GENIVAR

Final Report

Highway 103 Proposed Boutilier's Point Interchanges Traffic Study

Presented To:
Nova Scotia Department Of Transportation and Infrastructure Renewal

September, 2010

Project No. D10276

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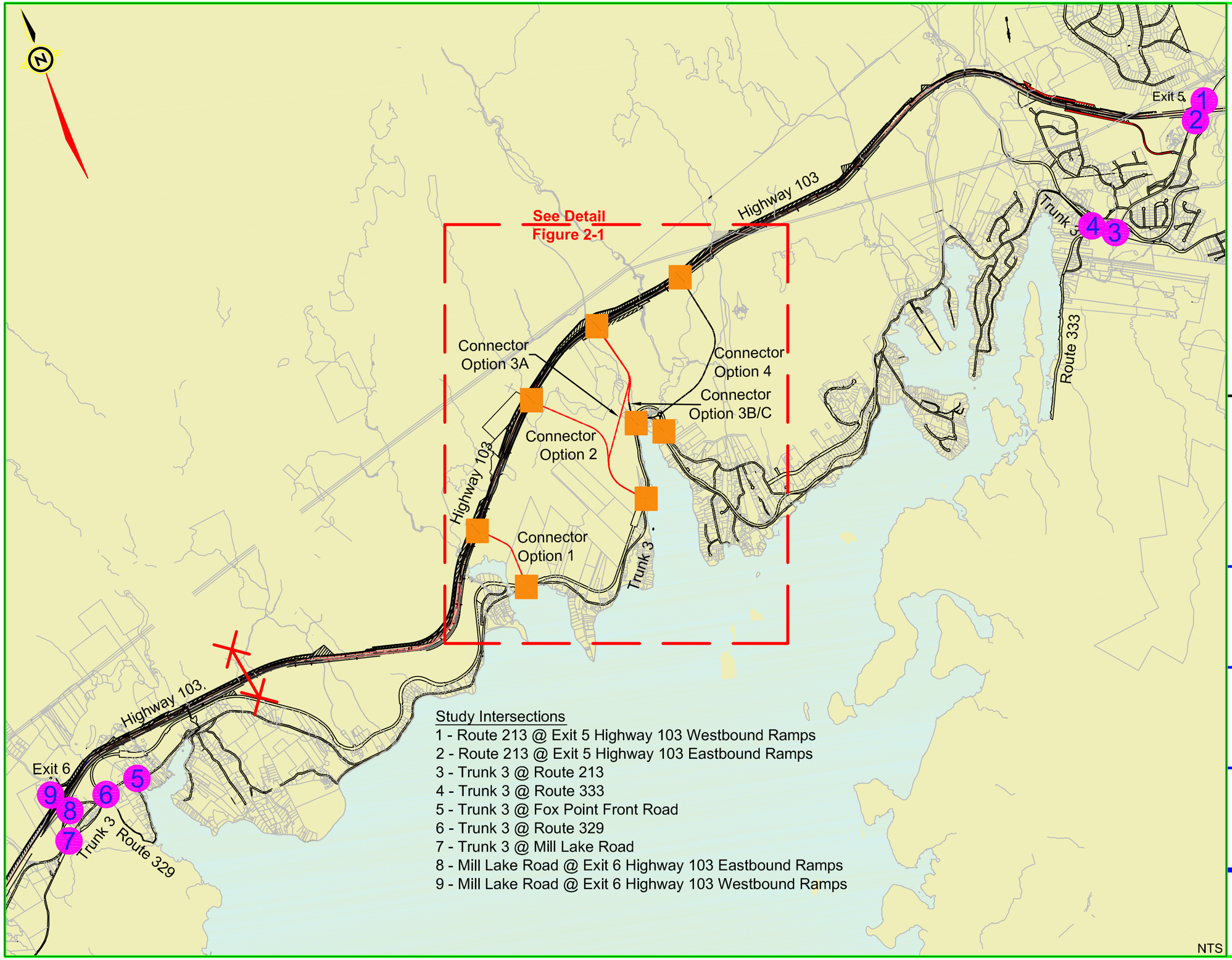
2.0 Description of Roadways and Traffic Volumes

2.1 Description of Roadways

Existing Road System - The primary road sections that now serve traffic travelling within and through the Study Area include:

1. ***Highway 103*** - between EXIT 5 at Upper Tantallon and EXIT 6 at Hubbards. The 21 kilometer long section of controlled access arterial highway includes a one km long four lane section at the east end and 20 km with two paved lanes plus appropriate passing lanes on upgrades. The posted speed limit throughout the section is 100 km/h, however, it will be increased to 110 km/h after the highway has been twinned.
2. ***Route 213*** - between Highway 103 EXIT 5 to Trunk 3 in Upper Tantallon. The 2.2 km long section of two lane controlled access collector road includes two sets of traffic signals at the EXIT 5 interchange ramps, as well as signals at Scholars Road, French Village Station Road, and at Trunk 3 opposite the Superstore entrance. The posted speed limit includes 1.3 km of 60 km/h, 0.9 km of 70 km/h.
3. ***Mill Lake Road*** - between Highway 103 EXIT 6 and Trunk 3 west of Hubbards. The 0.5 km long section of two-lane road has an unposted speed limit of 80km/h.
4. ***Trunk 3*** - between the Route 213 intersection in Upper Tantallon and the Mill Lake Road intersection west of Hubbards. This 24 km long section of two lane road was part of the main highway between Halifax and the South Shore prior to construction of Highway 103 over thirty years ago. While the eastern end of the road section includes a 0.3 km long improved section of roadway between the Route 213 and Route 333 signalized intersections, the remaining 23.7 km of the section is typical of most other parallel sections of the old truck road system in the province with two travel lanes, narrow gravel shoulders, and numerous curves with recommended reduce travel speeds. The posted speed limit includes 70 km/h throughout the majority of the road section, with 1.1 km of 60 km/h on the eastern end and approximately 2.8 km of 50 km/h through the Hubbards area.

Proposed Connector Options - The Highway 103 interchange and connector options that are considered in this study each includes an intersection on Trunk 3 at locations selected by NSTIR and illustrated on Figure 2-1. Photos of Trunk 3 at the four intersection locations under consideration illustrate the character of Trunk 3 in the Study Area.



Study Intersections
1 - Route 213 @ Exit 5 Highway 103 Westbound Ramps
2 - Route 213 @ Exit 5 Highway 103 Eastbound Ramps
3 - Trunk 3 @ Route 213
4 - Trunk 3 @ Route 333
5 - Trunk 3 @ Fox Point Front Road
6 - Trunk 3 @ Route 329
7 - Trunk 3 @ Mill Lake Road
8 - Mill Lake Road @ Exit 6 Highway 103 Eastbound Ramps
9 - Mill Lake Road @ Exit 6 Highway 103 Westbound Ramps

NTS

Study Intersection

Studied Connector Intersections

Highway 103 Permanent Counter

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CLIENT

NOVA SCOTIA
Transportation and Infrastructure Renewal

PROJECT

HIGHWAY 103 PROPOSED BOUTILIER'S POINT INTERCHANGE TRAFFIC STUDY

SHEET DESCRIPTION

FIGURE 1-1

STUDY AREA

SEPTEMBER 2010

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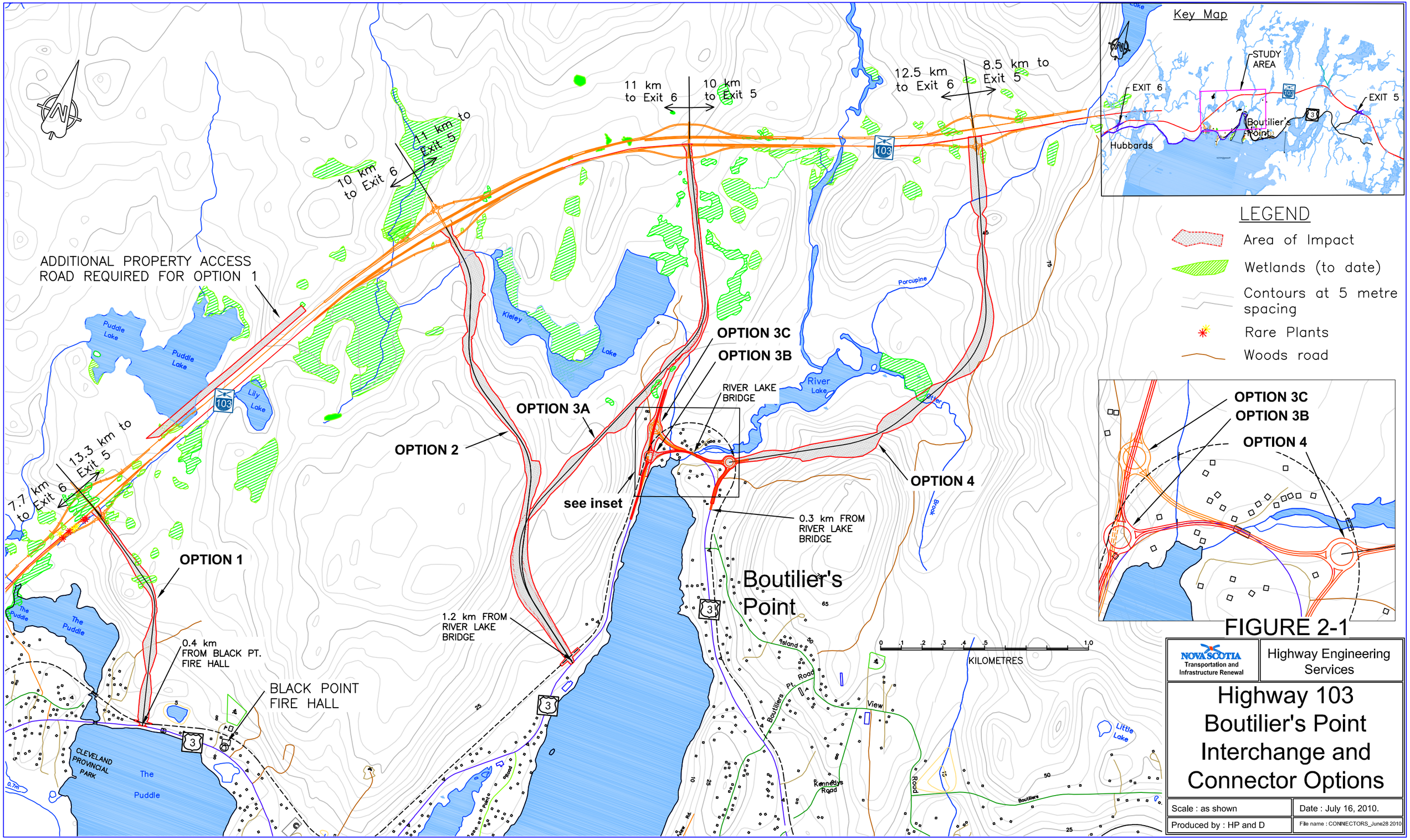


FIGURE 2-1

NOVA SCOTIA Transportation and Infrastructure Renewal

Highway Engineering Services

Highway 103 Boutilier's Point Interchange and Connector Options

Scale : as shown	Date : July 16, 2010.
Produced by : HP and D	File name : CONNECTORS_June28 2010

Photo 2-1 - Looking east on Trunk 3 towards Tantallon from the proposed intersection location for the Option 1 connector. Visibility is adequate for the posted 70 km/h speed limit.

