

APPENDIX G

TRAFFIC STUDY



Draft Final Report

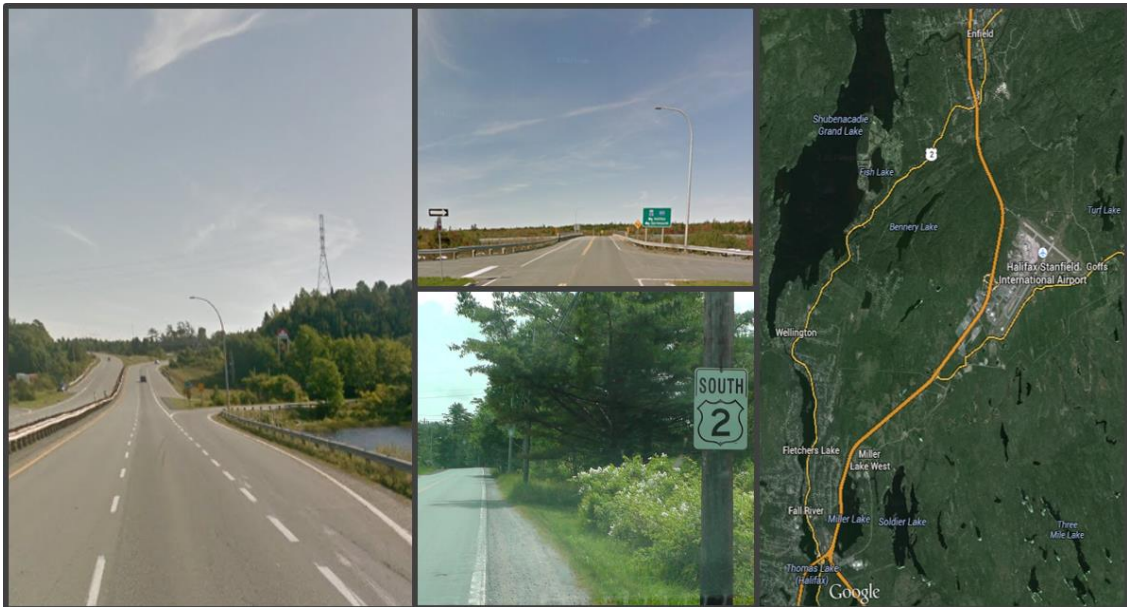
Aerotech Connector Traffic Study





Draft Final Report

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1 Introduction

This study was completed for the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) to assess the impacts associated with the completion of a proposed Aerotech Drive extension between Highway 102 at Exit 5A and Trunk Highway 2 in Wellington. The primary objectives of the study were to:

- Estimate the traffic flow impacts on existing infrastructure in the study area associated with the construction of the proposed Aerotech Connector Road;
- Assess future roadway and intersection performance levels, including warrants for left and right turning lanes, roundabouts and signalization based on traffic flow estimates with the completion of the proposed Aerotech Connector Road; and
- Determine the functional design requirements for the proposed Aerotech Connector Road and its intersections to handle the traffic at acceptable levels of service (i.e. typical roadway cross-section, intersection configurations, auxiliary lanes on intersection approaches, and types of traffic control).

This report has been organized as follows:

- Section 2 describes the study area and provides relevant background information;
- The study approach is presented in Section 3;
- Section 4 contains the results of the traffic forecasts;
- Section 5 identifies the traffic control and lane requirements for the new Aerotech Connector and Trunk 2 with and without the new road; and
- Geometric design issues to be addressed as the planning for the Aerotech Connector proceeds are discussed in Section 6.

2 Study Area and Background Information

The Fall River / Wellington area is predominantly comprised of residential land uses and is characterized as a bedroom community. Many commuters move to and from this community to the larger employment areas in Halifax and Dartmouth. The most convenient access point is currently via Exit 5, with an alternative and more circuitous route via Exit 7 (Enfield) to the north.

