,000 square feet, almost double the size of the existing terminal. The proposed building is separated into two sections with a common exitway between. One section is for the existing conventional ferries and the other for all of the new regional ferry services. The following are considerations for this building:

- Public washrooms should be provided that can be accessed without entering the secured area.
- Similar to the existing building, a second floor office space is recommended, although it should be less than two-thirds the floor area of the ground floor to allow for terracing.
- Since the building footprint will occupy some of the existing Nathan Green square, terracing of the building should be integrated into the park space to retain or expand public space.
- Construction of an escalator up from the ground floor level to an overhead pedway would provide additional comfort to passengers accessing the building during inclement conditions. This pedway could be extended to the transit area at Ferry Boat Lane and potentially to Hollis Street and a connection into the larger downtown pedway network. The cost of this option has not been included in the cost estimate for the building.
- As much of the building footprint is over the water, significant cost is required to add additional structural piles.

We estimate the cost of this building (including a 10,000 square foot second floor) to be \$14 million plus an additional \$1 million for the new ferry wharf.

QUICK START FACILITY

The existing Halifax Ferry Terminal building would undergo a minor internal reconfiguration to accommodate additional passengers (see Figure 49). Relocation of the security booths within the terminal building will create additional space for passenger waiting area. The entry doors to the ferry boarding ramp would be relocated to create three entry points instead of the current two. We expect that one additional security staff person will be required during the times when the Mill Cove ferry is in operation.

We see the proposed floating dock and interior reconfiguration of the ferry terminal building as short term measures that will accommodate the addition of a single new route. Any further expansion of the system will require replacement of the current building to improve its functionality. With limited availability of downtown waterfront lands, this will likely have to be on the existing terminal site. We believe the proposed floating dock can be incorporated into the redesign. As this structure will be less substantial than the current dock, it may be susceptible to heavy waves and may require periodic closure.

We acknowledge that HRM staff, citing passenger management and capacity issues currently experienced during seasonal peaks and major events, has expressed concern that any additional passenger traffic generated by a new route cannot feasibly be accommodated by the existing terminal, even with an increase in the overall waiting area.

We estimate the cost of the interior modifications to the terminal along with construction of the new dock and ramps to be \$1,300,000.

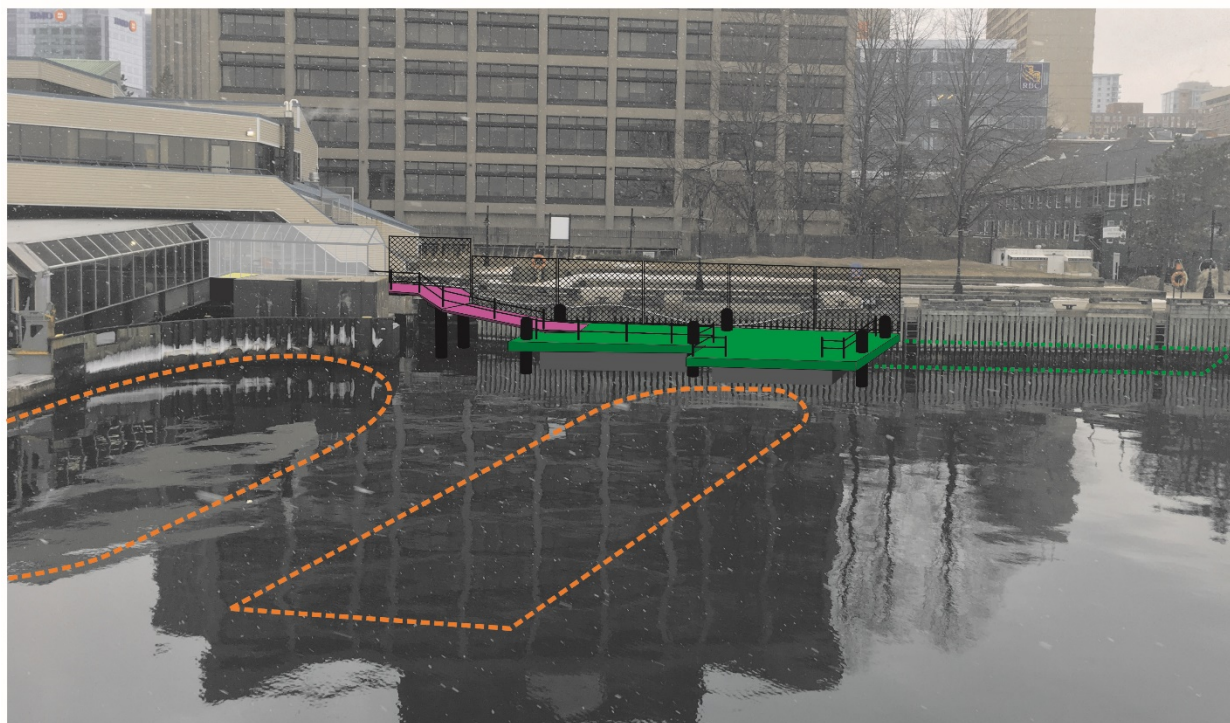
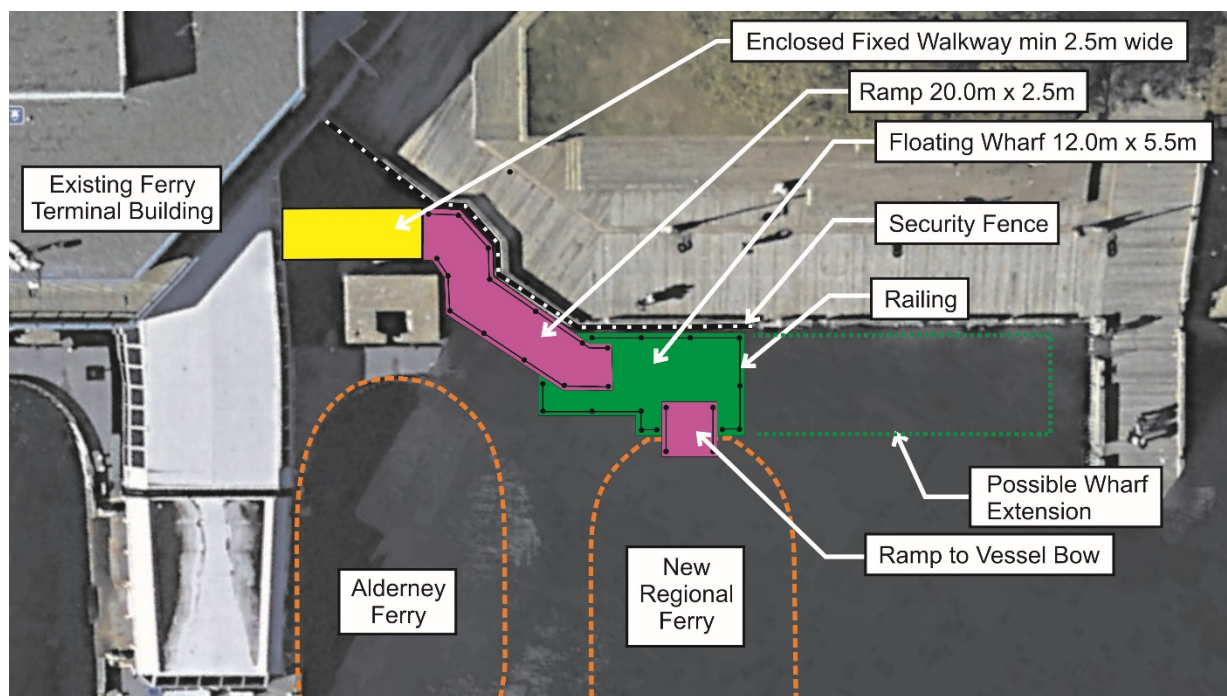
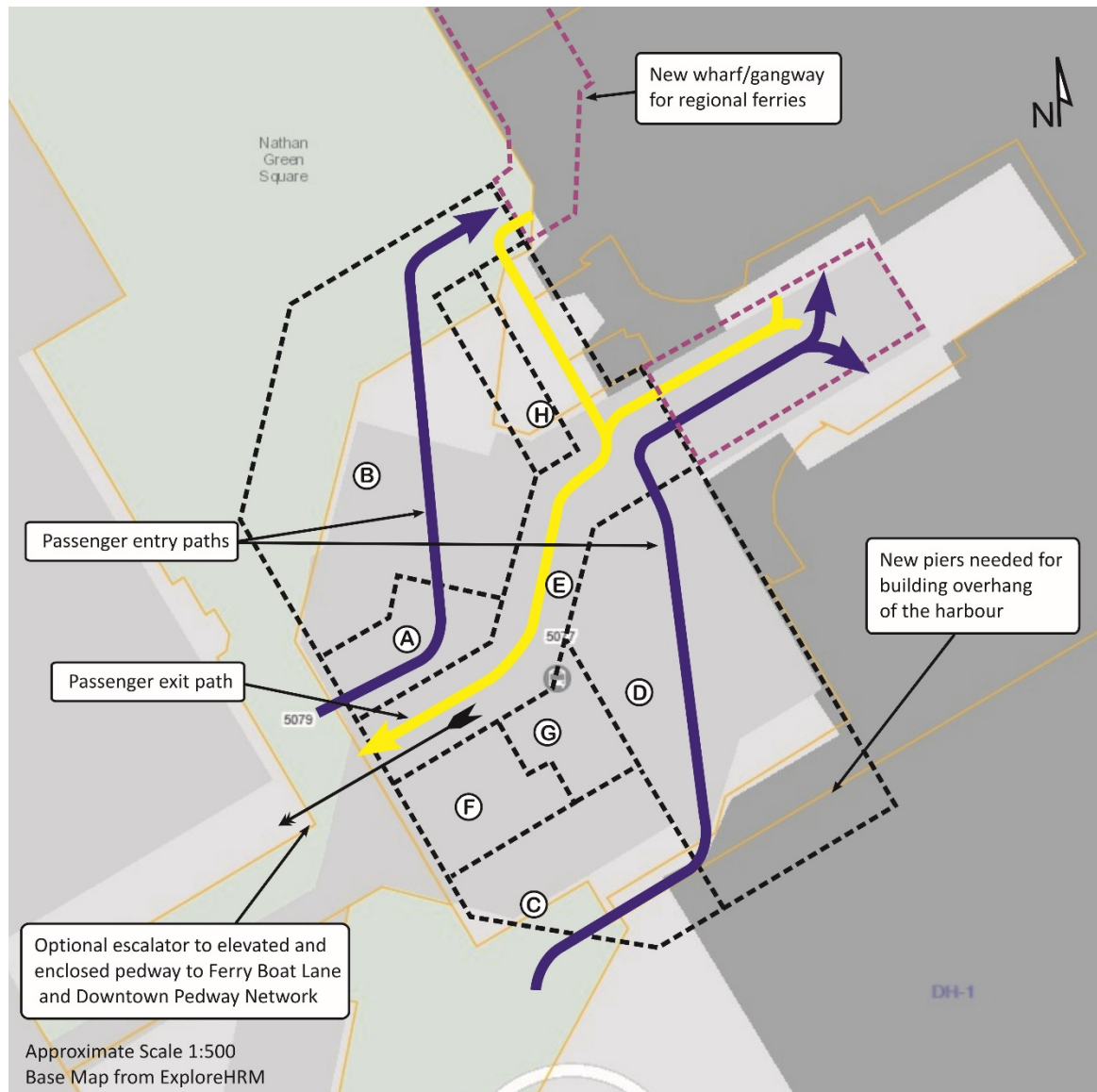


Figure 47 Layout of Proposed Wharf at Halifax Ferry Terminal



NEW EXPANDED FERRY TERMINAL

- (A) 600 sq.ft. Regional Ferry Unsecured Entry
 - (B) 5,000 sq.ft. Regional Ferry Secured Waiting Area
 - (C) 1,600 sq.ft. Conventional Ferry Unsecured Entry
 - (D) 4,200 sq.ft. Conventional Ferry Secured Waiting Area
 - (E) 2,600 sq.ft. Exitway
 - (F) 800 sq.ft. Public Washrooms
 - (G) 500 sq.ft. Stairs/Elevator to 2nd Floor plus Utility Area
 - (H) 700 sq.ft. Utility and Storage Rooms
-
- 16,000 sq.ft.