Photo 2-2 - Looking west on Trunk 3 towards Hubbards from the proposed intersection location for Option 1 connector. Visibility is adequate for the posted 70 km/h speed limit.

Photo 2-3 - Looking east on Trunk 3 towards Tantallon from the proposed intersection location for connector Options 2 and 3A. Visibility to the intersection may be marginal and must be considered during intersection design.

Photo 2-4 - Looking west on Trunk 3 towards Hubbards from the proposed intersection location for connector Options 2 and 3A. Visibility is adequate for the posted 70 km/h speed limit.

Photo 2-5 - Looking east on Trunk 3 towards Tantallon showing the character of Trunk 3 near the proposed Options 3B/C and Option 4 connector intersections.

Photo 2-6 - Looking west on Trunk 3 towards Hubbards showing the character of Trunk 3 near the proposed Options 3B/C and Option 4 connector intersections.

2.2 Volume Trends in the Study Area

NSTIR has obtained machine traffic counts periodically at locations within the study for over 30 years. Volume trends have been reviewed at the following locations:

- Highway 103 - east of Hubbards (permanent counter location; see Figure 1-1)
- Highway 103 - west of Hubbards
- Trunk 3 - 3.0 kilometers west of Route 333
- Trunk 3 - west of Hubbards beach area.

Tabulated historical volumes for the four locations are included in Tables A-1 to A-4, Appendix A, and graphical presentation of the data with regression analysis trend line are included in Figures A-1 to A-4. Volumes and trends are summarized in Table 2-1.

Based on review of traffic volume growth trends, an annual growth rate of 1.5% has been used in this study to project 2013 and 2020 volumes at study area intersections.

Table 2-1 - Study Area Volumes and Growth Trends

Location	Table & Figure [1]	Volume Growth (veh/d/y) [2]	Projected 2010 Volume (AADT) [3]	Percentage Growth Rate [4]	Projected 2013 Volume (AADT) [3]	Projected 2020 Volume (AADT) [3]
Highway 103 - east of Hubbards	A-1	180	10,400	1.7	10,950	12,750
Highway 103 - west of Hubbards	A-2	145	9,000	1.6	9,450	10,900
Trunk 3 - west of Route 333	A-3	75	4,950	1.5	5,200	5,950
Trunk 3 - west of Hubbards Beach area	A-4	50	3,850	1.3	4,000	4,500

NOTES:
1. Historical volume and trend data are included in Appendix A.
2. The annual volume growth expressed as 'vehicles per day per year' has been estimated for each location using regression analysis.
3. Volumes are expressed as Annual Average Daily Traffic (AADT) volume which is an estimation of the average daily volume that would be obtained by counting for an entire year and dividing by 365 days.
4. The annual percentage growth is based on the estimated volume growth and projected 2010 AADT at each location.

3.0 Review of Existing and Future Land Use

Identified Future Development - When planning for new highway interchanges, it is important to understand the potential impact of a proposed interchange on the development of lands near the interchange for residential and commercial purposes.

The current level of proposed development in the Study Area is low. Halifax Regional Municipality (HRM) have indicated that there are approximately 100 new lots at different stages of the development approval system currently being considered across the study area. The majority of these developments are being considered under the as-of-right provisions of the Regional Subdivision Bylaw. Consultation with HRM staff at that time did not indicate any proposed Development Agreements, which are generally required at the outset of a large-scale residential development. The current lack of development may be partially a result of the limitations on obtaining good access to a main road. The new interchange is likely to result in greater interest in the development of the lands for residential purposes with the possibility of small scale commercial developments being developed immediately around a new interchange.

Possible Future Development in the Detailed Study Area controlled by St. Margaret's Bay Land use Bylaw and Halifax Regional Subdivision Bylaw - Improved access resulting from any new highway interchange can enhance the development potential of adjoining lands. In order to understand the development potential of existing lands that adjoin the proposed connector options, one must refer to the Halifax Regional Municipal Plan, Halifax Regional Subdivision Bylaw and the St Margaret's Bay (Planning District 1 & 3) Municipal Land Use Bylaw (2008). The Land Use Bylaw areas and the relevant zoning are indicated on Figure 3-1.

The majority of lands along the southern side of Highway 103 in the vicinity of the proposed interchanges are zoned MU-1 (Mixed Use) under the Land Use Bylaw. This zone is structured to permit any use except those specifically listed as being excluded under the Land Use Bylaw. Mobile home parks, multi-unit dwellings and senior citizen housing over 20 units are not permitted as-of-right and would require a Development Agreement. While commercial uses up to 697m^2 (7,500sf) are permitted under MU-1, anything larger would require a Development Agreement. Development Agreements are a public process that result in specific conditions being placed on the proposed development if approved.

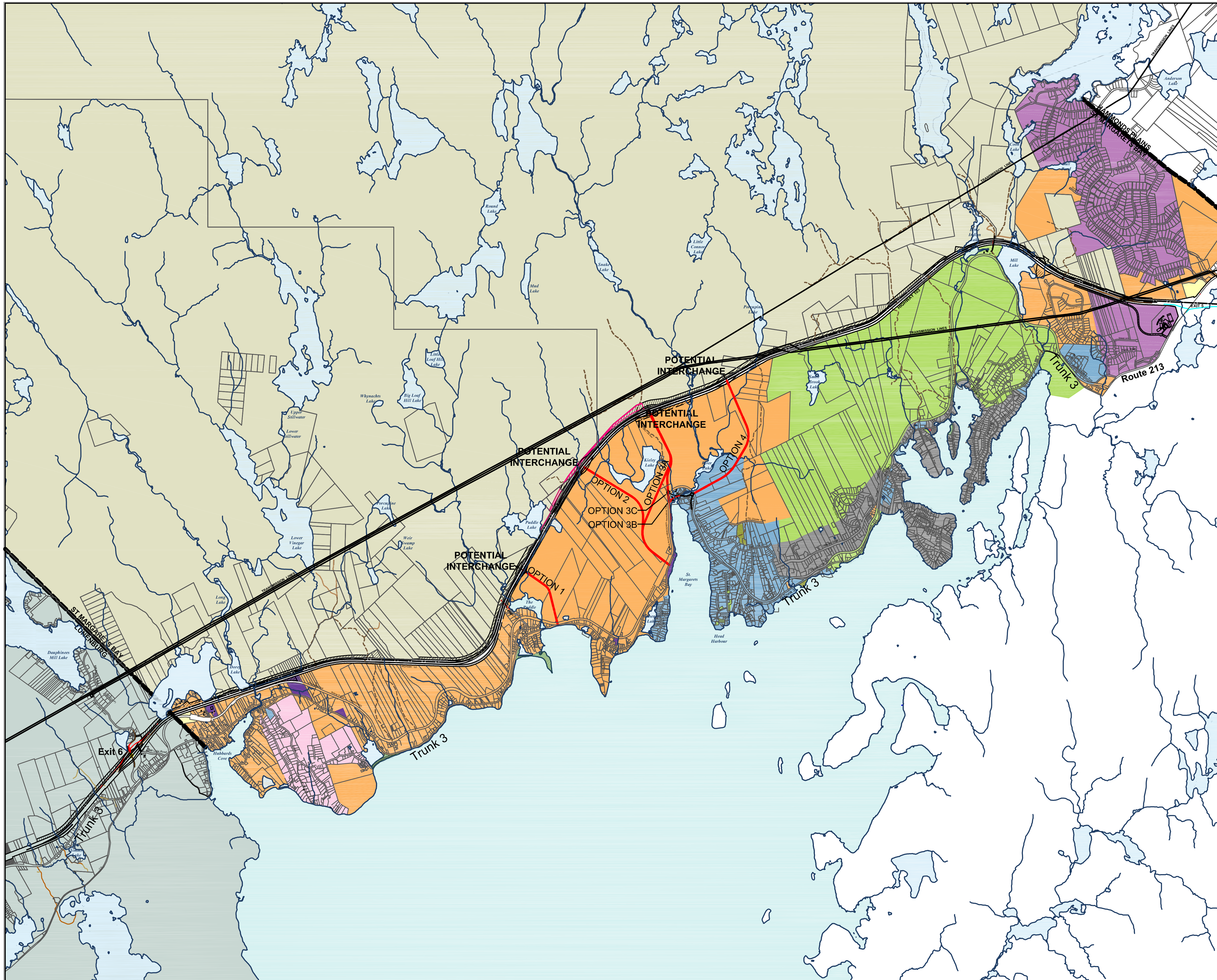
It should be noted that interchange Option 4 extends through an MRR-1 zone (Mixed Rural Residential). This zone permits the following residential and commercial uses:

A. Residential Uses
   - Single unit dwellings;
   - Two unit dwellings;
   - Mobile dwellings skirted;
   - Day care facilities for not more than fourteen (14) children and in conjunction with permitted dwellings;
   - Business uses in conjunction with permitted dwellings; and
   - Boat Houses.

B. Commercial Uses:
   - Bed and breakfast establishments;
   - Craft shops;
   - Antique shops;
   - Local convenience stores;
   - Service and personal service shops;
   - Medical clinics;
   - Grocery stores; and
   - Variety stores.

The permitted uses of the Land Use Bylaw are also inter-related with the Halifax Regional Municipal Subdivision Bylaw which only enables an as-of-right subdivision in the area based on the following conditions:

1. Where the lot has frontage to an existing public road the lot can be broken up into lots that meet the minimum lot frontage requirement and on-site servicing requirements.
2. Where a new road is proposed that would be taken over by the Municipality for a residential subdivision only eight new lots plus the remainder lot are permitted. Given HRM road construction requirements, the economics of this form of development lend itself to being undesirable.