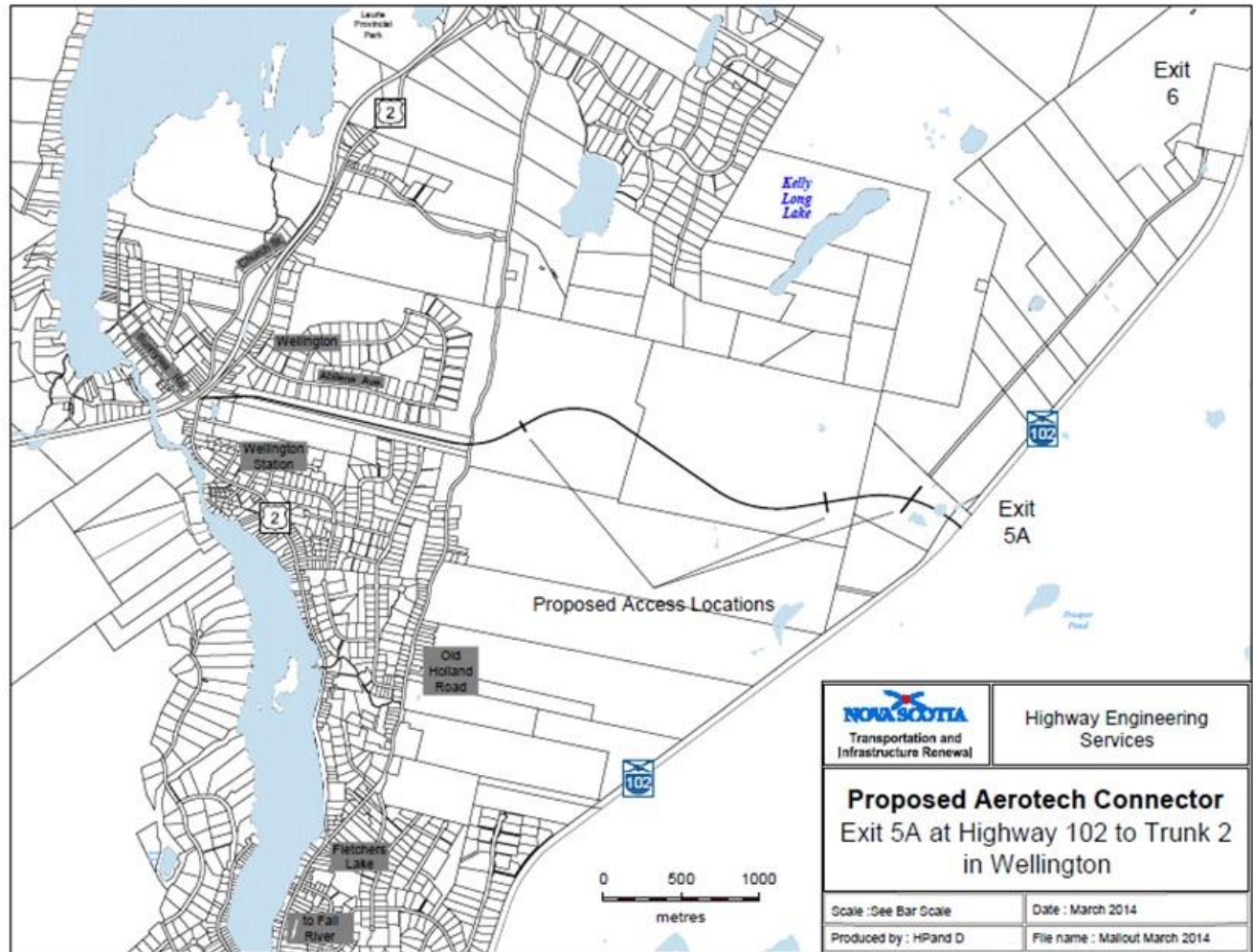


Figure 1: Aerotech Connector Location

Exit 5 provides a connection between Trunk 2 and both Highway 102 and Highway 118. As such, the Exit 5 interchange serves as one access point to two freeways, creating a “funnel” effect. The result is long queues and wait times along Trunk 2 in the morning peak period, and long queues on Highway 118 that extend beyond the off-ramp deceleration lane in the afternoon. Some of this congestion has been alleviated with the construction of a new roundabout at the northbound ramps at Exit 5.