EXISTING HALIFAX FERRY TERMINAL

- 3,000 sq.ft. Conventional Ferry Unsecured Entry (incl Stairs)
 - 3,300 sq.ft. Conventional Ferry Secured Waiting Area
 - 1,000 sq.ft. Exitway
 - 500 sq.ft. Public Washrooms
 - 700 sq.ft. Utility and Storage Rooms
-
- 8,500 sq.ft.

Figure 48 Layout of Proposed Changes to Halifax Ferry Terminal Building

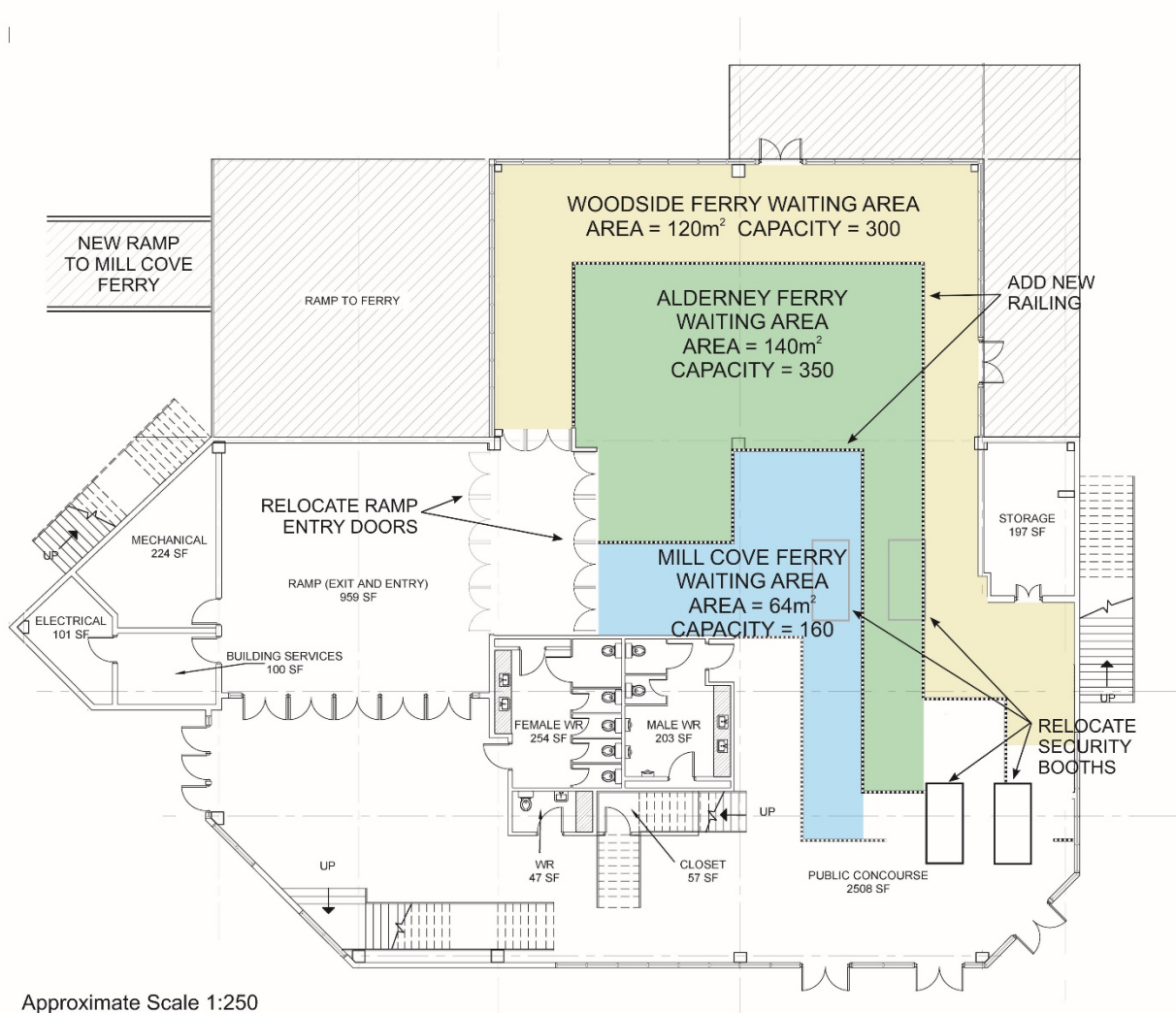


Figure 49 Proposed Reconfiguration of Halifax Ferry Terminal Waiting Area

5.1.10 FERRY MAINTENANCE FACILITY

From our documentation of other ferry systems, dedicated facilities are rare and most operators use common facilities for ferry maintenance. An exception to this is the WETA in San Francisco where a 12-berth facility is currently under construction at a cost of \$50 million US. Something like a 10,000 hour service would either be done alongside or done so as to coincide with a regular drydocking/refit period. Drydocking would, of course, be performed at a shipyard. There should be very little requirement to warehouse parts if Caterpillar engines are selected.

A study conducted in 2016 for Halifax Transit¹⁴ recommended that a dedicated two-berth facility for routine maintenance be constructed to avoid the conflicts and potential impact on passenger safety posed by performing these tasks at the Woodside (or any other) terminal wharf. A chart from the study showing the anticipated maintenance

¹⁴ Woodside Ferry Terminal – Expansion Study – Vessel Maintenance and Berthing; CBCL Limited, 2016

activities is reproduced in Table 34. This facility was recommended for servicing the existing fleet of ferries and this justification increases with expansion of the fleet to regional services.

Table 34 Regular Required Ferry Maintenance Activities

Regular Required Ferry Maintenance	
250 Hour Service	750 Hour Service (Includes 250 Hour Service Requirements)
➤ Change Lube Oil and Filters on Main Engines ➤ Change Fuel Filters on Main Engines ➤ Change Oil and Filter on Generator ➤ Change Fuel Filter on Generator ➤ Change Racor Fuel Filters ➤ Check All Belts and Hoses ➤ Check Boiler Pressure and Water Level ➤ Check All Battery Fluid Levels ➤ Check All Fluid Levels in Pumps ➤ Grease Electric Fire Pump ➤ Grease and Oil All Ramp and Door Hinges ➤ Pump Out Bilge and Holding Tank ➤ Inspect Air Filters on all Engines Replace if Necessary ➤ Change Accommodation Fan Air Filters ➤ Check Emergency Fire Pump Fuel Can Replenish if Necessary ➤ Replenish Oil in On Board Holding Tank	➤ Change Main Engine CCV Filters ➤ Grease All Voith Connections
	1000 Hour Service (Includes 250 Hour and 500 Hour Service Requirements)
	1 Month Interval
	➤ Test Emergency Batteries on the Wheelhouse ➤ Run belt driven pumps ➤ Grease Voith gear cuplink ➤ Check Voith belts
	3 Month Interval
	➤ Check Oil in Voith Schneider Fluid Couplings Replenish if Necessary ➤ Check Voith R.P.M Sensors ➤ Clean out Sea Suctions
	6 Month Interval
500 Hour Service (Includes 250 Hour Service Requirements)	➤ Change Oil in Diesel Fire Pump ➤ Change Air Filter on Diesel Fire Pump ➤ Change Oil in Air Compressor ➤ Change Oil in Voith Schneider Units ➤ Clean All Interior Vents
➤ Change Main Engine Gear Box Oils ➤ Change Boiler Fuel Filter ➤ Check All Battery Connections ➤ Grease All Shaft Bearings ➤ Grease All Upper Deck Machinery	

If a dedicated facility is felt to be needed, interpolation of the San Francisco project would suggest that a two-berth facility (for maintenance, not vessel storage) would cost approximately \$13 million without land cost.

During a recent study¹⁵ that proposed what has now become COVE (Centre for Ocean Ventures and Entrepreneurship), both the APA (Pilots) and Halifax Transit expressed some interest in using the floating dock on the north of the facility. There's also now talk of COVE 2.0 in Dartmouth Cove. This may be an opportunity to be explored.

5.1.11 SECURITY

In the descriptions of the passenger facilities at both ends of the route, we have assumed that the passenger waiting area and boarding area will be secure and staffed as they currently are at all three existing terminals.

The current security arrangements mandated under the Domestic Ferry Security Regulations are difficult to comprehend when compared to those applied to other mass transit options such as buses. We are advised that a stakeholder review process will be initiated by Transport Canada in the next two years and that the Regulations may be changed as a result.

We recommend that HRM and Halifax Transit develop a clearly reasoned position to the effect that the security requirements for the municipal ferry terminals are inconsistent with operation of a mass transit system, that the security measures as currently required do little to assure public security and that the added costs involved act as an impediment to the viability of ferries as a means of mass transit. It is, however, not certain that any change will be forthcoming, notwithstanding the most persuasive arguments.

¹⁵ WDCL & NSBI "Market Study of the Canadian Coast Guard Base"; MariNOVA, 2013

In such a case we believe that any terminal infrastructure should be designed with a very close eye on the Regulations to minimize the size of the passenger waiting area and as a result to minimize the associated staffing costs.

5.2 SERVICE EVALUTION

5.2.1 COMPARATIVE TRAVEL TIMES

A distinct advantage of the ferry routes being examined is their ability to deliver fast and reliable travel times in spite of chronic commuter congestion on the roadway network. A well-established methodology¹⁶ has been applied, with some modification for current conditions, to compare the travel cost, or “impedance” of various modes for trips from each of the ferry terminal areas to downtown Halifax (Scotia Square or Halifax Ferry Terminal). These impedances, along with just the in-vehicle travel time, are compared in Figure 50.

In addition to the in-vehicle travel time, the impedance calculation takes into account out-of-vehicle travel time (walking to and from transit and waiting for the bus/ferry) then factors those minutes up by fifty percent to account for the perceived ineffectiveness of that time. The calculation also includes out-of-pocket costs such as bus fare and car operating expenses and parking valued at \$20 per hour. The equation takes this form:

$$\text{Impedance} = (\text{In-vehicle Travel Time}) + 1.5 (\text{Out-of-vehicle Time}) + (\text{Out of Pocket Costs in \$}) (3\text{min}/\$)$$

This impedance calculation was applied to trips within the vicinity of each ferry terminal for each of the travel mode options. An average five minute walk to the nearest bus stop and an average eight minute walk to the ferry terminal was assumed. Not surprisingly, the in-vehicle travel time for ferry is lowest for all three terminal locations. However, even when the additional time to walk to the terminal and wait for the ferry (along with other factors) is added in through the impedance calculation, the Mill Cove and Larry Uteck ferry trips remain the “best” way to commute. For Shannon Park, the ferry trip has slightly higher impedance than the car trip but remains competitive.