PLANNING DISTRICT LANDS
(ST. MARGARETS BAY LAND USE BY-LAW 2008)

LEGEND

- C-3 (TOURIST INDUSTRY) ZONE
- CDD (COMPREHENSIVE DEVELOPMENT DISTRICT) ZONE
- I-1 (GENERAL INDUSTRIAL) ZONE
- I-2 (SALVAGE YARD) ZONE
- MR-2 (MIXED RESOURCE 2) ZONE
- MRR-1 (MIXED RURAL RESIDENTIAL) ZONE
- MU-1 (MIXED USE) ZONE
- MU-2 (MIXED USE) ZONE
- R-2 (TWO UNIT DWELLING) ZONE
- R-A (RESIDENTIAL) ZONE
- R-A1 (GENERAL RESIDENTIAL) ZONE
- RPK (REGIONAL PARK) ZONE
- P-3 ZONE
- GRAVEL / DIRT ROAD
- WATERCOURSE

MUNICIPALITY OF THE DISTRICT OF CHESTER LAND USE BY-LAW

- GB - GENERAL BASIC ZONE

FIGURE 3-1

SOURCES:

- BASE PLAN OBTAINED FROM NOVA SCOTIA DEPARTMENT OF TRANSPORTATION AND INFRASTRUCTURE RENEWAL LAND USE PLAN, DATED MAY 27,2010. CAD FILE: 103 LAND USE PLAN_Oct_2009.dwg
- ZONING INFORMATION OBTAINED FROM EXPLOREHRM (JUNE 2010)

Designer: BWHALEN
Planner: NPRYCE

VERSION
1.0

HIGHWAY 103 - ZONING PLAN
EXIT 5 TO EXIT 6

NOVA SCOTIA
Transportation and Infrastructure Renewal

AUGUST 24, 2010 FIGURE 3-2

NORTH

600 400 200 0 1000 m
1 : 20,000

N

GENIVAR
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CANADA, B3B 1X7
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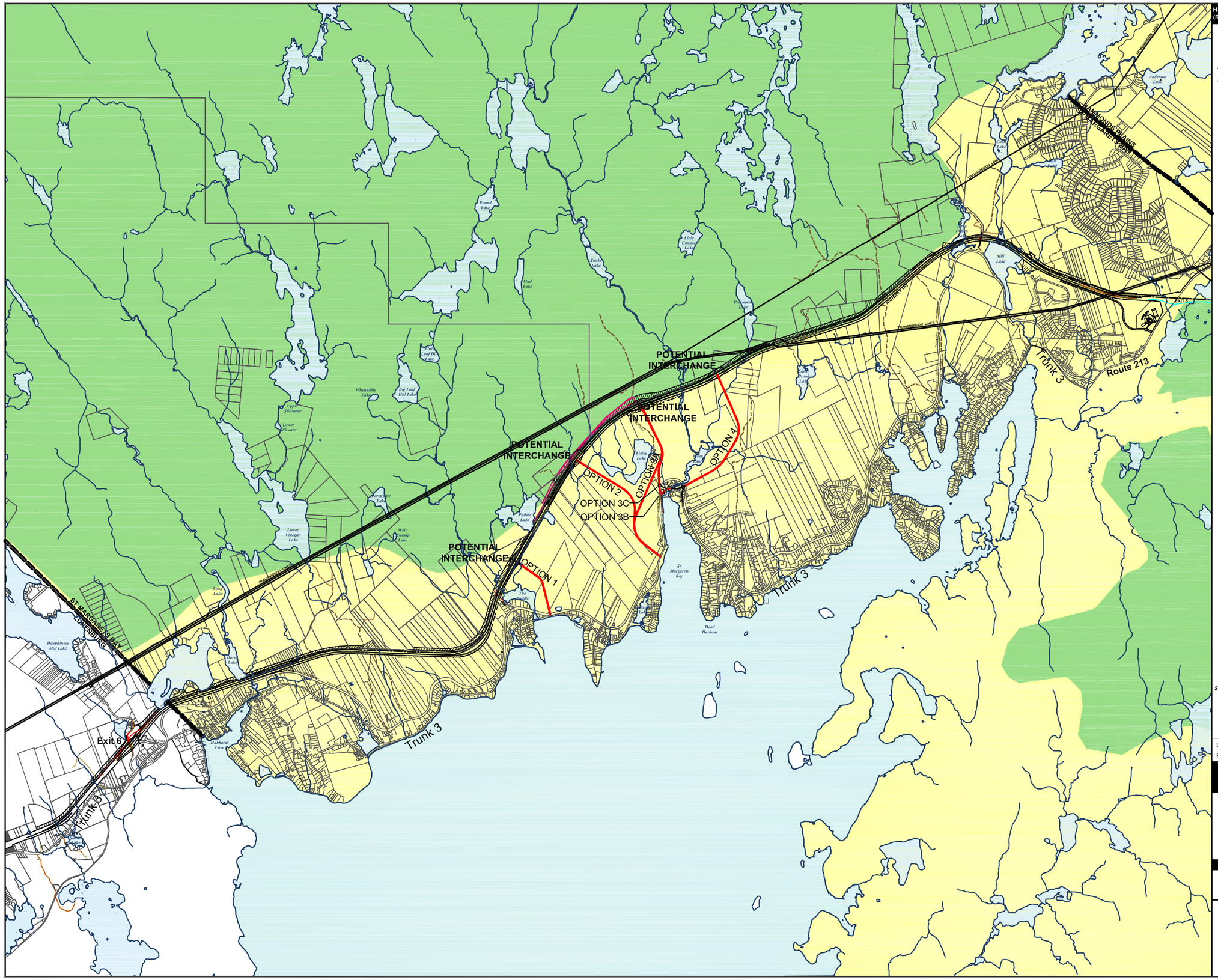
File: K:\Dartmouth\2010\DA10276\dwg\Eng\Figure 3-1 and 3-3.dwg Sheet: Fig 3-1



HRM PRIMARY DESIGNATIONS
(REGIONAL MUNICIPAL PLANNING STRATEGY 2006)

LEGEND

- RURAL COMMUTER
- OPEN SPACE
- GRAVEL / DIRT ROAD
- WATERCOURSE

FIGURE 3-2

SOURCES:

- BASE PLAN OBTAINED FROM NOVA SCOTIA DEPARTMENT OF TRANSPORTATION AND INFRASTRUCTURE RENEWAL LAND USE PLAN, DATED MAY 27,2010. CAD FILE: 103 LAND USE PLAN_Oct_2009.dwg
- APPROVED DEVELOPMENTS OBTAINED FROM HRM JULY 22, 2010

Designer: BWHALEN
Planner: NPRYCE

VERSION 1.0

HIGHWAY 103 - GENERALIZED FUTURE LAND USE PLAN
EXIT 5 TO EXIT 6

NOVA SCOTIA
Transportation and Infrastructure Renewal

September, 2010

NORTH

600 400 200 0 1000 m
1 : 20,000

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Sheet: FIGURE 3-2

File: K:\Dartmouth\2010\ADA\102\Drawing\Graphics\Figure 3-2 and 3-3.dwg

It should be noted that there is the ability, enabled under the Nova Scotia Municipal Government Act (Section 268), to create 25-acre lots without seeking approval from HRM. This type of subdivision needs only to be registered with the Provincial Land Registry Office.

The lands to the north of Highway 103 are zoned MR-2 (Mixed Resource) which effectively permits the development of single, two unit and mobile dwelling units. The remaining permitted uses are related to resource uses such as forestry. The same provisions noted above relating to subdivision would apply to these lands.

Possible Future Development in the Detailed Study Area controlled by the Halifax Regional Plan - Under the Halifax Regional Municipal Plan, the majority of the lands to the north are designated Open Space and Natural Resources. The exception being lands located to the west, as illustrated in Figure 3-2, which are designated Rural Commuter. The Open Space and Natural Resources designation effectively does not allow for any additional development beyond what is permitted under the MR-2 zone of the Land Use Bylaw. There effectively is no ability to develop the lands designated Open Space and Natural Resources in accordance with the Regional Plan Open Space requirements without re-designating the lands. Should the new interchange be located at options 2, 3A/B/C or 4, it is likely the owners of the lands adjoining the interchanges would seek an amendment to the Regional Plan to enable development in accordance with the Open Space provisions. Option 1 already has lands to the north of Highway 103 designated to enable development under the Open Space provisions of the Regional Plan. An outline of the provisions regarding Open Space developments is provided below.

To the south of Highway 103 the lands are designated Rural Commuter. This designation enables the owners to apply for a Development Agreement under the Open Space provisions of the Regional Plan. There are two forms of Open Space developments that a subdivision may proceed under:

1. Hybrid – This enables the opportunity to develop the land based on a density of one unit per hectare subject to meeting a number of criteria.
2. Classic – This enables the opportunity to develop the land based on one unit per 4,000 square meters (one acre) subject to meeting a number of criteria. This form of development has not been as desirable to developers because of issues surrounding capital costs and marketability that has resulted in the Hybrid being the preferred form of Open Space development.

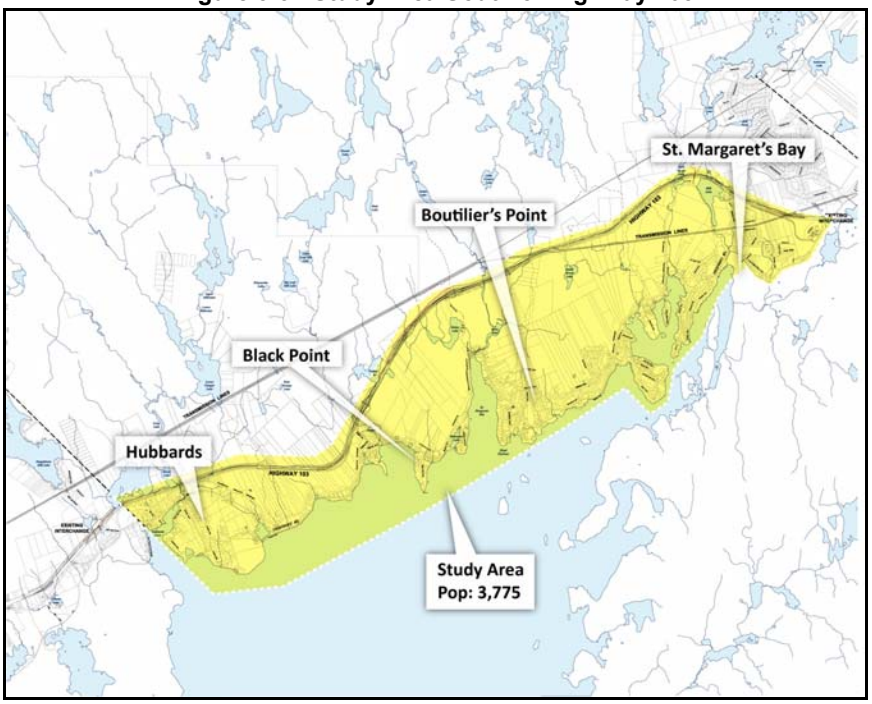
Any application to develop the lands would be by way of a public process (Development Agreement) and would require access to a public road. Table 3-1 summarizes the types and examples of major residential or commercial development that may be developed based on current planning regulations and legislation.

Table 3-1 - Example Developments Permitted Under Various Planning Regulations and Legislation	
St. Margaret's Bay Land Use Bylaw	
Example Permitted As-of-Right Uses	• MU-1 (Mixed Use) Zone: Any uses except those that are specified as excluded. Excluded uses such as Mobile Home Parks, Multi-Unit Dwellings and Commercial uses over 697 m^2. These excluded uses would require a Development Agreement to proceed. • MRR-1 (Mixed Rural Residential Zone): Permits certain residential and commercial uses, (e.g. single unit dwellings, mobile dwellings skirted, boat houses, craft shops, antique shops, medical clinics, etc...). • MR-2 (Mixed Resource Zone): Permits development of single, two unit and mobile dwellings in addition to allowing resource uses such as forestry.
Example uses Requiring a Development Agreement	• In MU-1 Zone: Mobile Home Parks • Multi-unit dwellings and senior citizen housing exceeding 20 units • Commercial uses over 697 m^2 (7,500 sf)
HRM Regional Subdivision Bylaw	
Permitted As-of-Right Subdivision	• Where a lot has frontage to an existing public road the lot can be broken up into lots that meet the minimum lot frontage requirement and on-site servicing requirements. • Were a new road is proposed that would be taken over by the Municipality for a residential subdivision only eight new lots plus the remainder lot.
HRM Regional Municipal Planning Strategy	
Developments that can proceed under a Development Agreement	Lands designated Rural Commuter may apply for Open Space developments: • Hybrid - This enables the opportunity to develop based on a density of one unit per hectare subject to meeting a number of criteria • Classic - This enables the opportunity to develop the land on one unit per 4,000 m^2 (one acre) subject to meeting a number of criteria. Lands designated Open Space and Natural Resources effectively cannot apply for developments beyond those allowed as of right under the relevant Land Use Bylaw.
Nova Scotia Municipal Government Act	
Permitted As-of-Right Subdivision	• Allows the creation of lots no smaller than 25 acres registered with the Provincial Land Registry Office
Note: The St. Margaret's Bay Land Use Bylaw covers a wide range zones with varying degree of uses permitted, this table is intended to provide some examples of types of development that could occur in the area	

St. Margaret's Bay Area Community Characteristics - The study area is located within Census tract 2050143.01, a division of the Halifax Census Metropolitan Area (CMA). This tract is 295.9 square kilometers, containing nine Dissemination Areas. The 2006 census tract indicates 5,033 people in 2,322 private dwellings within the census tract, making the population density 17 people per square kilometer. However, this population density is not spread evenly throughout the tract. Instead, most residents cluster near the coastline. The large dissemination area to the north of Highway 103 has a very low population density. The study area population density to the south of Highway 103 is significantly higher at 92 people per square kilometer, clearly demonstrating the tendency of residents to live near the coastline. The study area has experienced rapid growth during the previous five years. In 2001 the population was 4,295. Compared to its 2006 population (5,033), the tract demonstrated an increase of 17.2 percent.