The Exit 5 congestion is exacerbated by additional traffic that avoids the Bedford By-pass / Magazine Hill commuter route - due to its own congestion. The latter was evaluated in detail as part of the Highway 102 / 107 Corridor Study, completed in 2010. The study recommended a new Burnside Drive Connector Road be provided between the Burnside Industrial Park and the Highway 102 Exit 4C interchange. This new connection would divert traffic moving through the Exit 5 interchange, thus alleviating some of the existing congestion. However, given the continued and future expected residential and commercial development in the Fall River area, as documented in HRM's Fall River Vision Implementation Committee plan and the Regional Municipal Planning Strategy, any residual capacity at Exit 5 will be quickly consumed by the new study area growth. Therefore, there is still a need to provide additional and convenient access to the Highway 102 corridor and to do so in the vicinity of the future growth areas near Wellington.

The study area includes the following based on the traffic issues described above:

- Trunk 2 between Exits 5 and 7 including the following intersections:
 - » Exit 5 ramps for Highway 102 northbound lanes;
 - » Exit 5 ramps for Highway 102 southbound lanes;
 - » Fall River Road intersection;
 - » Holland Road intersection;
 - » Sunnylea Road intersection;
 - » Exit 7 ramps for Highway 102 southbound lanes; and
 - » Exit 7 ramps for Highway 102 northbound lanes;
- Highway 102 between Exits 5 and 7;
- Aerotech Drive at Exit 5a for Highway 102 including the intersections with the north and southbound ramps; and
- The new Aerotech Drive connector including the intersections with:
 - » Sky Boulevard;
 - » Accesses to properties along Aerotech Drive; and
 - » Trunk 2.

3 Study Approach

The study was divided into two phases. In the first phase, traffic volumes were forecasted for the study area with and without the Aerotech Connector Road for the present, 2020, and 2030 planning horizons. In the second phase, the traffic forecasts were used to:

- » Identify lane and traffic control requirements for the existing road network in the study area, with and without the new Aerotech Connector Road; and
- » Identify lane requirements and intersection configurations for the new Aerotech Connector Road.

The second phase also included a review of geometric design issues to be addressed in future planning phases. Table 3-1 lists specific tasks completed for each phase. More detailed descriptions of each task are provided in the remaining sections of the report.

Table 3-1: Study Tasks for Phases 1 and 2

Phase 1 Tasks	Phase 2 Tasks
<ul style="list-style-type: none"> - Review background documents - Design and conduct traffic data collection program - Estimate future land development - Develop traffic scenarios and volumes 	<ul style="list-style-type: none"> - Traffic signal and turning lane warrant analyses - Intersection performance analysis - Geometric design review

4 Traffic Forecasts

4.1 Analysis Scenarios

As defined by the study terms of reference, our proposal, and a change request by NSTIR¹, AM and PM peak hour traffic volumes were estimated for a total of six analysis scenarios. A summary of these traffic scenarios and the assumptions used to develop the traffic forecasts are provided in Table 4-1 below.