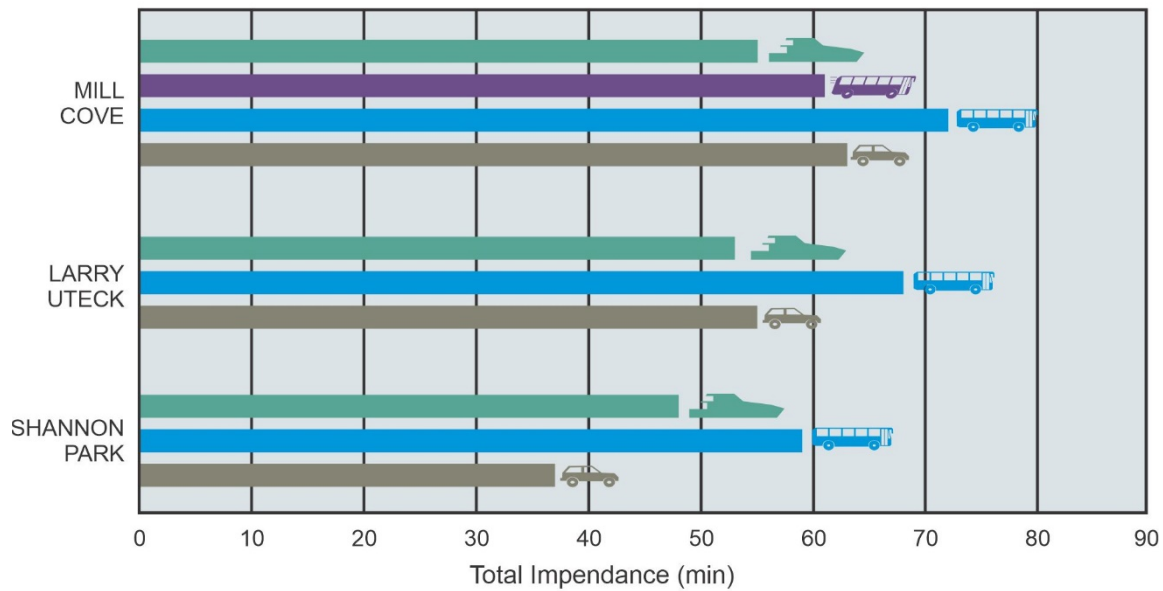
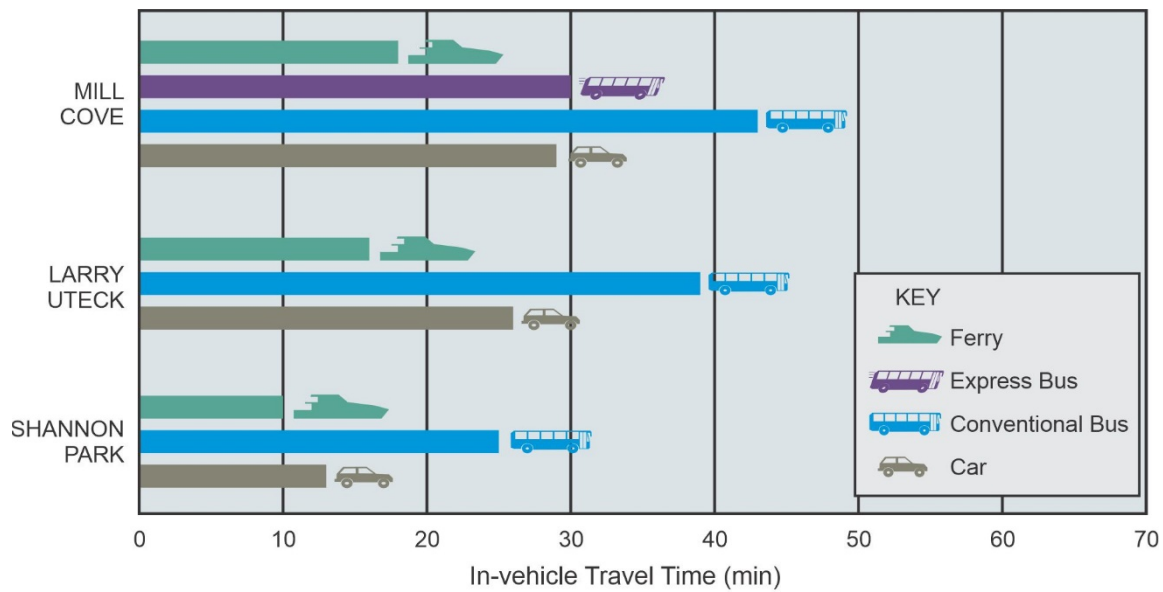
5.2.2 COMPARATIVE GREENHOUSE GAS EMISSIONS

One benefit of public transit is its ability to reduce greenhouse gas emissions and with higher occupancy vehicles (like ferries) that saving can be magnified. To quantify this for our planned Mill Cove service, we reviewed three alternatives for greenhouse gas emissions comparisons:

1. Ferry Route from Mill Cove Bedford to the current Halifax ferry terminal
2. Bus Route from Mill Cove Bedford to Scotia Square area (#8 Sackville bus)
3. Car Route from Mill Cove Bedford to Scotia Square (direct)

We assumed that car transport would be calculated as a single leg as a car would be driven to destination, parked and then driven back to origin. Bus and ferry transport would be calculated on the basis of an empty return trip as it is expected that load on the return to origin in peak hours would be negligible. The calculation shows (see Table 36) that the emissions per passenger by ferry are expected to be half as much as a car driver/passenger making the same trip.

¹⁶ NCHRP Report 187 Quick Response Urban Travel Estimation Techniques and Transferable Parameters; Transportation Research Board, 1978



Note: Details and sources are provided in Appendix D

Figure 50 Total Travel Time and Impedance by Mode

Table 35 Greenhouse Gas Emission Assumptions

GHG Emissions		Ferry	
Gasoline	2.29 kg/l (1)	Installed Power	1000 BHP
Diesel	2.66 kg/l (1)	Average Operation	70% Max Contin. Rating
ULS Diesel Density	0.86 kg/l	Fuel Consumption	170 g/hp/hr
ULS Diesel GHG	3.09 kg/l	Passenger Capacity	150
		Run Time per Round Trip	36.5 minutes
Bus (articulated)		Car	
Average Fuel Consumption	1.78 l/km (2)	Ave Fuel Cons. (stop-and-go)	10-12 l/100 km
One-way Distance	17.4 km	One-way Distance	15.4 km
Round Trip Distance	34.8 km	Passenger Load	1.2
Passenger Capacity	62		

Sources: 1. Environment Canada
2. Halifax Transit

Table 36 Greenhouse Gas Calculation per Person Trip

	Automobile	Bus (Artic)	Ferry
Load	1.2	62	150
Distance	15.4 kms	34.8 kms	36.5 mins
Consumption	10-12 litres/100 kms	1.78 litres/km	700 bhp x 170g/hp/hr
Fuel Consumed	1.54-1.85 litres	61.94 litres	72.39 kgs
Fuel per passenger trip	1.3 – 1.5 litres	1.0 litres	0.5 litres
GHG Produced	3.53 - 4.23kgs	164.77 kgs	223.69
GHG per passenger trip	2.94 – 3.53 kgs	2.65 kgs	1.49 kgs

5.3 FINANCIAL ANALYSIS

5.3.1 *TERMINAL INFRASTRUCTURE CAPITAL COSTS*

Infrastructure to support each of the ferry terminal sites may be built at various stages in the host site's development or through different delivery mechanisms. Capital costs for terminal and wharf structures are very high level and are based on standard per-square-foot rates and data from our jurisdictional scan.

To simplify our analysis, we have created three scenarios under which terminal sites might be constructed:

QUICK START SCENARIO – This scenario is relevant to implementation of the Mill Cove service and strives to minimize start-up costs by modifying existing facilities and making minor improvements to vacant Mill Cove land. For the Halifax Ferry Terminal, this scenario involves construction of a new wharf and renovation to the existing building to expand passenger waiting capacity.

INTEGRATION SCENARIO – This scenario assumes that the ferry terminal is closely integrated into the overall site development or redevelopment plans and that the terminal is part of a multi-use public building. It may also be leased space in a commercial building. A dedicated passenger dropoff and bus connection area is part of the project, but parking is assumed to be integrated into other elements of the site planning. Master planning for the area may, in fact, determine that parking for park-and-ride is not appropriate for that site.

STAND-ALONE SCENARIO – Here we assume that all of the required infrastructure would be purpose-built including parking. It would still be closely integrated with overall site planning, but not involve any sharing of space.

Table 37 breaks down costs for each of these scenarios by terminal.

Table 37 Ferry Terminal Capital Costs

		COST (\$ MILLION)		
		QUICK START SCENARIO	INTEGRATED SCENARIO	STAND-ALONE SCENARIO
Halifax	Wharf	1.0	1.0	1.0
	Terminal Building	0.3	14.0	14.0
	Total	\$1.3	\$15.0	\$15.0
Mill Cove	Wharf	0.5	1.2	1.2
	Terminal Building	0.5	1.4	2.0
	Ped/Bike Access	1.2	1.3	1.3
	Dropoff/Transit	0.2	0.5	0.5
	Parking	0.5	0	10.3
	Total	\$2.9	\$4.4	\$15.3
Larry Uteck	Wharf		1.2	1.2
	Terminal Building		2.6	2.8
	Ped/Bike Access		0.2	0.2
	Dropoff/Transit		0.8	0.8
	Parking		0	0
	Total		\$4.8	\$5.0
Shannon Park	Wharf		1.2	1.2
	Terminal Building		1.3	1.8
	Ped/Bike Access		0.2	0.2
	Dropoff/Transit		0.3	0.3
	Parking		0	3.1
	Total		\$3.0	\$6.6
Total Cost		\$4.2	\$27.2	\$41.3

5.3.2 OPERATING COST PROJECTION

Current compensation figures provided by HRM have been used to generate annual per vessel costs. Costs are based on a three-person crew as per our discussions with Transport Canada and operating 7 hours per day and approximately 260 days per year.

We understand that the Vancouver SeaBus uses ship's crew working ashore to fulfill the shore side security requirements outlined in the Regulations. This would entail using two Deckhands, one at each end of the run, working the same hours as the ships' crews. A summary of staffing costs is provided in Table 38.

Table 38 Staffing Costs

Service Type		Base Salary	Benefits (22%)	Replacement (12%)	Annual Cost
Ferry Crew	Captain	\$80,068	\$17,615	\$11,722	\$109,405
	Mate	\$71,596	\$15,751	\$10,482	\$97,829
	Deckhand/SVMO	\$58,360	\$12,839	\$71,199	\$79,743
TOTAL PER VESSEL					\$287,000
Shore-side Security	Deckhand	\$54,652	\$12,023	\$8,001	\$74,678
Customer Service	Commissionaire	Contracted at \$15/hour, 7 hours per day, 260 days per year			\$27,300
TOTAL PER TERMINAL					\$102,000

We have used specific fuel consumption information published by both Caterpillar and Volvo Penta for appropriately sized engines. The engines chosen for comparison are slightly larger than may be required for actual service, and will offer a more conservative (i.e. higher) estimate than the consumption levels that may be experienced once the vessels are in service. A summary of fuel costs is provided in Table 39.

Table 39 Fuel Costs

Engine Type	USGP/ Engine	Engines	USGal/h	litres/h	hours	Daily Consumption (l)	Days Operation	Annual Cost
Caterpillar C7.1	27	2	55	207	7	2,894	260	\$752,326
Volvo Penta D8-IPS 700	24	2	48	182	7	2,544	260	\$661,385
AVERAGE				194		AVERAGE		\$707,000

We have used a price of \$1.10 per litre as an estimate of the fuel price for ultra-low Sulphur diesel, however, as we are all aware, this price has the potential to fluctuate wildly or to be subject to future taxes. At this price, the annual fuel budget per vessel operating seven hours per day and two hundred sixty days per year would be approximately \$700,000 per annum.