According to the 2006 Census, the 41 km^2 surrounding the study area to the south of Highway 103 (Figure 3-3) is home to approximately 3,775 residents. Statistics Canada defines four communities within the study area: Hubbards, Black Point, Boutilier's Point, and St. Margaret's Bay. Combined, these four communities contain 2,482 people, approximately two-thirds of the study area population.

Figure 3-3 - Study Area South of Highway 103



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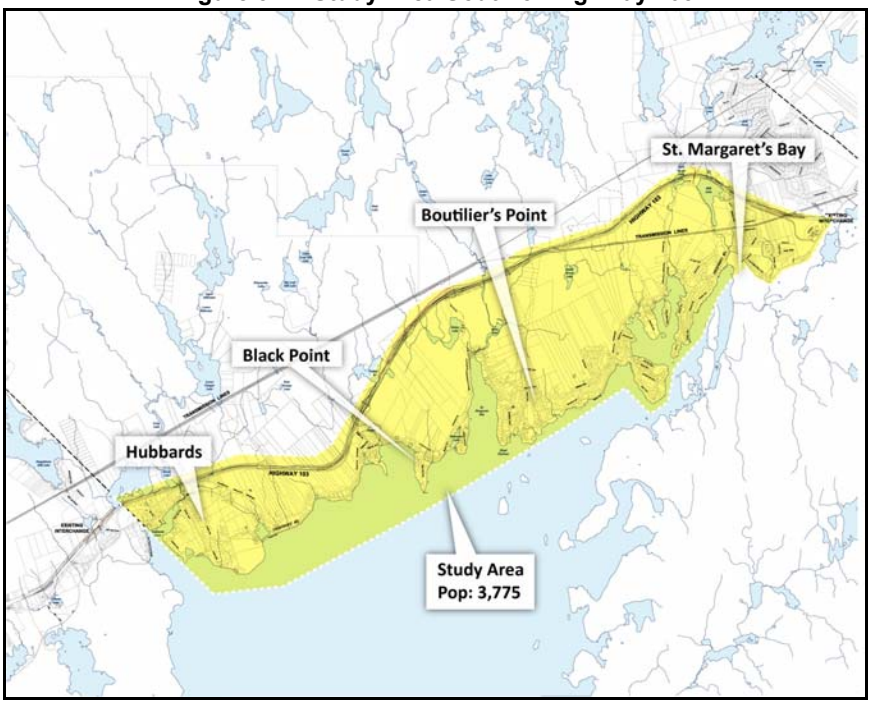
According to the 2006 Census, the 41 km^2 surrounding the study area to the south of Highway 103 (Figure 3-4) is home to approximately 3,775 residents. Statistics Canada defines four communities within the study area: Hubbards, Black Point, Boutilier's Point, and St. Margaret's Bay. Combined, these four communities contain 2,482 people, approximately two-thirds of the study area population.

Figure 3-4 - Study Area South of Highway 103



4.0 Traffic Volume Projections for Interchange Options

4.1 License Plate Match Study

Study Description - A license plate match study was completed on Thursday, June 10, 2010, to obtain trip characteristics required to determine projected volumes for the proposed connector and interchange ramp options. License plate numbers were recorded in one minute increments between 7:00 AM and 10:00 AM and 3:30 PM and 6:30 PM for all vehicles travelling in both directions. Plate numbers were recorded at the following locations shown on Figures 4-1 and Figure B-1, Appendix B:

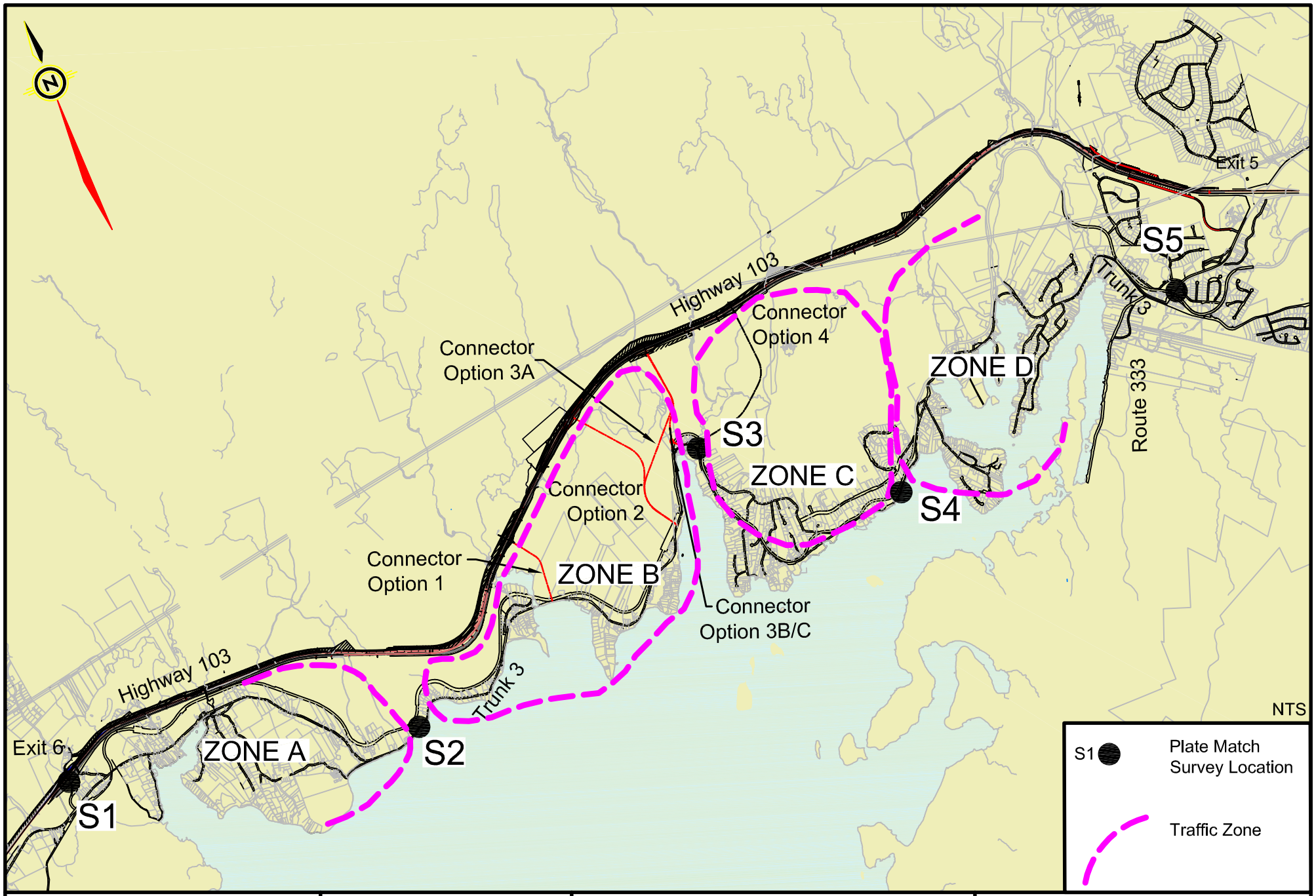
S1 Hubbards Interchange western ramps
S2 Trunk 3 west of Connector Option 1 intersection
S3 Trunk 3 between Connector Options 3B/3C and 4 intersections
S4 Trunk 3 east of Connector Option 4 intersection
S5 Route 213 just north of the Trunk 3 intersection.

Summary of Plate Match Study Results - License plate numbers were matched between vehicles passing Station 1 and those passing Stations 2, 3, and 4 to obtain trip patterns between the Study Area on Trunk 3 and areas west of the Highway 103 EXIT 6 interchange. License plate numbers were matched between vehicles passing Station 5 and those passing Stations 2, 3, and 4 to obtain trip patterns between the Study Area and areas near the Highway 103 EXIT 5 interchange. The vehicle plate match results for the AM and PM survey periods are shown in Table 4-1.

Table 4-1 - Two Way Total Trip Matches Between Plate Match Stations

Stations [1]	Time Period [2]	# Matches Recorded [3]	Vehicles Passing [4]	Vehicle Matches
Between S1* and S2	AM	57	210	27.1%
	PM	96	290	33.1%
Between S1* and S3	AM	44	210	21.0%
	PM	78	290	26.9%
Between S1* and S4	AM	44	210	21.0%
	PM	63	290	21.7%
Between S2* and S5	AM	224	523	42.8%
	PM	392	925	42.4%
Between S3* and S5	AM	320	632	50.6%
	PM	516	1070	48.2%
Between S4* and S5	AM	530	916	57.9%
	PM	733	1411	51.9%

Notes: 1. Stations indicated on Figure 4-1
2. AM Peak Period is 7AM to 10AM; PM Peak Period is 3:30PM to 6:30PM
3. Number of matched vehicles recorded between stations during peak period
4. Vehicles passing station indicated by '*' during peak period



	GENIVAR	Highway 103 Proposed Boutilier's Point Interchanges Traffic Study	Figure 4-1
		License Plate Match Survey Locations And Traffic Zones	September 2010

4.2 Volumes Diverted to Connector Options

Plate Volume Matches between Stations (Table B-1, Appendix B)- The percentage match data obtained from analysis of the license plate study (Table 4-1) have been used with projected 2013 and 2020 AM and PM DHVs to provide projected hourly volumes between Station 1 and Stations 2, 3 and 4, as well as projected hourly volumes between Station 5 and Stations 2, 3 and 4 (Table B-1, Appendix B).

Study Area Traffic Zones (Table B-2) - Four traffic zones were created between Hubbards and Upper Tantallon to facilitate diverting trips from Trunk 3 to the proposed Highway 103 connector options. The following Trunk 3 traffic zones are shown on Figures 4-1 and B-1 (Appendix B):

Zone A West of Station 2
Zone B Between Stations 2 and 3
Zone C Between Stations 3 and 4
Zone D East of Station 4.