Table 4-1: Traffic Analysis Scenario Descriptions and Assumptions

Traffic Scenario	Year	Description
1. Existing Conditions	2014	Current AM & PM peak hour volumes based on: <ul style="list-style-type: none"> - Observed intersection counts (2012-2014) - Recent historical NSTIR/HRM traffic data
2. Midterm without Aerotech Dr.	2020	Forecast AM & PM peak hour volumes developed using: <ul style="list-style-type: none"> - Scenario 1 volumes, plus - A 1% per year growth factor (compounding), plus - Traffic diversion at Exit 5 associated with the Burnside Dr. connector, plus - Planned study area developments by 2020.
3. Midterm with Aerotech Dr.	2020	Forecast AM & PM peak hour volumes developed using: <ul style="list-style-type: none"> - Scenario 2 volumes, plus - Background traffic diversion to Aerotech Dr., plus - Induced Aerotech corridor developments by 2020.
4. Long term without Aerotech Dr.	2030	Forecast AM & PM peak hour volumes developed using: <ul style="list-style-type: none"> - Scenario 1 volumes, plus - A 1% per year growth factor (compounding), plus - Traffic diversion at Exit 5 associated with the Burnside Dr. connector, plus - Planned study area developments by 2030.
5. Long term with Aerotech Dr. and existing access to Fletcher Lake development	2030	Forecast AM & PM peak hour volumes developed using: <ul style="list-style-type: none"> - Scenario 4 volumes, plus - Background traffic diversion to Aerotech Dr., plus - Induced Aerotech corridor developments by 2030.
6. Long term with Aerotech Dr. and a second, new access to Fletcher Lake development	2030	Forecast AM & PM peak hour volumes developed using: <ul style="list-style-type: none"> - Scenario 5 volumes, plus - Fletcher Lake development traffic diverted from Fall River Rd to Sunnylea Rd via the new access.

4.2 Background Development Assumptions

The land development expected to occur in the Fall River area, regardless of whether the Aerotech Connector is built, was a key factor in forecasting traffic volumes for the analysis scenarios. Members of the project team held discussions with representatives from NSTIR, HRM's Business Park group

¹ Change Request #2, issued 20 Jan. 2015.

and HRM Planning to gain an understanding of the recent and current development patterns and trends in the study area. Through these discussions, assumptions were made regarding future development areas, their magnitude, and land use types as described in Table 4-2 and shown in Figure 2. Table 4-2 also includes the trips expected to be generated in 2020 and 2030 based on the Institute of Transportation Engineers (ITE) Trip Generation Report².

Table 4-2: Assumed Background Land Development and Trips Generated

Name	Land Area	Land Use	Trip Rate	2020 Total Trips ^A	2030 Total Trips ^B
1. Fletcher Lake/St. Andrews Lands	n/a	Residential (suburban) 1,000 units	ITE Code 210: 0.84 trips/unit ^C	417	835
2. Oaken Hills /Cameron Lands	n/a	Residential (suburban) 150 units	ITE Code 210: 1.0 trips/unit	75	150
3. Shwartzwald Lands	n/a	Residential (suburban) 115 units	ITE Code 210: 1.0 trips/unit	58	115
4. Inn on the Lake	n/a	Residential (serviced) 75 units	ITE Code 230: 0.52 trips/unit	20	39
5. Aerotech Business Park	50 acres	Industrial Park 50 acres	ITE Code 130: 8.53 trips/acre	213	427

A – All developments assumed to be 50% complete by the 2020 planning horizon.

B - All developments assumed to be 100% complete by the 2030 planning horizon.

C – Following ITE guidelines the regression formula was applied given the large scale of this development.

² The trip generation information was taken from the Institute of Transportation Engineers *Trip Generation, 9th Edition* document.