Given the preference expressed by Halifax Transit staff for Caterpillar propulsion in order to best align with the current fleet, the consultants contacted Toromont Cat, the local Caterpillar dealer and solicited pricing for a complete maintenance contract, in essence this would be a “hands off” arrangement for Halifax Transit and represents the most expensive potential option. Should Halifax Transit staff undertake some of the maintenance tasks, the expected operating cost would be reduced.

The ferries’ engines are expected to operate 1820 hours per year however for ease of calculation we have assumed an annual operating limit of 2000 hours. Table 40 provides a summary of maintenance costs.

Table 40 Maintenance Schedule and Cost

Cumulative Hours	Service Interval	Cost
250	250	\$1,132
500	500	\$1,295
750	250	\$1,132
1000	1000	\$11,121
1250	250	\$1,132
1500	500	\$1,295
1750	250	\$1,132
2000	1000	\$11,121
Annual Service Cost per Engine		\$29,000

We have also allowed an annual amount of \$20,000 per vessel for paint, lines, cleaning supplies etc.

5.3.3 REVENUE PROJECTION

Although the passenger capacity of each vessel is 150, the effective system capacity for each three-hour commuter peak will be far less than the capacity multiplied by the number of departures. Demand will follow a normal distribution around the height of the commuting peak. Two sample passenger distribution bell-curves from the Alderney Ferry and the Sackville MetroLink were used to shape the expected passenger distribution for the Mill Cove Ferry (see Figure 51). From this plot, the sum of the bars for the Mill Cove Ferry produces an effective system capacity of 1250 passengers per three-hour peak. The morning peak distribution was used to make this determination with the assumption that the afternoon peak will produce a similar result.

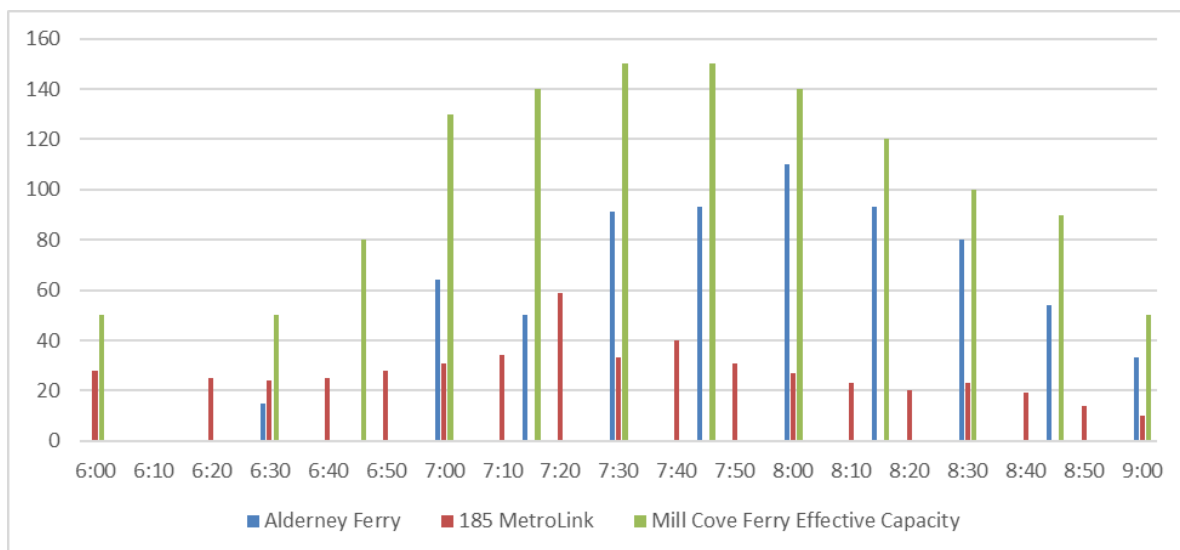


Figure 51 Distribution of Ridership AM Peak

This projected effective capacity of 1250 is insufficient for the ridership projected in Section 3.5 of 1460 per peak period. Nevertheless, we believe this is a sound approach as ridership will likely take a while to build to its peak and it guards against the risk of ridership projections not being met. If it appears that growing ridership will begin to result in waiting passengers not boarding a ferry due to its capacity being exceeded, consideration may be given to adding capacity (by procuring additional or larger capacity vessels) or increasing fares to reduce demand. Additionally, high usage of the ferry will result in a natural “peak-spreading” of passengers which will increase the effective capacity of the system.

Using this same methodology, the estimated effective capacity of the Larry Uteck route (with three departures per hour) is 950 and for Shannon Park (with two departures per hour) is 650. This is close to the ridership expected for Larry Uteck and above the ridership projected for Shannon Park.

The total daily revenue projected for the Mill Cove route is the effective capacity of the system (1250 in the morning and 1250 in the afternoon) times the average fare of \$2.70¹⁷. The total daily revenue projection is \$6,750 which, at 260 operating days per year, totals \$1,755,000 annually. If the fare was set to be consistent with conventional service, the annual revenue would be \$1,131,000 assuming that ridership is unchanged.

Using a similar approach for Larry Uteck yields a revenue projection of \$1,334,000. Using the projected ridership for Shannon Park results in a revenue expectation of \$588,000 assuming that the same fare as conventional ferries will be charged for this shorter route.

It should be noted that projected ridership and revenue is based on the methodology described in Appendix C. These projections are based on attracting customers from the surrounding primary and secondary markets. With this, there are some omissions that can both add to or decrease from these projections. They key areas are:

- There is potential to attract passengers from outside of the primary or secondary markets who are passing by the site, either by car or bus, or are drawn to park-and-ride from more remote trip origins.
- The size of the market is based on existing population. The likelihood of additional growth, particularly in some of the primary markets, will undoubtedly add to demand.
- During commuting peaks, only the trip to-and-from-work passenger is modeled and the ferries are assumed to travel in the reverse direction empty.
- Secondary markets for Mill Cove and Larry Uteck have some overlap. Therefore, some passengers will be double-counted if both services are put into operation.

5.3.4 FINANCIAL SUMMARY

The total capital and operating costs are summarized in Tables 41, 42 and 43.

¹⁷ Halifax Transit reports that the average fare is calculated as 63% of the single-trip adult cash fare. This accounts for reduced fares for tickets, monthly passes, and other discounted passes.

Table 41 Financial Summary – Capital Costs

		CAPITAL COST (\$ MILLION)					
		Halifax	Mill Cove	Uteck	Shannon	Spare	Total
Scenario 1 – Mill Cove Quick Start	Ferries		\$19.5				\$23.7
	Terminal	\$1.3	\$2.9				
Scenario 2 - Integration	Ferries		\$19.5	\$13.0	\$6.5	\$6.5	\$72.7
	Terminal	\$15.0	\$4.4	\$4.8	\$3.0		
Scenario 3 – Stand Alone	Ferries		\$19.5	\$13.0	\$6.5	\$6.5	\$87.4
	Terminal	\$15.0	\$15.3	\$5.0	\$6.6		

Table 42 Financial Summary - Operating Costs

	OPERATING COST (\$ MILLION)			
	Halifax	Mill Cove	Uteck	Shannon
Crew		\$861,000	\$574,000	\$287,000
Terminal Staff	\$102,000	\$102,000	\$102,000	\$102,000
Terminal Operating	\$40,000	\$30,000	\$30,000	\$30,000
Fuel		\$2,100,000	\$1,400,000	\$700,000
Ferry Maintenance		\$90,000	\$60,000	\$30,000
Misc. Ferry Operating		\$60,000	\$40,000	\$20,000
TOTAL	\$142,000	\$3,243,000	\$2,206,000	\$1,169,000

Table 43 Financial Summary - Revenue and Cost Recovery

	Mill Cove	Uteck	Shannon
Revenue	\$1,755,000	\$1,334,000	\$588,000
Operating Cost*	\$3,234,000	\$2,206,000	\$1,169,000
Revenue as Pct. of Operating	54%	60%	50%

* Does not include operating cost of Halifax Ferry Terminal

6 SUMMARY & NEXT STEPS

6.1 SUMMARY AND RECOMMENDATIONS

It is evident from our jurisdictional scan that many cities have a long and successful history operating ferries for public transit with networks that are much larger and reach more broadly than our current two-route network. We can learn from these successes in expanding our own network.

In exploring five potential sites for new ferry service, it was clear that Mill Cove in Bedford exhibits more of the characteristics that will make for a successful destination. The terminal site, water lot, and surrounding lands are all owned by the Provincial government (and administered by Develop Nova Scotia) which may lead to a partnership that will benefit both levels of government. Ideally, the development of the ferry terminal as part of a multi-use municipal building and the launch of the ferry service will go hand-in-hand with development of the Mill Cove site.

We used recently-collected and robust transportation data produced by the Dalhousie Transportation Collaboratory to conservatively project over 1400 trips per day in each direction for the Mill Cove route. Even with high ridership potential, we have recommended acquiring three relatively smaller ferries with a capacity of 150 passengers each. Vessels this size are beneficial primarily because this allows for delivery of service every fifteen minutes during commuting peaks like the existing ferry routes. The smaller size also eases regulatory and crewing requirements. The operating plan we have designed requires speeds of 25 knots in the Bedford Basin and 20 knots through the Narrows and Harbour. These are speeds that are lower than many similar services operating in similar conditions, but provide comfort in meeting the service needs and expectations of other harbour stakeholders.

The capital cost of our recommended Mill Cove service plan and supporting infrastructure is roughly estimated to be \$38.9 million including the three vessels at an expected cost of \$6.5 million each. If the Halifax Ferry Terminal is refurbished instead of replaced, as an interim measure, that cost drops to \$25.2 million.

We have recommended the Halifax Transit Regional Express fare rate (\$4.25 adult cash fare) to be applied to the Mill Cove service, expected to generate \$1.755 million in revenue each year. This amount covers approximately 54% of the operating cost of the service, a proportion that is fairly standard for urban transit services.

Ferry routes to Larry Uteck and to Shannon Park have also been shown in the study to be viable and to perform as well as the Mill Cove route. A successful operation of the Mill Cove Ferry can be expected to spur on the implementation of these two, and possible other, routes. A summary of the recommended services is provided in Table 44.

Table 44 Service Summary

	Mill Cove	Uteck	Shannon
Vessels	3	2	1
Departure Frequency in Peak	15 min	20 min	30 min
Dock-to-Dock Travel Time	18 min	16 min	10 min
Effective Capacity During Peak	1250	950	650
Projected Peak Ridership	1460	1030	300
Recommended Fare	Regional (\$4.25)	Regional (\$4.25)	Conventional (\$2.75)

6.2 OTHER PROJECT CONSIDERATIONS

Although not part of our recommendation or project costing, there are several other optional approaches that the Municipality may wish to consider when developing an implementation plan for ferry expansion. Those optional approaches are listed below.

6.2.1 ALTERNATIVE OPERATING/FUNDING MODELS

Although our jurisdictional scan indicates that a municipally owned and operated ferry system is far from the norm, that model has seen a long and successful history in Halifax. This operating model remains the recommended approach.

At the same time, it should be recognized that most, or all, of the vessels operating the Mill Cove service will not be in operation during the mid-day hours or weekends. These are times when a vessel of this type may have value in doing additional duty in tourism-related routes. This could be achieved either by having the vessels owned by a private sector business and operated on behalf of the Municipality, owned by a private sector business and leased to the municipality to be operated by municipal crews, or owned and operated by the Municipality but leased to the private sector outside of normal operating hours.