Projected hourly volumes between plate match stations (Table B-1) were used to create origin-destination trip tables between EXIT 6 and Zones B, C, and D, as well as between EXIT 5 and zones A, B, and C. AM and PM DHV trip tables for 2013 and 2020 are included in Table B-2.

Distance and Time Savings for Connector Options (Tables B-3 and B-4) - If a new connector is constructed between Trunk 3 and Highway 103, drivers are expected to make decisions concerning travel patterns based on travel time and distance savings possible using a connector option compared to those for the existing roads. Also, drivers may be attracted to using a new connector to Highway 103 to take advantage of the comfort and increased safety of travelling on a four-lane divided highway.

Travel distance and time comparisons between existing travel routes and routes using a new connector to Highway 103 were determined for each Connector Option. Travel times were based on travel distances and the following assumed travel speeds:

- Highway 103 - four-lane divided highway with a posted speed limit of 110 km/h and an assumed operating speed of 110 km/h;
- Connectors - two-lane roads with average operating speeds of 70 km/h; and
- Trunk 3, Mill Lake Road and Route 213 - assumed average travel speed of 66 km/h.

Travel distance and time comparisons between the Trunk 3 intersection for each Connector Option and the EXIT 5 interchange at Upper Tantallon are included in Table B-3. Distance savings vary from 0.8 to 2.9 kilometers, with time savings of from 5.0 to 7.5 minutes per trip.

Travel distance and time comparisons between the Trunk 3 intersection for each Connector Option and the EXIT 6 interchange at Hubbards are included in Table B-4. Travel distance comparisons vary from 1.9 kilometers longer to 0.5 kilometers shorter, with time savings of from 2.5 to 4.6 minutes per trip.

Travel distance and time savings to Highway 103 EXIT 5 and EXIT 6 interchanges between existing routes and each connector option are summarized in Table 4-2.

Table 4-2 - Travel Distance and Time Savings between Existing Routes and Connector Options				
Connector Option	Travel Distances Savings (kilometers)		Travel Time Savings (minutes)	
	to EXIT 5	to EXIT 6	to EXIT 5	to EXIT 6
Option 1	2.9	0.4	7.5	3.2
Option 2	0.8	0.1	5.0	3.8
Option 3A	1.7	-1.9	5.3	2.5
Option 3B/C	2.0	0.5	5.5	4.6
Option 4	2.0	-1.3	5.0	3.5

NOTES:
1. Distance and time savings are calculated by comparing travel distance and travel time by way of the existing roads and again by way of each Connector Option from the Trunk 3 / Connector Option intersection to EXIT 5 and EXIT 6
2. Assumed average travel speed of 70 km/h on the connector roads
3. Assumed average travel speed of 110 km/h on four-lane Highway 101
4. Assumed average travel speed of 66 km/h on Trunk 3, Mill Lake Road and Route 213

Trip Diversion to Connector Options (Tables B-5 to B-9) - Trips with origins or destinations in the Study Area (Table B-2) have been diverted from the existing road system to the proposed Connector Options based on traffic zone proximity to a connector intersection on Trunk 3 and evaluation of distance and time savings offered by each Connector Option. The percentage of diverted trips and diverted trips for 2013 and 2020 AM and PM peak hours are shown for each Connector Option in Tables B-5 to B-9.

Assigned Connector Option Peak Hour Volumes (Figures C-4 to C-13) - Assigned 2013 and 2020 AM and PM peak hourly volumes at the Trunk 3 intersections and Highway 103 interchange ramps for the Connector Options are shown diagrammatically in the following Appendix C figures:

Option 1 - 2013 volumes Figure C-4; 2020 volumes Figure C-5
Option 2 - 2013 volumes Figure C-6; 2020 volumes Figure C-7
Option 3A - 2013 volumes Figure C-8; 2020 volumes Figure C-9
Option 3 B/C - 2013 volumes Figure C-10; 2020 volumes Figure C-11
Option 4 - 2013 volumes Figure C-12; 2020 volumes Figure C-13.

The assigned 2020 AM and PM peak hour volumes for connector and interchange ramps for each Connector Option are summarized in Table 4-3.

Impact of Diverted Connector Volumes on Trunk 3 Volumes - Two-way traffic volumes on Trunk 3 east and west of a connector are expected to be reduced as a result of some existing Trunk 3 traffic diverting to a new connection to Highway 103. Volumes assigned to the eastern ramps of a connector interchange (Table 4-3) will reduce Trunk 3 volumes east of that connector and volumes assigned to the western interchange ramps will reduce Trunk 3 volumes west of a connector location. While these volume reductions will be realized one or two kilometers from a connector location, Trunk 3 traffic patterns near a connector intersection will change as some Trunk 3 traffic backtracks to take advantage of a connector. For example, eastbound Trunk 3 trips which divert to a connector will reduce the number of eastbound vehicles travelling on Trunk 3 east of the connector, however, traffic from locations just east of the connector that backtracks to access the connector will increase the number of westbound vehicles travelling on Trunk 3 near the connector.

Table 4-3 - Projected 2020 Peak Hour Connector and Interchange Ramp Volumes

Connector	Time of Day	Connector Road			Western Ramps of New Interchange		Eastern Ramps of New Interchange	
		NB	SB	2-Way	WB Access	EB Exit	EB Access	WB Exit
Option 1	AM Peak	95	60	155	25	5	70	55
	PM Peak	125	155	280	30	20	95	135
Option 2	AM Peak	100	60	160	20	5	80	55
	PM Peak	125	155	280	25	15	100	140
Option 3A	AM Peak	90	60	150	10	5	80	55
	PM Peak	110	150	260	10	10	100	140
Option 3B/C	AM Peak	130	65	195	15	5	115	60
	PM Peak	140	205	345	20	15	120	190
Option 4	AM Peak	130	65	195	15	5	115	60
	PM Peak	130	200	330	10	10	120	190

NOTE: Connector and interchange ramp volumes for 2020 AM and PM peak hours are shown diagrammatically in Figures C-5, C-7, C-9, C-11, and C-13, Appendix C.

5.0 Warrant Evaluations

5.1 Left Turn Lane Warrants

Left turn movements on a two lane highway may cause both operational and safety problems. Operational problems result as a vehicle stopped waiting for an opportunity to turn across 'heavy' opposing traffic causes a queue of stopped vehicles to form. Safety problems result from rear end collisions when a stopped left turning vehicle is struck by an advancing vehicle, or from head-on or right angle collisions when a left turning vehicle is struck by an opposing vehicle.

The *Geometric Design Standards for Ontario Highways Manual* contains nomographs for left turn lane analysis for two lane streets. The analysis method, which is normally used by *GENIVAR* and *NSTIR* to evaluate need for left turn lanes, uses a series of nomographs that consider speed, advancing volumes, left turns as a percentage of advancing volumes, and opposing volumes. A point, based on 'opposing' and 'advancing' volumes, plotted to the right of the 'warrant line' of the appropriate '% left turns' and 'approach speed' nomograph, indicates that a left turn lane is warranted for the conditions used in the analysis. Similarly, a point that is plotted to the left of the warrant line indicates that a left turn lane is not warranted.

The warrant for left turn lanes was evaluated for Trunk 3 intersections for all Connector Options. The analysis results which are included Figure D-1 and D-2, Appendix D, indicate that projected 2020 volumes will not warrant construction of left turn lanes on Trunk 3.

5.2 Right Turn Lane Warrants

Operational problems may result at an intersection where a 'high' number of vehicles slow to make a right turn into a site. The *Ohio Department of Transportation State Highway Access Management Manual* contains nomographs for evaluating right turn lane warrants on two lane roads. The analysis is based on right turning and advancing volumes for a given approach speed.

The warrant for right turn lanes was evaluated for Trunk 3 intersections for all Connector Options. The analysis results which are included on Figure D-3, Appendix D, indicate that projected 2020 volumes will not warrant construction of right turn lanes on Trunk 3.

6.0 Performance Analysis

6.1 Intersection Level of Service Analysis (Without Connector)

The level or quality of performance of an intersection in terms of traffic movement is determined by a level of service (LOS) analysis. LOS for intersections is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and increased travel time.

Evaluation of the volume-to-capacity ratio, or v/c ratio, provides another measure of intersection performance. A low v/c ratio indicates that volumes using an intersection are much less than intersection capacity and the intersection will operate without congestion. A high v/c ratio over 0.85 indicates that volumes are approaching intersection capacity and congestion can be expected.

Table 6-1 - Level of Service (LOS) Criteria for Intersections

LOS	Signalized Intersections Control Delay (seconds per vehicle)	LOS Description	Two Way Stop Controlled (TWSC) Intersections Control Delay (seconds per vehicle)
A	less than 10.0	Very low delay; most vehicles do not stop **(Excellent)**	less than 10.0
B	between 10.0 and 20.0	Higher delay; more vehicles stop **(Very Good)**	between 10.0 and 15.0
C	between 20.0 and 35.0	Higher level of congestion; number of vehicles stopping is significant, although many still pass through intersection without stopping **(Good)**	between 15.0 and 25.0
D	between 35.0 and 55.0	Congestion becomes noticeable; vehicles must sometimes wait through more than one red light; many vehicles stop **(Satisfactory)**	between 25.0 and 35.0
E	between 55.0 and 80.0	Vehicles must often wait through more than one red light; considered by many agencies to be the limit of **acceptable** delay	between 35.0 and 50.0
F	greater than 80.0	This level is considered to be unacceptable to most drivers; occurs when arrival flow rates exceed the capacity of the intersection **(Unacceptable)**	greater than 50.0

LOS criteria (Table 6-1) are stated in terms of average control delay per vehicle which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Level of service analysis has been completed for Study Area intersections for projected 2013 and 2020 AM and PM peak hours without the proposed Boutilier's Point Connector using Synchro / SimTraffic software. Analysis sheets are included in Appendix E and results for are summarized in Tables 6-2 to 6-10.

Summary Level of Service Analysis - The follow comments summarize the level of service analysis:

1. *Route 213 @ Highway 103 EXIT 5 WB Ramp / Shopping Center Entrance (Table 6-2)* - The intersection will continue to provide satisfactory LOS 'B' during 2020 AM peak hours and LOS 'C' during 2020 PM peak hours.
2. *Route 213 @ Highway 103 EXIT 5 EB Ramps (Table 6-3)* - While the intersection will continue to provide satisfactory LOS 'B' during 2020 AM peak hours and LOS 'C' during 2020 PM peak hours, the northbound through movement should be monitored as analysis indicates a 0.86 v/c ratio by during the PM peak hour.