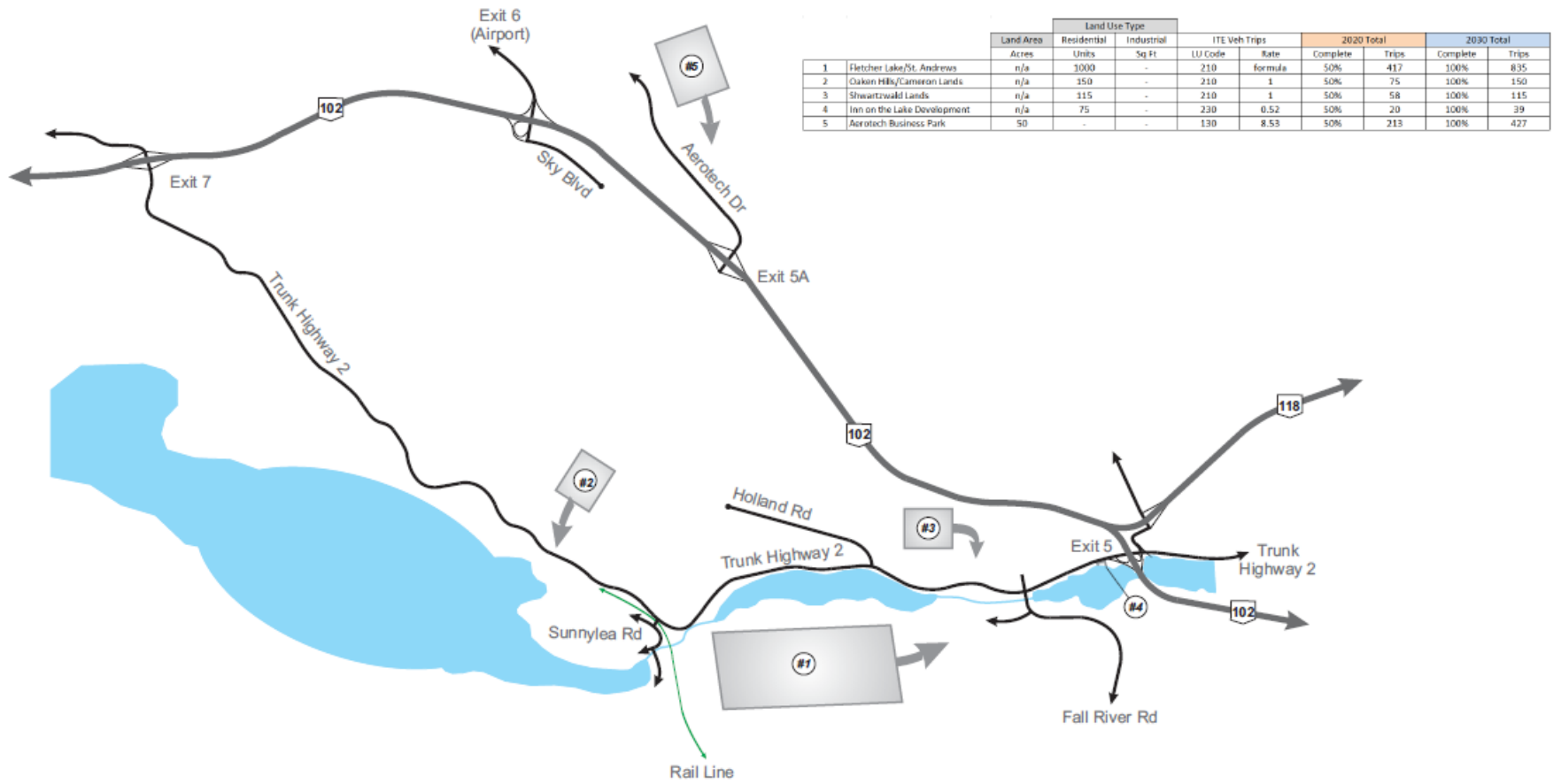
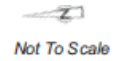


Figure 2: Planned Study Area Development Locations

Over time there is also expected to be a continuation of small infill developments occurring within the study area. This study incorporates the effects of these small-scale developments through a 1% per year traffic growth rate, in addition to the explicitly considered major developments shown in Figure 2.

Separate traffic distributions were used to assign the traffic generated by all of the large-scale developments identified in Table 4-2. The distribution percentages, presented in Table 4-3, were developed based on the proximity of existing population centres, employment nodes, shopping/tourist destinations as well as information gleaned from the existing traffic patterns and available background traffic studies.