6.2.2 PROCURING USED VESSELS

There is a substantial market for used ferries and procuring vessels through that route may bring a considerable saving in capital cost.

We contacted an Australian broker of high speed and fast ferries for input regarding the market for second-hand vessels. They provided a sample of five such vessels, ranging in size from 165 to 200 passenger capacity, mainly built in 2016, with one built in 2006. In their sample, price ideas ranged from US\$1.7 million to US\$3.4 million. Besides the actual purchase price, a would-be buyer would need to arrange transportation to Halifax.

The down side of purchasing through this method is that the vessel can't be custom designed for the route conditions and dock design. In addition, second-hand vessels will likely cost more to maintain than new vessels, which would, to some degree, offset the savings on the purchase price.

6.2.3 ALTERNATIVE FUELS

We have selected conventional diesel power for purposes of study. This decision was made for a number of reasons:

- The proposed propulsion equipment is in line with the type of main engines currently used on the exiting ferry fleet.
- The proposed propulsion equipment would allow the use of existing ferry crews and maintenance staff with very little additional training required.
- The size of the proposed vessels does not lend itself to either LNG or CNG fueling due to space constraints – an LNG fuel tank typically occupies about 4x the space of the equivalent amount of diesel fuel with CNG occupying a much larger volume than LNG.
- The increased regulatory burden associated with gaseous fuels (LNG & CNG) in the areas of vessel construction, crew training and infrastructure would add significantly to the capital cost of the vessels, to the costs of fueling infrastructure and to the cost crew training and crew compensation. It would significantly reduce the ability of crews to move between the conventional ferry fleet and the new vessels.
- The suggested size of vessel and length of run would present challenges for use of battery power both in terms of weight and power duration. The possibility exists to use hybrid battery/diesel power, however this is a topic that would require very careful study from a cost/benefit perspective once a particular vessel model is selected.

It should be noted that the field of marine propulsion is in a state of transition and battery technology and other fueling technologies are evolving very rapidly. The size, weight and energy storage capacities of batteries available by the time that this project is adopted are likely to be radically different than those available today and could make a battery driven vessel a viable option

Other technologies such as hydrogen fuel cells are undergoing rapid change and early adopters in other transportation modes are entering the market and are investing in hydrogen power in areas where hydrogen fuel is available.

Fuel availability is a significant constraint to early adoption. Fuel choice in the marine industry is much more heavily regulated than in other modes of transportation so any choice to use a non-conventional fuel is likely to generate significant costs and other burdens in order to comply.

Due to the rapid rate of change in the marine propulsion sector, any decision to move to an unconventional fuel or propulsion method would best be addressed closer to the issuance of an RFP for construction of new vessels.

6.2.4 LAND BANKING AND LAND VALUE UPLIFT CAPTURE

It is clear that the addition of a higher order transit service, particularly a ferry route, can have a positive impact on the attractiveness of residential units nearby resulting in an increase in the value of those units or the land upon which future units might be built. As the Municipality, perhaps with other partners, is making the investment in the infrastructure for the ferry service, it stands to reason that it should receive some of that benefit of increased land value. This is less of a consideration for the Mill Cove or Shannon Park sites, as these sites are owned by other government partners and consideration of this added value should be reflected in that partnership. For other sites such as Larry Uteck and Birch Cove, a mechanism to capture the land value increase from the private sector land owners should be considered early in the planning process.

6.2.5 A HAMMONDS PLAINS ROAD TRANSIT/SHUTTLE CORRIDOR

While we have not considered the potential to create new markets for the Mill Cove ferry or add new transit service to support it, consideration should be given to increasing the value of the Hammonds Plains corridor as a contributor to the service. Future development along this corridor with a frequent transit service between the Mill Cove terminal and Gary Martin Boulevard could create an additional primary market for the service and open the opportunity to build park-and-ride spaces at the BMO Centre, the Highway 102 interchange area, or another location along the corridor.

6.2.6 ADDITIONAL DESTINATIONS

In addition to the ferry terminal sites explored in this study, destinations such as Eastern Passage, Purcell's Cove and Herring Cove have been suggested in the past. At first glance, Purcell's Cove seems of particular interest as it is a short trip by water to downtown Halifax but congestion at the Armdale Roundabout and Bayers Road make the trip by car and bus very lengthy during the commuting peaks. Ongoing evaluation of all alternative sites should be undertaken so that candidates can be identified early and development can be shaped appropriately.

6.3 RISKS

This report has developed a ferry service plan and budgeting assumptions based on high level data collected. There is, however, risk to the service operating as planned if some of these assumptions vary or are inaccurate. A summary of potential risks and their potential mitigation is provided below.

RISK: FERRIES ARE UNABLE TO MAINTAIN THEIR ROUTE DESIGN SPEEDS DUE TO ADVERSE WEATHER

This report discusses route contingency planning when ferry speeds must be reduced for adverse weather in section 5.1.2. Providing up-to-date technology on-board the vessels can improve performance in low-visibility situations. Imperfect schedule compliance is characteristic of any transit system and, to some degree, an expectation of its passengers. Nevertheless, we believe that ferries can provide a greater degree of reliability than buses which are subject to traffic collisions, congestion, weather conditions and construction on the roadway system, even when operating in dedicated transit lanes. Good communication with the public on occasions when the ferries need to operate on modified schedules due to weather events will aid in the understanding and tolerance of passengers.

RISK: HARBOUR USERS EXPRESS CONCERN THAT FERRIES ARE "TOO FAST" AND MUST SLOW DOWN

The routing plans and associated design speed assumptions are very precisely and optimally designed so that any reduction in the design travel speed will require an adjustment that will significantly reduce operational effectiveness. While slowing speed to respect weather conditions may result in occasional schedule adjustment, pressure to reduce speed in all conditions will nullify the budgeting assumptions made in this report. From our stakeholder interviews, we believe that our plan will be accepted by the Halifax Port Authority and by other commercial and government users of the harbour. It is possible, however, that recreational users may express concerns regarding ferry speeds. It will be important for the Halifax Port Authority, as regulators of harbour operations, to buy into an operating plan before implementation and be willing to defend it when faced by public complaints. Ongoing engagement with boat clubs and marinas and working with them to identify areas for recreational use so that route tracks can be designed to avoid those areas will help to allay concerns.

RISK: INABILITY TO ACQUIRE NEEDED PARCELS OF LAND

Some sites, Larry Uteck in particular, will require the acquisition or leasing of private property to create a terminal, wharf and passenger access facilities. Negotiation with private landowners, as well as provincial and federal land owners may be lengthy and add to project implementation time lines.

RISK: INABILITY TO GET APPROVAL FOR WHARFS

Our discussions with the Halifax Port Authority have given a strong indication that construction of marine facilities in the locations being considered for ferry terminals would be consistent with the use of the Harbour and Bedford Basin and would, in fact, be a welcome addition to their transportation value. Early examination of the environmental and cultural impacts of the terminal sites and docking areas will be of benefit.

RISK: EXPECTED DEVELOPMENTS DO NOT MOVE FORWARD

While using the presence of a ferry terminal to lead the development of any one of the terminal sites considered in this plan is valuable, there needs to be a strong degree of certainty that development will follow. Transit-oriented development around the ferry terminal will be a critical element of its success. Establishing development partnerships with the agencies or landowners at a potential terminal site will be an important mechanism to ensuring success. As an example, the Mill Cove site currently faces the challenge of creating a second roadway connection which may be more effectively resolved through a partnership with the Municipality.

RISK: APPROVAL TO CROSS CN MAIN LINE IS DIFFICULT

A critical component of connecting adjacent communities to the Mill Cove and Larry Uteck terminals for active transportation is the ability to cross the CN Main Line. Although this is unlikely that an approval to construct an overpass or underpass would not ultimately be secured from CN, experience has shown that the approval process may be lengthy and complicated.

RISK: ACTUAL RIDERSHIP IS BELOW THE PROJECTED LEVEL

The ridership projections in this report are based on 2016 population and employment and we expect that future growth, particularly if it is focused on proposed terminal sites, will add to demand. A key benefit of using three smaller vessels on one initial route is that low ridership volumes can be addressed by reducing service by one-third and redeploying one of the vessels to a second route.

RISK: ACTUAL RIDERSHIP IS ABOVE THE PROJECTED LEVEL

Ferries have strict capacity limits and if passengers being denied entry to a ferry and being asked to wait for the next ferry becomes a regular occurrence, support for the service will quickly decline. One solution that might be considered is to manage demand by raising the fare. This should only be considered as an interim measure, however, as carrying higher volumes of passengers is in the best interest of managing regional transportation demands. A better solution, in the longer term, is to add additional ferries to the route or to purchase larger ferries for the high demand route and redeploy the original smaller ferries to new secondary routes.

6.4 NEXT STEPS

There are a number of steps that the Municipality should consider taking to confirm the viability of the ferry service expansion, optimize the procurement of vessels, and gain public buy-in to the concept.

6.4.1 UPDATE MARKET ANALYSIS

Although several market studies have been conducted, it is always beneficial to ensure that data is current. An updated market survey will benefit from greater detail about the ferry service gained from this study. Further surveying could examine, for the first time, the potential to capture “pass-by” trips or trips originating from outside of the primary or secondary market areas near to the terminal sites.

6.4.2 CONDUCT VISIBILITY MONITORING

This study has assessed the ability of the ferries to operate in adverse weather conditions and modeled the expectation of events where speed must be decreased. This assessment was based on limited data and a survey of weather and visibility conditions in the study area over a period of a year would better quantify the expectation of schedule reliability.

6.4.3 USE A MARINE SIMULATOR TO PLAN ROUTING COURSES

Section 1.4.6 of this report described previous use of DND’s Harbour Training Simulator. This is a valuable tool, not only to instill confidence in harbour stakeholders regarding the safety of ferry operations, but to plan out routing tracks for the ferries to use in avoiding conflict with other harbour and shoreside uses. Participation in these exercises should include Halifax Port Authority, Atlantic Pilotage Authority, and DND.

6.4.4 WORK WITH TRANSPORT CANADA TO OPTIMIZE SECURITY REGULATIONS TO FIT THE HALIFAX FERRY SERVICE

Terminal Security Requirements will be assessed by Transport Canada’s Security branch which will determine whether the terminals are to be included under the Canadian Domestic Ferry Terminal Regulations. Careful

consideration of the regulations, and of the evaluation criteria for inclusion under the regulations, should be undertaken. The ferry service stands to benefit from significantly reduced operating costs, both for current and expanded ferry operations, and the Municipality should make a concerted effort to demonstrate to Transport Canada that the service can be operated safely and securely in ways other than status quo.

6.4.5 CONDUCT PROPULSION PACKAGE ASSESSMENT

This study has drawn on experience from other jurisdictions to select a vessel type and to approximate an acquisition cost. Before procuring the first vessels, it would be prudent to conduct a life cycle cost analysis to ensure that the propulsion package selected is optimized for Halifax conditions. Although the results of this assessment will have little impact on the overall acquisition cost of the ferry, it will pay dividends in reducing operating costs and extending the life expectancy of the vessel.

6.4.6 CHARTER A FERRY DEMONSTRATION

The chartering of the Whaling City Express in 2005 was valuable in introducing residents of the region to the idea of higher speed ferry travel. Five trial runs were conducted over a period of two days for both the public and key stakeholders. An exit survey of those who took the ferry yielded a high positive response. Re-offering this type of a trial could bring a renewed appreciation of this type of travel and build understanding, interest and support within the community.