3. *Trunk 3 @ Route 213 / Superstore Entrance (Table 6-4)* - While the intersection will continue to provide good LOS 'B' during both 2020 AM and PM peak hours, the southbound right turn movement should be monitored as analysis indicates a 0.83 v/c ratio by during the PM peak hour.
4. *Trunk 3 @ Route 333 / Commercial Entrance (Table 6-5)* - While the intersection will continue to provide good LOS 'A' during 2020 AM peak hours and LOS 'B' during 2020 PM peak hours, the westbound left turn movement should be monitored as analysis indicates a 0.82 v/c ratio by during the PM peak hour.
5. *Trunk 3 @ Fox Point Front Road (Table 6-6)* - The intersection will continue to provide good LOS 'A' during both 2020 AM and PM peak hours.
6. *Trunk 3 @ Route 329 / Commercial Entrance (Table 6-7)* - The intersection will continue to provide good LOS 'A' during both 2020 AM and PM peak hours.
7. *Trunk 3 @ Mill Lake Road (Table 6-8)* - The intersection will continue to provide good LOS 'A' during both 2020 AM and PM peak hours.
8. *Mill Lake Road @ Highway 103 EXIT 6 EB Ramps (Table 6-9)* - The intersection will continue to provide good LOS 'A' during both 2020 AM and PM peak hours.
9. *Mill Lake Road @ Highway 103 EXIT 6 WB Ramps (Table 6-10)* - The intersection will continue to provide good LOS 'A' during both 2020 AM and PM peak hours.

Conclusion Level of Service Analysis - The five STOP sign controlled intersections at the western end of the Study Area will provide good levels of performance for projected 2020 peak hour volumes without a proposed Highway 103 connector road. While the four signal controlled eastern intersections should provide satisfactory levels of performance during 2020 peak hours, several movements will require monitoring as v/c ratios of between 0.82 and 0.86 are predicted.

Table 6-2 - LOS Results for Route 213 @ WB Highway 103 Exit Ramp / Shopping Center Intersection

LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement								Intersection LOS
	EB-L	EB-R	WB-L	WB-T	WB-R	NB-L	NB-T	SB-TR	
AM Peak Hour - 2013 Projected Volumes (Page E-1)									
Delay	19.5	9.8	20.9	18.7	7.0	17.6	6.5	6.1	10.0
LOS	B	B	C	B	A	B	A	A	B
v/c	0.08	0.51	0.39	0.13	0.19	0.65	0.32	0.35	-
Queue	9.5	29.6	40.1	16.6	10.3	38.5	31.2	29.3	-
AM Peak Hour - 2020 Projected Volumes (Page E-19)									
Delay	21.7	13.1	24.0	21.0	7.3	20.9	6.9	6.2	11.2
LOS	C	B	C	C	A	C	A	A	B
v/c	0.08	0.55	0.43	0.13	0.20	0.69	0.37	0.37	-
Queue	9.6	36.7	44.7	16.8	10.7	47.8	40.6	35.6	-
PM Peak Hour - 2013 Projected Volumes (Page E-10)									
Delay	22.3	17.6	26.9	19.9	17.8	35.8	18.8	12.1	19.2
LOS	C	B	C	B	B	D	B	B	B
v/c	0.32	0.67	0.69	0.35	0.71	0.77	0.71	0.46	-
Queue	30.5	83.9	110.8	54.3	90.3	58.7	115.2	54.7	-
PM Peak Hour - 2020 Projected Volumes (Page E-28)									
Delay	24.2	21	32	21.8	26.3	43.5	21.6	12.9	23
LOS	C	C	C	C	C	D	C	B	C
v/c	0.32	0.69	0.75	0.35	0.81	0.81	0.77	0.48	-
Queue	30.5	90.3	126.4	54.3	130.0	69.8	136.9	60.3	-

Table 6-3 - LOS Results for Route 213 @ EB Highway 103 Exit Ramps Intersection							
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement						Intersection LOS
	EB-L	EB-R	NB-T	NB-R	SB-L	SB-T	
AM Peak Hour - 2013 Projected Volumes (Page E-2)							
Delay	26.4	11.9	17.5	6.2	8.4	4.2	10.0
LOS	C	B	B	A	A	A	B
v/c	0.37	0.07	0.57	0.42	0.59	0.25	-
Queue	33.0	5.7	80.8	26.5	30.4	24	-
AM Peak Hour - 2020 Projected Volumes (Page E-20)							
Delay	29.3	12.3	18.9	7.3	12	4.4	11.6
LOS	C	B	B	A	B	A	B
v/c	0.41	0.07	0.62	0.45	0.68	0.26	-
Queue	38.7	5.8	93.9	33.0	45.1	27.4	-
PM Peak Hour - 2013 Projected Volumes (Page E-11)							
Delay	34.0	11.1	20.4	8.1	22	6.3	14.2
LOS	C	B	C	A	C	A	B
v/c	0.54	0.09	0.64	0.23	0.7	0.44	-
Queue	54.9	7.1	154.3	26.6	49.2	63.1	-
PM Peak Hour - 2020 Projected Volumes (Page E-29)							
Delay	38.1	10.8	32.7	9.5	38.7	7.3	20.4
LOS	D	B	C	A	D	A	C
v/c	0.59	0.09	0.86	0.30	0.8	0.5	-
Queue	58.9	7.1	198.0	30.5	83.2	70.8	-

Table 6-4 - LOS Results for Trunk 3 @ Route 213 / Superstore Intersection										
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement									Intersection LOS
	EB-L	EB-TR	WB-L	WB-TR	NB-L	NB-TR	SB-L	SB-T	SB-R	
AM Peak Hour - 2013 Projected Volumes (Page E-3)										
Delay	8.5	4.3	22.5	13.8	20.0	15.4	24.5	20.6	6.6	10.5
LOS	A	A	C	B	B	B	C	C	A	B
v/c	0.61	0.08	0.06	0.38	0.02	0.11	0.35	0.11	0.46	-
Queue	62.4	10.0	6.3	21.8	2.9	9.7	23.3	11.4	15.3	-
AM Peak Hour - 2020 Projected Volumes (Page E-21)										
Delay	9.9	4.6	22.8	15.3	20.2	15.5	25.5	20.8	6.6	11.3
LOS	A	A	C	B	C	B	C	C	A	B
v/c	0.67	0.10	0.06	0.41	0.02	0.11	0.38	0.11	0.48	-
Queue	75.3	11.8	6.3	24.5	2.9	9.8	25.6	11.5	16.0	-
PM Peak Hour - 2013 Projected Volumes (Page E-12)										
Delay	12.6	6.5	23.9	29.0	25.6	22.9	33.6	25.4	9.2	16.6
LOS	B	A	C	C	C	C	C	C	A	B
v/c	0.67	0.13	0.13	0.66	0.19	0.26	0.55	0.24	0.8	-
Queue	61.2	16.1	13.2	68.2	18.2	29.2	45.6	29.5	34.9	-
PM Peak Hour - 2020 Projected Volumes (Page E-30)										
Delay	15.7	6.5	23.7	30.3	26.6	23.7	36.0	26.4	10.1	18.0
LOS	B	A	C	C	C	C	D	C	B	B
v/c	0.74	0.14	0.13	0.69	0.19	0.26	0.58	0.24	0.83	-
Queue	76.4	17.8	13	74.6	18.7	29.9	50.3	30.2	39.9	-

Table 6-5 - LOS Results for Trunk 3 @ Route 333 Intersection								
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement							Intersection LOS
	EB-L	EB-TR	WB-L	WB-TR	NB-LT	NB-R	SB-TR	
AM Peak Hour - 2013 Projected Volumes (Page E-4)								
Delay	5.3	7.9	8.3	5.5	11.2	4.7	10.5	7.0
LOS	A	A	A	A	B	A	B	A
v/c	0.06	0.47	0.31	0.22	0.13	0.47	0.13	-
Queue	3.9	35.3	13.3	14.7	8.7	12.3	8.4	-
AM Peak Hour - 2020 Projected Volumes (Page E-22)								
Delay	5.2	8.3	9.1	5.5	12.2	5.1	11.5	7.3
LOS	A	A	A	A	B	A	B	A
v/c	0.06	0.51	0.37	0.23	0.14	0.50	0.14	-
Queue	3.9	41.2	15.4	16.2	9.6	13.7	9.2	-
PM Peak Hour - 2013 Projected Volumes (Page E-13)								
Delay	6.0	6.0	15.8	8.0	24.8	6.6	29.5	11.9
LOS	A	A	B	A	C	A	C	B
v/c	0.06	0.26	0.68	0.47	0.19	0.45	0.55	-
Queue	4.8	35.8	96.6	76.1	18.1	17.1	46.9	-
PM Peak Hour - 2020 Projected Volumes (Page E-31)								
Delay	6.1	6.3	24.1	8.8	28.3	6.9	34.3	14.7
LOS	A	A	C	A	C	A	C	B
v/c	0.07	0.3	0.82	0.53	0.22	0.48	0.58	-
Queue	4.9	40	137.6	85.4	19.4	17.7	46.9	-

Table 6-6 - LOS Results Trunk 3 @ Fox Point Front Road Intersection				
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement			Intersection LOS
	EB-TR	WB-LT	NB-LR	
AM Peak Hour - 2013 Projected Volumes (Page E-5)				
Delay	0.0	1.4	9.3	2.0
LOS	A	A	A	A
v/c	0.07	0.12	0.05	-
Queue	0.0	0.5	1.3	-
AM Peak Hour - 2020 Projected Volumes (Page E-23)				
Delay	0.0	1.3	9.4	2.0
LOS	A	A	A	A
v/c	0.08	0.13	0.06	-
Queue	0.0	0.5	1.5	-
PM Peak Hour - 2013 Projected Volumes (Page E-14)				
Delay	0.0	1.8	10.9	1.8
LOS	A	A	B	A
v/c	0.15	0.24	0.07	-
Queue	0.0	1.1	1.8	-
PM Peak Hour - 2020 Projected Volumes (Page E-32)				
Delay	0	1.9	11.6	2
LOS	A	A	B	A
v/c	0.16	0.27	0.1	-
Queue	0.0	1.2	2.4	-

Table 6-7 - LOS Results for Trunk 3 @ Roue 329 / Commercial Site Entrance Intersection					
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement				Intersection LOS
	EB-LTR	WB-LTR	NB-LTR	SB-LTR	
AM Peak Hour - 2013 Projected Volumes (Page E-6)					
Delay	1.3	1.1	11.7	10.3	4.7
LOS	A	A	B	B	A
v/c	0.10	0.09	0.17	0.05	-
Queue	0.4	0.3	4.7	1.2	-
AM Peak Hour - 2020 Projected Volumes (Page E-24)					
Delay	1.2	1.0	12.1	10.4	4.6
LOS	A	A	B	B	A
v/c	0.11	0.10	0.19	0.05	-
Queue	0.4	0.3	5.2	1.2	-
PM Peak Hour - 2013 Projected Volumes (Page E-15)					
Delay	2.0	1.7	19.8	15.2	7.0
LOS	A	A	C	C	A
v/c	0.22	0.16	0.35	0.27	-
Queue	1.1	0.7	11.6	8.2	-
PM Peak Hour - 2020 Projected Volumes (Page E-33)					
Delay	1.9	1.8	22.1	16	7.4
LOS	A	A	C	C	A
v/c	0.23	0.18	0.39	0.28	-
Queue	1.1	0.9	13.9	8.8	-