6.4.7 ORGANIZE A FACT-FINDING MISSION

The proximity of Boston and New York and the successful high speed ferry networks that they run provides a valuable opportunity to visit and learn from these services. A select group of municipal staff, key stakeholders and project champions could inexpensively gain valuable lessons from meeting with lead staff of these systems. Bermuda, which internally operates its own network, is also nearby and a good model to draw from.

Appendix A

STAKEHOLDER INTERVIEW SUMMARIES

Appendix B

EXISTING FERRY TERMINAL TIME MEASUREMENTS

Appendix C

FERRY RIDERSHIP MODELING AND ANALYSIS

Ferry Ridership Modeling and Analysis

BACKGROUND

The ferry ridership modelling for this study relies on the NovaTRAC Halifax Survey 2018 (Habib, 2019) and the Halifax Travel Demand Model (HTDM) developed in Bela and Habib (2019). Below is a brief description of the zonal system, predicted ridership, model development process and data used in predicting the ridership.

ZONAL SYSTEM

The study delineates super-zones around each ferry station proposed in this study. Two types of super-zones are considered: Catchment A and Catchment B. Catchment A refers to the adjacent traffic analysis zones (TAZ) that are within 2 kilometers, convenient for walking, biking and/or kiss-n-ride possibilities. Catchment Area B refers to the potential hinterland within 10 kilometers that may generate ferry trips. The study considers four super zone areas corresponding to the station area considered: 1) Mill Cove, 2) Larry Uteck, 3) Birch Cove and 4) Shannon Park. We have adjusted the inclusion of a few TAZs from the initial sets for Catchment A and B for each area depending on network considerations (such as highway location) and proximity to Downtown Halifax. The destination super-zone is identified as Destination area A, that includes areas within 2 km of the downtown ferry terminal (meaning that at least the centroid of the TAZ falls within 2 km). Figures B-1 to B-5 shows the TAZs considered for each super-zone developed for this project.

PREDICTED RIDERSHIP

The predicted ferry ridership for each super-zone is shown in Table B-1. The Daily Trip Potential is the total number of trips that originated from each Origin super-zone and destined to the Destination super-zone of Downtown Halifax. The O-D paired trips for each TAZ is obtained from the Halifax Travel Demand Model (HTDM). The Capture Rate is the estimated mode share that utilizes a 2011 Stated Preference Survey and Logit Modeling methods.

Table C-1 Predicted Ferry Ridership by Superzone

Predicted Ferry Ridership							
	Catchment A			Catchment B			Total Daily Ridership
	Daily Trip Potential	Capture Rate (%)	Daily Predicted Ferry Trips	Daily Trip Potential	Capture Rate (%)	Daily Predicted Ferry Trips	
Mill Cove	4890	13.1757598	644	7396	11.0582345	818	1460
Larry Uteck	3598	10.6474420	383	7324	8.8344067	647	1030
Birch Cove	4413	10.3093902	455	8021	8.5283852	684	1140
Shannon Park	521	13.1643913	69	2353	9.6847361	228	300

MODEL DEVELOPMENT PROCESS

The model uses the NovaTRAC Halifax Survey 2018 to estimate trip rates for all trip purposes. Then it develops a travel demand forecasting model for the Halifax Regional Model. This comprehensive HTDM is developed within

the EMME/4 Platform. The details of the HTDM is described elsewhere (see Bela and Habib, 2019). All trips originated from the TAZs to Downtown Halifax TAZs (see the Halifax Downtown super-zone in Figure B-5) are extracted from the output of the EMME model. This version of HTDM uses NovaTRAC Halifax Survey 2018 for estimation purposes, where applicable. Annex B-1 provides a general overview of trip patterns for each super-zone, which includes percentage of trips by purposes and existing mode share by Catchment Area A and B.

The model development also involves probability estimation for all modes, including a hypothetical ferry mode for each super-zone. Stated preference surveys are most suitable for estimating capture rate for modes that are not currently available for trip makers. This study uses a 2011 study to estimate the parameter for the mode choice model. NLOGIT/6 is used to estimate the model. The modes considered for this analysis includes ferry, car and bus transit. The parameter estimates of the model is shown in Annex B-3. The model includes key factors including ‘travel time’, ‘travel cost’ and ‘service frequency’. The model also takes into account other socio-economic and network factors (e.g. access to car, proximity to transit and age of population). Note that the model was estimated at the most disaggregate level. The mathematical relationships obtained from this analysis is used to calculate the probability and daily ferry ridership utilizing zonal characteristics of each super-zone considered. The probability of choosing each mode for all super-zones are shown in Table B-2.

Table C-2 Probability of Choosing Each Mode by Super-Zones

Probability of Mode Choice (%)			
Area	Mode	Catchment A	Catchment B
Mill Cove	Ferry	13.1757598	11.0582345
	Bus	4.7094127	1.3353970
	Car	82.1148275	87.6063685
Larry Uteck	Ferry	10.6474420	8.8344067
	Bus	6.0644230	2.9216523
	Car	83.2881349	88.2439410
Birch Cove	Ferry	10.3093902	8.5283852
	Bus	8.6294662	6.2910192
	Car	81.0611436	85.1805956
Shannon Park	Ferry	13.1643913	9.6847361
	Bus	1.0307770	-0.5021850
	Car	85.8048317	90.8174490

Annex B-4 includes a sample calculation illustrating the estimation process of Mill Cove Super-zone. Note that the 2011 study only surveyed Bedford residents – so it would reflect the preference structure of Mill Cove and Larry Uteck areas. However, we have applied the same preference structure for all zones. Based on the parameters of the logit model that we have used; it is likely that we have overestimated ferry ridership for Birch Cove and Shannon Park



areas. For example, the model is sensitive to 'travel time'; but the preference structure of Birch Cove and Shannon Park residents are unknown. Due to the close proximity to the downtown, it is likely that they would be highly sensitive to 'travel time' (between ferry and car) compared to Bedford residents, yielding a higher parametric value for the 'travel time' coefficient.

Finally, the predicted ridership is solely based on the current population, which has been obtained from the 2016 Census tabulations. It doesn't account for any growth of planned housing supply and population in each area.

Figure C-1 Mill Cove, Bedford Catchment Areas

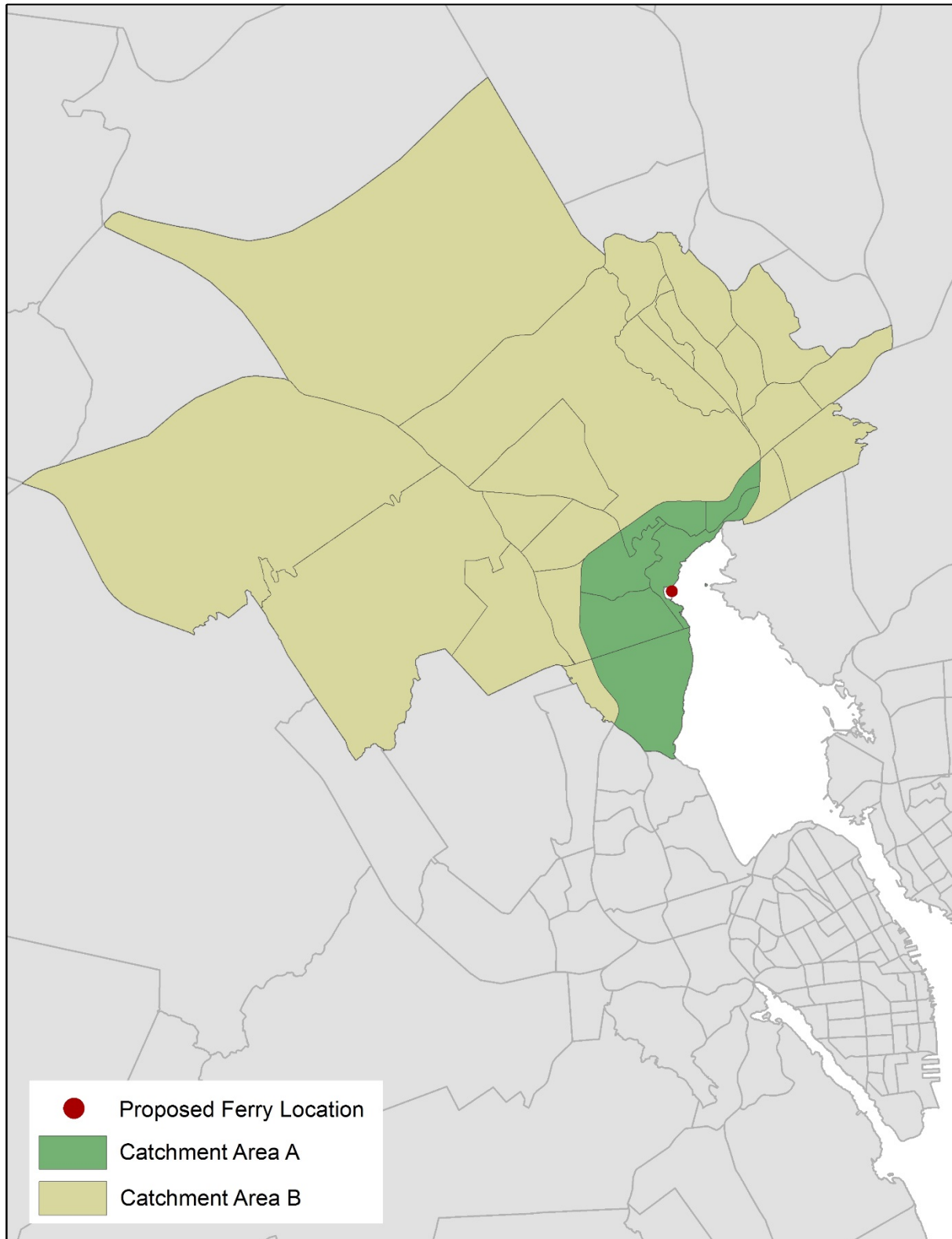


Figure C-2 Larry Uteck Catchment Areas

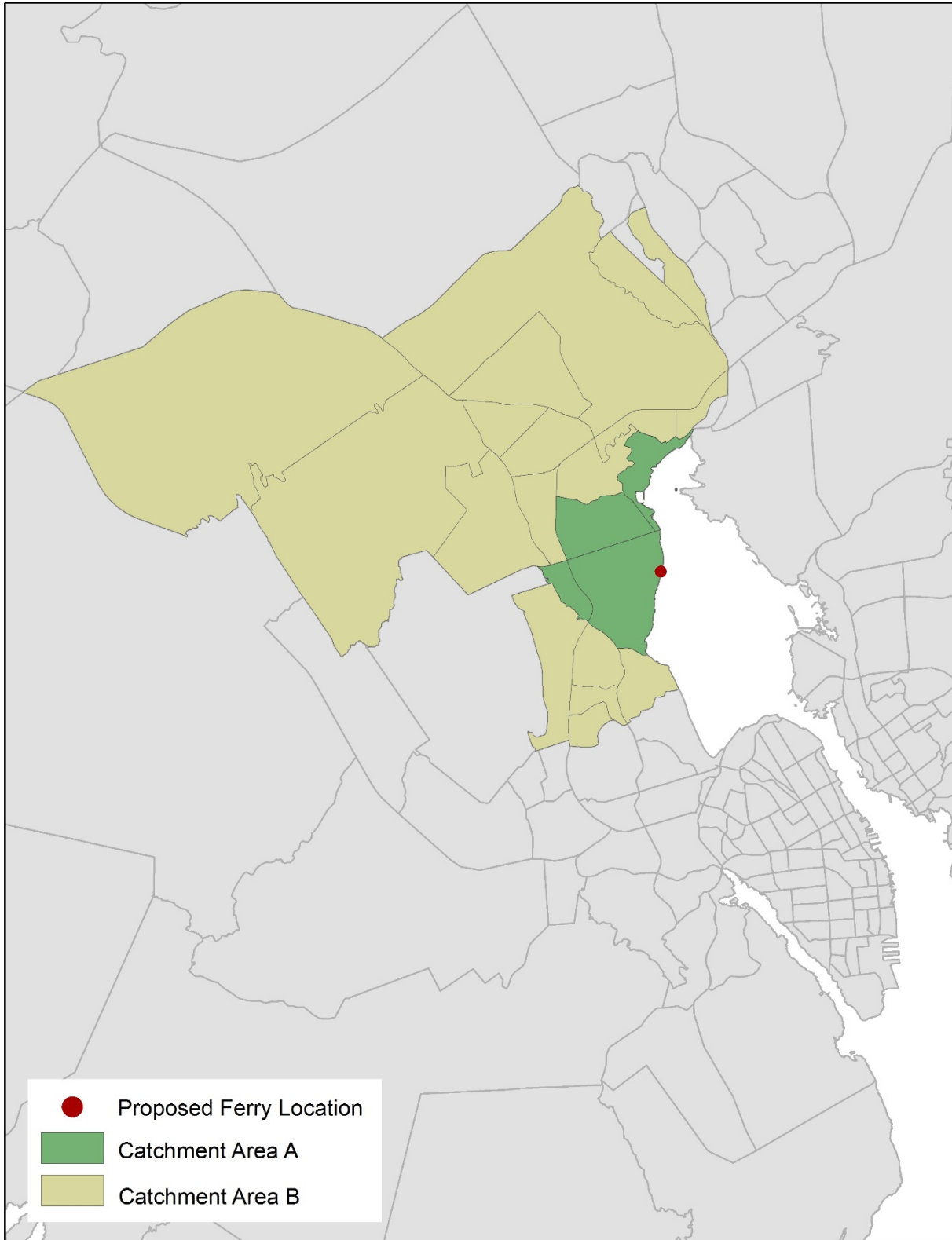


Figure C-3 Birch Cove Catchment Areas

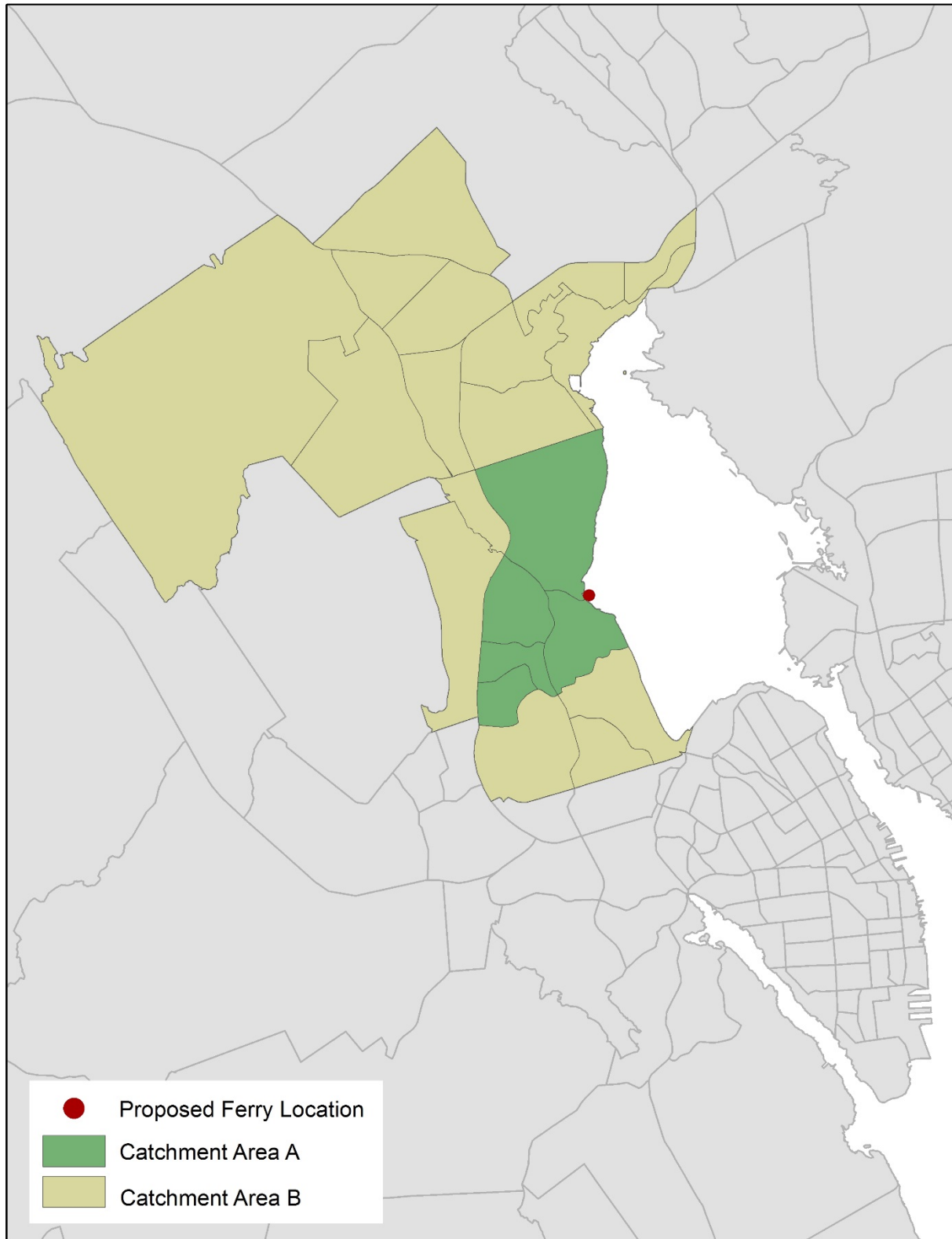


Figure C-4 Shannon Park Catchment Areas

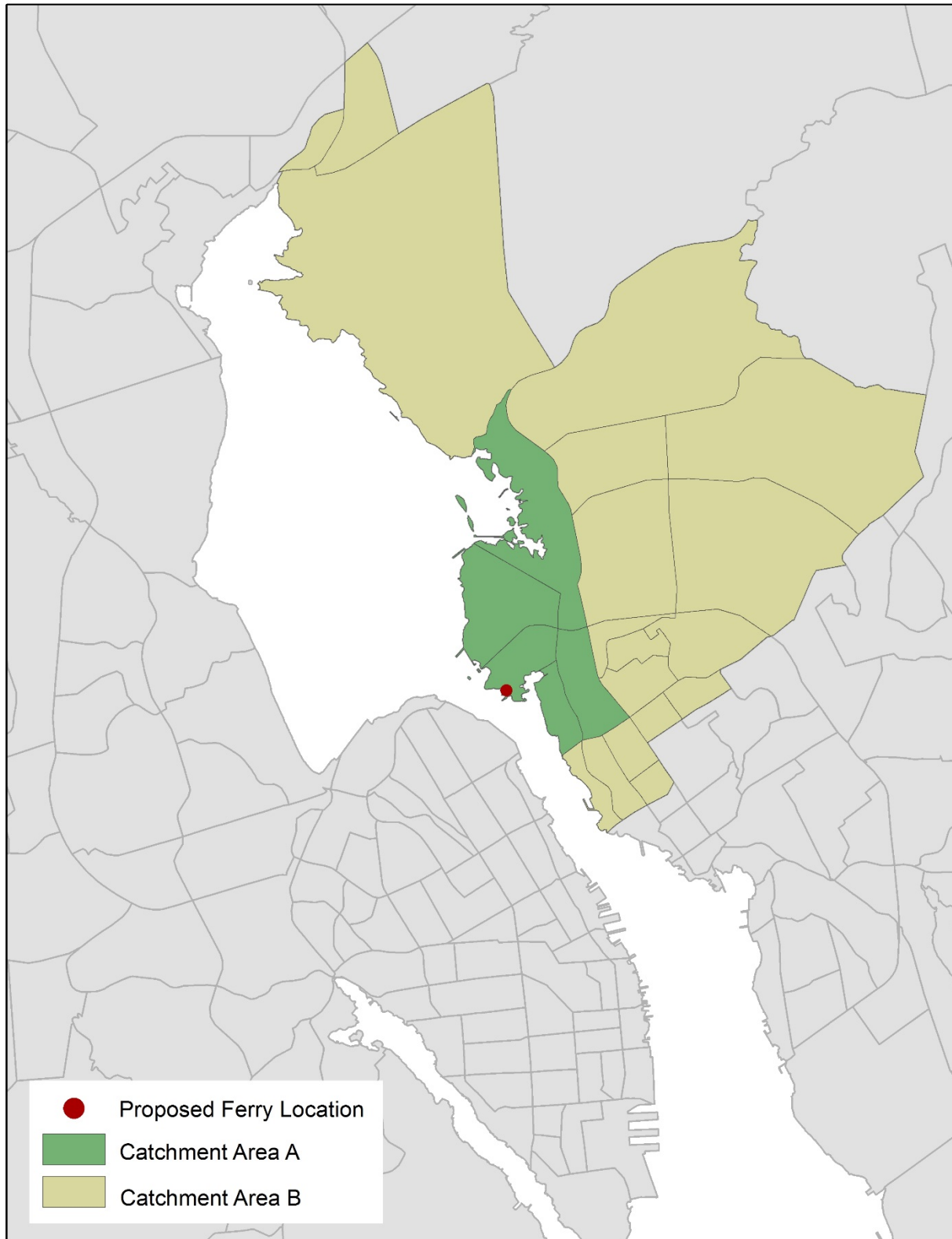
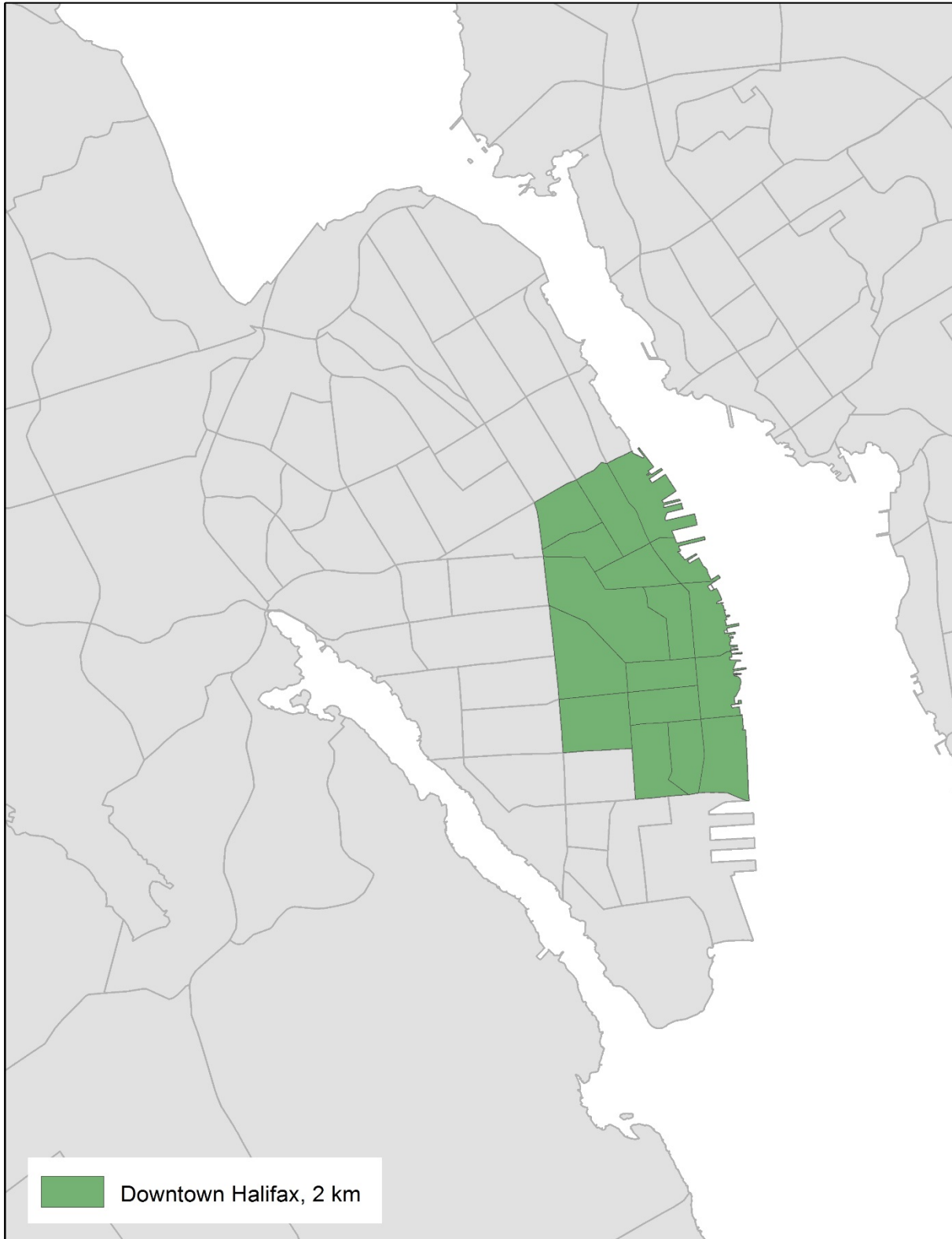