Table 6-8 - LOS Results Trunk 3 @ Mill Lake Road Intersection						
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement					Intersection LOS
	EB-L	EB-T	WB-T	WB-R	SB-LR	
AM Peak Hour - 2013 Projected Volumes (Page E-7)						
Delay	7.6	0.0	0.0	0	9.8	2.4
LOS	A	A	A	A	A	A
v/c	0.01	0.05	0.04	0.08	0.1	-
Queue	0.2	0.0	0.0	0.0	2.5	-
AM Peak Hour - 2020 Projected Volumes (Page E-25)						
Delay	7.7	0.0	0.0	0	9.9	2.4
LOS	A	A	A	A	A	A
v/c	0.01	0.05	0.04	0.09	0.11	-
Queue	0.2	0.0	0.0	0.0	2.7	-
PM Peak Hour - 2013 Projected Volumes (Page E-16)						
Delay	7.8	0.0	0.0	0	12.6	4.7
LOS	A	A	A	A	B	A
v/c	0.01	0.07	0.09	0.07	0.32	-
Queue	0.3	0.0	0.0	0.0	10.6	-
PM Peak Hour - 2020 Projected Volumes (Page E-34)						
Delay	7.9	0.0	0.0	0	13.7	5.1
LOS	A	A	A	A	B	A
v/c	0.02	0.08	0.10	0.08	0.38	-
Queue	0.4	0.0	0.0	0.0	13.2	-

Table 6-9 - LOS Results for Mill Lake Road @ Highway 103 EXIT 6 EB Ramps Intersection				
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement			Intersection LOS
	EB-LTR	NB-TR	SB-LT	
AM Peak Hour - 2013 Projected Volumes (Page E-8)				
Delay	8.6	0.0	0	1.4
LOS	A	A	A	A
v/c	0.03	0.08	0.03	-
Queue	0.8	0.0	0.0	-
AM Peak Hour - 2020 Projected Volumes (Page E-26)				
Delay	8.6	0.0	0	1.5
LOS	A	A	A	A
v/c	0.04	0.09	0.03	-
Queue	0.9	0.0	0.0	-
PM Peak Hour - 2013 Projected Volumes (Page E-17)				
Delay	9.4	0.0	0.4	1.9
LOS	A	A	A	A
v/c	0.08	0.10	0.1	-
Queue	2.0	0.0	0.1	-
PM Peak Hour - 2020 Projected Volumes (Page E-35)				
Delay	9.5	0.0	0.3	1.9
LOS	A	A	A	A
v/c	0.09	0.10	0.11	-
Queue	2.2	0.0	0.1	-

Table 6-10 - LOS Results for Mill Lake Road @ Highway 103 EXIT 6 WB Ramps Intersection				
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement			Intersection LOS
	WB-LTR	NB-LT	SB-TR	
AM Peak Hour - 2013 Projected Volumes (Page E-9)				
Delay	9.8	6.8	0	6.9
LOS	A	A	A	A
v/c	0.04	0.05	0.01	-
Queue	0.9	1.0	0.0	-
AM Peak Hour - 2020 Projected Volumes (Page E-27)				
Delay	9.9	6.9	0	6.9
LOS	A	A	A	A
v/c	0.04	0.05	0.01	-
Queue	0.9	1.1	0.0	-
PM Peak Hour - 2013 Projected Volumes (Page E-18)				
Delay	11.1	6.3	0	8.2
LOS	B	A	A	A
v/c	0.17	0.07	0.01	-
Queue	4.8	1.4	0.0	-
PM Peak Hour - 2020 Projected Volumes (Page E-36)				
Delay	11.4	6.4	0	8.5
LOS	B	A	A	A
v/c	0.19	0.07	0.01	-
Queue	5.4	1.5	0.0	-

6.2 Intersection Level of Service Analysis (With Connector)

Connector Option Intersection Analysis - Level of service analyses have been completed for 2020 AM and PM assigned volumes for five connector options with intersections on Trunk 3 and four interchange locations on Highway 103. The Trunk 3 intersections have been evaluated as T-intersections without left turn lanes on Trunk 3 and a two-lane approach to Trunk 3 to provide for left and right turns at the STOP controlled intersections for each connector except Option 3B/C. The Option 3B/C intersection at Trunk 3 is oriented with the Trunk 3 east being the stem of the 'T' with a two-lane STOP sign approach and with Trunk 3 west being continuous with the connector road (Figures C-10 and C-11). The Highway 103 interchanges have been evaluated as diamond interchanges with single lane STOP controlled exit ramps and a two-lane overpass. The LOS analysis sheets are included in Appendix E, Page E-37 to E-66, and are summarized in Table 6-11. Three intersections have been analysed for each Connector Option as indicated below.

Roundabout Analysis - Assigned 2020 volumes at the Trunk 3 / Connector Option 3 B/C and Trunk 3 / Option 4 intersections were evaluated as a three leg roundabout using ARCADY 7 software. The analysis results are included on Pages E-67 to E-70, Appendix E, and are summarized in the lower section of Table 6-11.

Table 6-11 - Summary LOS Results for Connector and Interchange Options

Option (Pages)	Time of Day	LOS for Option Intersections			Comments
		WB Ramp	EB Ramp	Trunk 3	
1 (E-37 to E-42)	AM	A	A	A	Exit ramps and Trunk 3 approaches operate at LOS 'A' during both AM and PM. The Connector STOP sign approach to Trunk 3 operates at LOS 'A' during the AM and LOS 'B' during the PM.
	PM	A	A	A	
2 (E-43 to E-48)	AM	A	A	A	Exit ramps and Trunk 3 approaches operate at LOS 'A' during both AM and PM. The Connector STOP sign approach to Trunk 3 operates at LOS 'A' during the AM and LOS 'B' during the PM.
	PM	A	A	A	
3A (E-49 to E-54)	AM	A	A	A	Exit ramps and Trunk 3 approaches operate at LOS 'A' during both AM and PM. The Connector STOP sign approach to Trunk 3 operates at LOS 'A' during the AM and LOS 'B' during the PM.
	PM	A	A	A	
3B/C (E-55 to E-60)	AM	A	A	A	Exit ramps operate at LOS 'A' during both AM and PM. The Trunk 3 'T' intersection is oriented with Trunk 3 EB and the connector aligned as the through movement and Trunk 3 WB forming the stem of the 'T'. The WB approach operates at LOS 'A' during the AM and LOS 'B' during the PM; the WB left turn operates at LOS 'C'.
	PM	A	A	A	
4 (E-61 to E-66)	AM	A	A	A	Exit ramps operate at LOS 'A' during both AM and PM. The Trunk 3 'T' intersection is oriented with Trunk 3 EB and the connector aligned as the through movement and Trunk 3 WB forming the stem of the 'T'. The WB approach operates at LOS 'A' during the AM and LOS 'B' during the PM; the WB left turn operates at LOS 'C'.
	PM	A	A	A	

Roundabout Evaluations for Trunk 3 @ Connector Option 3B/C and Connector 4 Intersections					
3B/C (E-67 to E-68)	AM			A	Evaluation of a three leg roundabout at the Trunk 3 / Connector Option 3 B/C intersection indicated that all approaches would operate at LOS 'A' during both AM and PM peak hours with average delays of about four seconds per vehicle.
	PM			A	
4 (E-69 to E-70)	AM			A	Evaluation of a three leg roundabout at the Trunk 3 / Connector Option 4 intersection indicated that all approaches would operate at LOS 'A' during both AM and PM peak hours with average delays of about four seconds per vehicle.
	PM			A	

Comparison of 2020 LOS Results for Trunk 3 @ Route 213 Intersection - The potential for reduced AM and PM peak hour traffic volumes at the Trunk 3 / Route 213 intersection in Upper Tantallon is illustrated in Table 4-3. Volumes assigned to the EB access ramps at interchange options represent potential volume reductions for eastbound left turns from Trunk 3 to Route 213. Volumes assigned to WB exit ramp at interchange options represent reductions in southbound right turns from Route 213 to Trunk 3. Connector Option 1 has the least impact on volume reductions at the intersection, while Connector Options 3 B/C and 4 would have the greatest impact on volume reductions. LOS results for projected 2020 AM and PM peak hourly volumes without a Highway 103 connector, and with least impact (Option 1) and greatest impact (Options 3 B/C or 4) are compared in Table 6-12.

All Study Area intersections will benefit from reduced volumes as trips are diverted to Highway 103 at the proposed connector. However, volume reductions from trips diverted to a new Highway 103 interchange will provide significant improvements in v/c ratios and queues for the eastbound left turn from Trunk 3 to Route 213 during both AM and PM peak hours, as well as improvements at the southbound right turn from Route 213 to Trunk 3 during PM peak hours. The reduced volumes for these two busy intersection movements, and resultant improvements in v/c ratios, could possibly accommodate the equivalent of about ten years of the current volume growth for the turning movements.

Table 6-12 - Comparison of LOS Results for Trunk 3 @ Route 213 / Superstore Intersection										
LOS Criteria	Control Delay (sec/veh), LOS, v/c Ratio, and 95% Queue (m) by Intersection Movement									Intersection LOS
	EB-L	EB-TR	WB-L	WB-TR	NB-L	NB-TR	SB-L	SB-T	SB-R	
Comparison LOS Results for 2020 AM Peak Hourly Volumes										
Projected Volumes Without a Connector (Page E-21)										
Delay	9.9	4.6	22.8	15.3	20.2	15.5	25.5	20.8	6.6	11.3
LOS	A	A	C	B	C	B	C	C	A	B
v/c	0.67	0.10	0.06	0.41	0.02	0.11	0.38	0.11	0.48	-
Queue	75.3	11.8	6.3	24.5	2.9	9.8	25.6	11.5	16.0	-
Projected Volumes for Least Impact by Diverted Trips (Option 1) (Page E-71)										
Delay	8.7	4.6	22.6	14.9	20.0	15.4	24.9	20.6	6.4	11.0
LOS	A	A	C	B	C	B	C	C	A	B
v/c	0.60	0.10	0.06	0.40	0.02	0.11	0.38	0.10	0.40	-
Queue	62.6	11.8	6.3	24.5	2.9	9.8	25.6	11.5	14.3	-
Projected Volumes for Greatest Impact by Diverted Trips (Options 3 B/C and 4) (Page E-72)										
Delay	8.1	4.6	22.4	14.7	20.0	15.3	24.5	20.3	6.4	10.7
LOS	A	A	C	B	C	B	C	C	A	B
v/c	0.56	0.10	0.06	0.39	0.02	0.10	0.37	0.10	0.39	-
Queue	54.9	11.8	6.3	24.5	2.9	9.8	25.6	11.5	14.2	-
Comparison LOS Results for 2020 PM Peak Hourly Volumes										
Projected Volumes Without a Connector (Page E-30)										
Delay	15.7	6.5	23.7	30.3	26.6	23.7	36.0	26.4	10.1	18.0
LOS	B	A	C	C	C	C	D	C	B	B
v/c	0.74	0.14	0.13	0.69	0.19	0.26	0.58	0.24	0.83	-
Queue	76.4	17.8	13	74.6	18.7	29.9	50.3	30.2	39.9	-
Projected Volumes for Least Impact by Diverted Trips (Option 1) (Page E-73)										
Delay	11.5	6.5	23.2	29.1	26.2	23.3	35.3	25.8	8.5	16.9
LOS	B	A	C	C	C	C	D	C	B	B
v/c	0.62	0.14	0.12	0.67	0.19	0.26	0.58	0.24	0.76	-
Queue	51.5	17.8	13.0	74.6	18.7	29.9	50.3	30.2	32.1	-
Projected Volumes for Greatest Impact by Diverted Trips (Options 3 B/C and 4) (Page E-74)										
Delay	10.9	6.5	22.9	28.4	26.0	23.0	34.9	25.5	8.0	16.8
LOS	B	A	C	C	C	C	D	C	B	B
v/c	0.59	0.14	0.12	0.67	0.19	0.26	0.58	0.24	0.74	-
Queue	47.5	17.8	13.0	74.6	18.7	29.9	50.3	30.2	29.8	-

7.0 Summary, Conclusions and Recommendations

1. ***Study Objectives*** - The Department of Transportation and Infrastructure Renewal (NSTIR) commissioned the *Highway 103 - Proposed Boutiliers' Point Interchange Traffic Study* to provide an assessment of the traffic volume impacts of constructing an additional interchange on Highway 103 approximately halfway between the existing Tantallon and Hubbards interchanges.