Figure C-5 Destination Catchment Area: Downtown Halifax, 2 km from Ferry Terminal



Annex C-1 Trip Pattern Overview for Super-Zones

Mill Cove	Travel Pattern		
		Catchment A	Catchment B
	Total No. of TAZ	7	21
	Total Population	22783	33917
	All Modes		
	Total Trips produced	47389	70547
	Trips O-D Paired (Bedford-Peninsula)	4890	7396
	Trip Purpose	Trip Number	
	H to W	17087	25438
	W to H	15265	22724
	H to S	5924	8818
	S to H	5468	8140
	H to Sh	2050	3053
	Sh to H	4101	6105
	H to O	12986	19333
	O to H	13214	19672
	NHB	18682	27812

Larry Uteck	Travel Pattern		
		Catchment A	Catchment B
	Total No. of TAZ	4	18
	Total Population	16850	35464
	All Modes		
	Total Trips produced	35048	73765
	Trips O-D Paired (Bedford-Peninsula)	3598	7324
	Trip Purpose	Trip Number	
	H to W	12638	26598
	W to H	11290	23761
	H to S	4381	9221
	S to H	4044	8511
	H to Sh	1517	3192
	Sh to H	3033	6384
	H to O	9605	20214
	O to H	9773	20569
	NHB	13817	29080

Birch Cove	Travel Pattern		
		Catchment A	Catchment B
	Total No. of TAZ	5	17
	Total Population	22046	35793
	All Modes		
	Total Trips produced	45856	74449
	Trips O-D Paired (Bedford-Peninsula)	4413	8021
	Trip Purpose	Trip Number	
	H to W	16535	26845
	W to H	14771	23981
	H to S	5732	9306
	S to H	5291	8590
	H to Sh	1984	3221
	Sh to H	3968	6443
	H to O	12566	20402
	O to H	12787	20760
	NHB	18078	29350

Shannon Park	Travel Pattern		
		Catchment A	Catchment B
	Total No. of TAZ	5	18
	Total Population	3313	14860
	All Modes		
	Total Trips produced	6891	30909
	Trips O-D Paired (Bedford-Peninsula)	521	2353
	Trip Purpose	Trip Number	
	H to W	2485	11145
	W to H	2220	9956
	H to S	861	3864
	S to H	795	3566
	H to Sh	298	1337
	Sh to H	596	2675
	H to O	1888	8470
	O to H	1922	8619
	NHB	2717	12185

Annex C-2 Existing Mode Share by Super-Zone (NovaTRAC, 2018)

	Mode Share		
		Catchment A	Catchment B
Mill Cove	Auto (%)	82.23	83.14
	Transit (%)	3.49	3.6
	Bicycling (%)	0.24	0.22
	Walking (%)	7.77	7.96
	Other (%)	6.27	7.96
Larry Uteck	Auto (%)	82.8	78.9
	Transit (%)	3.74	5.36
	Bicycling (%)	0.0	0.39
	Walking (%)	5.89	11.64
	Other (%)	7.56	3.72
Birch Cove	Auto (%)	67.98	78.51
	Transit (%)	8.97	5.6
	Bicycling (%)	0.38	0.28
	Walking (%)	17.95	11.24
	Other (%)	4.37	4.37
Shannon Park	Auto (%)	60.13	80.82
	Transit (%)	5.95	5.67
	Bicycling (%)	0.44	0.55
	Walking (%)	25.99	9.91
	Other (%)	7.49	3.04

Annex C-4 Parameters of Mode Choice Model

Variables	MNL	
	Coeff.	(t-statistic)
Alternative Specific Constants		
Ferry Constant	5.592	(15.370)
Train Constant	4.291	(12.519)
BRT Constant	4.695	(11.747)
Alternative Specific Variables		
Ferry		
Travel Time	-0.113	(-17.713)
Drive Alone Dummy (1, if currently drive alone)	-0.530	(-3.791)
Travel Cost	-0.283	(-8.793)
Bus		
Travel Time	-0.063	(-8.864)
Travel Cost	-0.428	(-9.005)
Drive Alone Dummy (1, if currently drive alone)	-1.674	(-10.927)
Age Dummy (1, if age between 25-35)	-0.411	(-3.606)
Car		
Distance to Transit Dummy (1, if <500m)	-0.298	(-2.764)
Household Size	0.106	(2.454)
Access to Vehicle Dummy (1, if yes)	0.314	(2.139)
Generic Variables		
TFREQ (Frequency of Service)	0.016	(2.824)
Final Log-Likelihood	-3566.696	
Adjusted Rho-Square	0.144	

Annex C-5 Sample Calculation of Estimation Process

Mill Cove, Bedford Catchment Area A

Co-efficient	Constant	Travel time	Travel cost	Drive Alone Dummy	Age Dummy	Distance to Transit Dummy (if <500 m)	Household size	Access to Vehicle Dummy	TFREQ
Ferry	5.592	-0.113	-0.283	-0.53					0.016
Bus	4.695	-0.063	-0.428	-1.674	-0.411				0.016
Car						-0.298	0.106	0.314	0.016

	Constant	Travel time	Travel cost	Drive Alone Dummy	Age Dummy	Distance to Transit Dummy (if <500 m)	Household size	Access to Vehicle Dummy	TFREQ
Ferry	1	20	4	0.587					51
Bus	1	50	2.75	0.587	0.123				102
Car						0.0847	2.62	0.908	1020

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Bela, P.L. and Habib, M.A. (2019). "Commercial Vehicle Movement Network Modeling for Halifax, Canada: A Tour-Based Model for Local Truck Delivery", Peer-reviewed proceedings of the 98th Annual Meeting of the Transportation Research Board (TRB), Washington DC, January 13-17.

Habib, M.A. (2019). "Halifax Regional Municipality Travel Activity Study". Halifax Regional Municipality, Halifax (62 pages).

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Corridor: A Stated Preference Study", 58th Annual North American Meeting of the Regional Science Association International, Florida, USA, November 9-12.

Appendix D

TRIP IMPEDANCE COMPARISON BY MODE

Trip Impedance Comparison by Mode

Terminal Location	Mode	OUT OF VEHICLE (min)			In-Vehicle Car/Ferry /Bus	COST (\$)			IMPEDANCE (min) = 1.5(Out-of-Vehicle Time) + (In-Vehicle Time) + (Cost)(3min/\$)
		Walk to	Wait	Walk from		Fare/Toll	Operating	Parking	
Mill Cove	Car			4	29.6		\$6.90	\$2.31	63.2
	Bus	5	5	6	43.0	\$1.74			72.2
	ExpBus	5	6	6	30.0	\$1.74			60.7
	Ferry	8	4	6	18.0	\$3.20			54.6
Larry Uteck	Car			4	26.0		\$5.29	\$2.31	54.8
	Bus	5	5	6	39.0	\$1.74			68.2
	Ferry	8	4	6	16.0	\$3.20			52.6
Birch Cove	Car			4	22.6		\$4.39	\$2.31	48.7
	Ferry	8	4	6	15.0	\$3.20			51.6
Wright's Cove	Car			4	14.2	\$0.80	\$3.41	\$2.31	39.7
	Ferry	8	5	6	15.0	\$3.20			53.1
Shannon Park	Car			4	12.6	\$0.80	\$2.96	\$2.31	36.8
	Bus	5	8	6	25.0	\$1.74			58.7
	Ferry	8	5	6	9.5	\$3.20			47.6

BUS TRIP TIME (Terminal Area to Scotia Square) [4]					
	Starting Location	Route	Headway(min)	Schedule Time	
	Mill Cove	8	20	43	
	Mill Cove Express	196	30	30	
	Larry Uteck	22	20	39	
	Shannon Park	51 & 1	30	25	

DRIVING KM Terminal to Scotia Square [1]			
		Distance	
	Mill Cove	15.4	
	Larry Uteck	11.8	
	Birch Cove	9.8	
	Wright's Cove	7.6	
	Shannon Park	6.6	

OUT-OF-POCKET COSTS				
Parking (\$/Month)	\$	100.00	(Assumption)	
Parking (\$/Year)	\$	1,200.00		
One-way trips per year		520		
Parking (\$/Trip)	\$	2.31		
Parking (\$/HBW Trip)	\$	2.31		
Ferry Fare		\$127.50/month [4]		
		40 one-way trips per month		
Ferry Fare (\$/trip)		\$3.20		

CAR OPERATING COST \$/km [2][3]				
2019 Honda Accord		\$0.42		
2017 Toyota Prius		\$0.39		
2016 Hyundai Accent		\$0.40		
2015 Ford F150		\$0.45		
2013 GMC Terrain		\$0.50		
Revenue Canada (all vehicles)		\$0.53		
Average		\$0.45		

CAR DRIVING TIME (Terminal to Scotia Square) [1]							Time (in minutes) to drive from each of the proposed terminal location to Scotia Square (Downtown Halifax) for five trials over five days during the AM weekday peak period.	
	Starting Location	Time of Day						Average Travel Time During AM Peak (min)
		Trial #1	Trial #2	Trial #3	Trial #4	Trial #5		
	Mill Cove	28	30	31	30	29		29.6
	Larry Uteck	25	25	28	26	26		26.0
	Birch Cove	22	20	25	24	22		22.6
	Wright's Cove	15	14	14	14	14		14.2
	Shannon Park	14	13	12	12	12		12.6

Sources [1] Google Maps
[2] Canadian Automobile Association Auto Cost Calculator
[3] Revenue Canada
[4] Halifax Transit