   The primary objectives of this study are to complete the following tasks for each proposed interchange and connector road option:
   - Estimate 2013 and 2020 traffic flow impacts on existing infrastructure associated with the construction of a new Highway 103 interchange and Trunk 3 connector road.
   - Assess future roadway and intersection performance levels, including warrants for left and right turn lanes and signalization, based on traffic flow estimates with construction of an interchange.
   - Recommend functional design requirements for the proposed interchange, connector road, and Trunk 3 intersection, based on projected volumes.

2. ***Traffic Volume Trends*** - Since historical traffic volumes in the Study Area have generally increased by about 1.5% per year, an annual growth rate of 1.5% has been used to project 2013 and 2020 volmes. Since study specific volume data was obtained during June 2010, the following seasonal adjustment factors have been used to estimate 2010 AM and PM Design Hourly Volumes (DHVs):
   - Intersections west of Route 333 - AM peak hourly volumes were increased by 5% and PM peak hourly volumes were increased by 20%;
   - Route 333 / Trunk 3 intersection and Route 213 intersections - Since these intersections are more heavily travelled and have higher percentages of year round commuter trips, AM peak hourly volumes were not increased, however, PM peak hourly volumes were increased by 15%.

3. ***Impacts of Future Developments*** - Since a new interchange with a connector to Trunk 3 is likely to result in interest to the develop lands near the connector, existing development proposals and possible future development were reviewed. The current level of proposed development in the Study Area is low with 98 lots now in the Halifax Regional Municipality (HRM) system for approval.

   Development throughout the Study Area is controlled by one or more of the following - *St. Margaret's Bay Land Use Bylaw, Halifax Regional Subdivision Bylaw,* and *Halifax Regional Plan*. While these controls may permit limited development, any proposed significant development would require a public process and a Development Agreement.

   Given the extensive commercial development at and near the EXIT 5 interchange in Upper Tantallon and the absence of development at the EXIT 6 interchange in Hubbards, it is unlikely that commercial development would occur at the proposed interchange location during the next ten years.

4. ***License Plate Match Study*** - A license plate match study was completed on Thursday, June 10, 2010, to obtain trip characteristics required to determine projected volumes for the proposed connector and interchange ramp options. License plate numbers were recorded in one minute increments between 7:00 AM and 10:00 AM and 3:30 PM and 6:30 PM for all vehicles travelling in both directions. Plate numbers were recorded at the following locations:
   - S1 - Hubbards Interchange western ramps
   - S2 - Trunk 3 west of Connector Option 1 intersection
   - S3 - Trunk 3 between Connector Options 3B/3C and 4 intersections
   - S4 - Trunk 3 east of Connector Option 4 intersection
   - S5 - Route 213 just north of the Trunk 3 intersection.

5. ***Distance and Time Comparisons*** - If a new connector is constructed between Trunk 3 and Highway 103, drivers are expected to make decisions concerning travel patterns based on travel time and distance savings possible using a connector option compared to those for the existing roads. Also, drivers may be attracted to using a new connector to Highway 103 to take advantage of the comfort and increased safety of travelling on a four-lane divided highway.

   Travel distance and time comparisons between existing travel routes and routes using a new connector to Highway 103 which were determined for each Connector Option indicate:
   - Distance savings vary from 0.8 to 2.9 kilometers, with time savings of from 5.0 to 7.5 minutes per trip, for trips between the Trunk 3 intersection for each Connector Option and the EXIT 5 interchange at Upper Tantallon.
   - Travel distance comparisons vary from 1.9 kilometers longer to 0.5 kilometers shorter, with time savings of from 2.5 to 4.6 minutes per trip, for trips between the Trunk 3 intersection for each Connector Option and the EXIT 6 interchange.

6. ***Trip Assignment to Connector Options*** - Trips with origins or destinations in the Study Area were diverted from the existing road system to the proposed Connector Options based on traffic zone proximity to a connector intersection on Trunk 3 and evaluation of distance and time savings offered by each Connector Option. The assigned 2020 AM and PM peak hour volumes for connector and interchange ramps for each Connector Option are summarized in Table 7-1 on the next page. If the PM peak hour is assumed to represent 10% of the daily volume, the daily volumes on the Connector Options would vary between 2600 vehicles per day for Connector Option 1 and 3500 vehicles per day for Connector Options 3 B/C and 4.

7. ***Impact of Diverted Connector Volumes on Trunk 3 Volumes*** - While two-way traffic volumes on Trunk 3 east and west of a connector are expected to be reduced as a result of some existing Trunk 3 traffic diverting to a new connection to Highway 103 (Table 7-1), Trunk 3 traffic patterns near a connector intersection will change as some Trunk 3 traffic backtracks to take advantage of a connector.

8. ***Left Turn Lane Analysis*** - Left turn lane warrant analyses, completed for Trunk 3 intersections for all Connector Options, indicated that projected 2020 volumes will not warrant construction of a left turn lane on Trunk 3.

Table 7-1 - Projected 2020 Peak Hour Connector and Interchange Ramp Volumes								
Connector	Time of Day	Connector Road			Western Ramps of New Interchange		Eastern Ramps of New Interchange	
		NB	SB	2-Way	WB Access	EB Exit	EB Access	WB Exit
Option 1	AM Peak	95	60	155	25	5	70	55
	PM Peak	125	155	280	30	20	95	135
Option 2	AM Peak	100	60	160	20	5	80	55
	PM Peak	125	155	280	25	15	100	140
Option 3A	AM Peak	90	60	150	10	5	80	55
	PM Peak	110	150	260	10	10	100	140
Option 3B/C	AM Peak	130	65	195	15	5	115	60
	PM Peak	140	205	345	20	15	120	190
Option 4	AM Peak	130	65	195	15	5	115	60
	PM Peak	130	200	330	10	10	120	190

9. ***Right Turn Lane Analysis*** - Right turn lane warrant analyses, completed for Trunk 3 intersections for all Connector Options, indicated that projected 2020 volumes will not warrant construction of a right turn lane on Trunk 3.

10. ***Level of Performance of Study Area Intersections Without Connector*** - Level of service analysis completed at Study Area intersections indicated that the five STOP sign controlled intersections at the western end of the Study Area will provide good levels of performance for projected 2020 peak hour volumes without a proposed Highway 103 connector road. While the four traffic signal controlled eastern intersections are expected to provide satisfactory levels of performance during 2020 peak hours, several movements will require monitoring as v/c ratios of between 0.82 and 0.86 are predicted.

11. ***Level of Performance of Connector and Interchange Ramps*** - Level of service analyses completed for 2020 AM and PM assigned volumes for five connector options with intersections on Trunk 3 and four interchange locations on Highway 103, indicated the following:
    - Trunk 3 and interchange ramp intersections are expected to operate at level of service (LOS) 'A' for all scenarios that were evaluated;
    - Trunk 3 approaches to connector intersections are expected to operate at LOS 'A' for all options except Option 3 B/C.
    - Since the westbound Trunk 3 is a STOP approach for Option 3B/C, that approach is expected to operate at LOS 'B' for projected 2020 volumes;
    - Connector approaches with STOP sign control to Trunk 3 are expected to operate at LOS 'A' during AM peak periods and LOS 'B' during PM peak periods.
    - Since the connector approach to Trunk 3 is a through movement for Option 3 B/C, the connector approach is expected to operates at LOS "A' during both AM and PM peak hours.

12. ***Roundabout Analysis for Connector Option 3B/C and Option 4*** - Evaluation of assigned 2020 volumes at the Trunk 3 / Connector Option 3 B/C and Option 4 intersections as three approach roundabouts using ARCADY 7 software, indicated that all approaches would

operate at LOS 'A' during both AM and PM peak hours with average delays of about four seconds per vehicle.

13. ***Level of Performance Impacts on Trunk 3 @ Route 213 Intersection due to Diverted Trips*** - Volumes diverted to the EB access ramp at a new Highway 103 interchange will result in volume reductions for eastbound left turns from Trunk 3 to Route 213, and volumes diverted to the WB exit ramp will cause reductions in southbound right turns from Route 213 to Trunk 3.

    Level of service analysis indicated that volume reductions from trips diverted to a new Highway 103 interchange will provide significant improvements in v/c ratios and queues for the eastbound left turn from Trunk 3 to Route 213 during both AM and PM peak hours, as well as improvements at the southbound right turn from Route 213 to Trunk 3 during PM peak hours. The reduced volumes for these two busy intersection movements, and resultant improvements in v/c ratios, could possibly accommodate the equivalent of about ten years of the current volume growth for the turning movements.

14. ***Conclusions*** -
    A. Since proposed large residential developments in the Study area will require a public process and a Development Agreement, significant uncontrolled residential development is not expected to occur as a result of the proposed interchange.

    B. Given the extensive commercial development at and near the EXIT 5 interchange in Upper Tantallon and the absence of development at the EXIT 6 interchange in Hubbards, it is unlikely that commercial development will occur at the proposed interchange location during the next ten years.

    C. Since the majority of trips that will divert to a Connector Option will be to the east, Options 3 B/C and 4 will attract significantly more trips than Options 1, 2, and 3A.

    D. All Study Area intersections are expected to provide satisfactory levels of performance for projected 2020 volumes without construction of an additional Highway 103 interchange.

    E. All intersections at the eastern end of the Study Area will benefit from reduced volumes as trips are diverted to Highway 103 at the proposed connector. The Trunk 3 / Route 213 intersection would realize the most benefit from improved performance for critical movements, which could accommodate about ten years of the current volume growth.

15. ***Recommendations*** -
    A. While this study has provided projected 2020 peak hour volumes for each Option, analysis of annual time and travel distance savings for each option is required to provide additional information to support selection of the preferred option.

    B. The Highway 103 interchange should be designed as diamond interchange with single lane STOP controlled exit ramps and a two-lane overpass. While the need for left turn

lanes on the overpass is not likely to occur within the next 20 years, interchange ramp terminals should be designed to allow conversion to future roundabouts.

C. The connector should be a designed with two-lane travel lanes (and climbing lanes if required) with an 80 km/h design speed.

D. The connectors for Options 1, 2, or 3A should be designed with two approach lanes to Trunk 3 to provide for left and right turns at the STOP controlled intersections.

E. While a left turn lane will not be warranted on Trunk 3 for Options 1, 2, or 3A, a left turn lane should be provided on Trunk 3 since NSTIR has provided left turn lanes at most connector intersections constructed in recent years.

F. The Trunk 3 intersections for Option 3 B/C and Option 4 should be designed as three leg roundabouts.