Table 4-3: Planned Background Developments – Trip Distribution

Direction	To/From Gateways Via	Residential Land Use Percent Split	Industrial Park Percent Split
North	Highway 102	5%	20%
	Trunk 2 (Enfield)	2%	10%
South	Highway 102	10%	30%
	Trunk 2 (Waverley)	5%	5%
	Highway 118	50%	30%
East	Aerotech Dr.	5%	0%
West	Fall River Rd.	12%	5%
	Sunnylea Rd.	1%	0%
Internal to Study Area		10%	0%
TOTAL		100%	100%

It should be noted that the trip distribution also accounted for vehicle trips originating and ending within the study area (eg. a home-to-grocery store trip). For the purposes of this study, all internal trips have been assigned to/from the retail shopping centre located at the Trunk 2 / Fall River Road intersection.

4.3 Traffic Diversion Assumptions

4.3.1 Aerotech Drive Diversion Assumptions

The completion of the proposed Aerotech Drive extension will offer a new connection from the Fall River/Wellington area to Highway 102. Therefore, it is expected to have some impact on travel patterns within the study area, particularly during the weekday peak periods when congestions occurs at the Exit 5 (Fall River) interchange. A detailed review of the potential travel pattern changes was carried out and the resulting diversion of traffic to/from the new Aerotech Drive corridor is discussed in this section.

For this study, it is expected that a new interchange connection will influence travel behavior on two key sections of roadway in the study area:

- **Exit 5** (10% diversion during peak hours) – Traffic moving between Fall River and Exit 5 during the peak hours will divert away from Exit 5 to Exit 5A via the new Aerotech Drive extension.
- **Exit 7** (25% diversion throughout the day) - Traffic in the vicinity of Exit 7 moving to/from the Wellington area throughout the day (i.e. during peak and off-peak periods) will divert away from the Trunk 2 corridor to Exit 5A via Aerotech Drive.

Both diversion rates (i.e. 10% and 25%) generally suggest that only a minority of all drivers will choose to use the proposed Aerotech Drive extension. This is due in part to the capacity limitations of the existing roadway and intersection network within the study area as well as the travel distances of the existing route versus the proposed route.

4.3.2 Exit 5 / Burnside Drive Diversion Assumptions

Although located outside of the study area, the planned Burnside Drive extension from Akerley Boulevard to Duke Street in Bedford is expected to have a noticeable impact on the traffic volumes at the Highway 102 Exit 5 (Fall River) interchange. This is due to the fact that a number of drivers currently traveling between the Sackville/Bedford areas and the Halifax/Dartmouth areas currently choose to use Highway 118 as opposed to the more congested Bedford By-pass/Magazine Hill route. By using Highway 118 these drivers must travel through Exit 5 to get to their destination and this has an additive effect on the current congestion at Exit 5. The planned Burnside Drive extension is anticipated to be completed prior to the 2020 planning horizon and will offer a new convenient route for these drivers. Given the expected timeframe, the impacts on Exit 5 have been explicitly considered in the traffic volume forecasts for Scenarios 2 through 6.

Using the background traffic study material³, as well as field observations of vehicles moving through Exit 5, a 75% reduction in peak hour volumes is forecasted to occur at both of the Exit 5 ramp intersections. The specific travel movements through Exit 5 impacted by the expected diversion are described in the following table.

³ Traffic Study for Highway 107 Phase 1 – Burnside to Sackville. Genivar, February 2011.

Table 4-4: Exit 5 / Burnside Drive Diversion Assumptions

Travel Origins and Destinations	Route Description Through Exit 5	Traffic Diversion from Exit 5 to Planned Burnside Dr Extension
Sackville / Bedford to Halifax / Dartmouth	<ul style="list-style-type: none"> • Northbound (outbound) on Highway 102 to Exit 5; • Northbound through movement at Trunk 2/Exit 5 NB ramps intersection; • To southbound (inbound) Highway 118. 	75%
Halifax / Dartmouth to Sackville / Bedford	<ul style="list-style-type: none"> • Northbound (outbound) on Highway 118 to Exit 5; • Westbound right turn movement at Trunk 2/Exit 5 NB ramps intersection; • Northbound left turn at Trunk 2/Exit 5 SB ramps intersection; • To southbound (inbound) Highway 102. 	75%

The assumed weekday peak hour volumes diverted away from Exit 5 are shown in Figure 3.

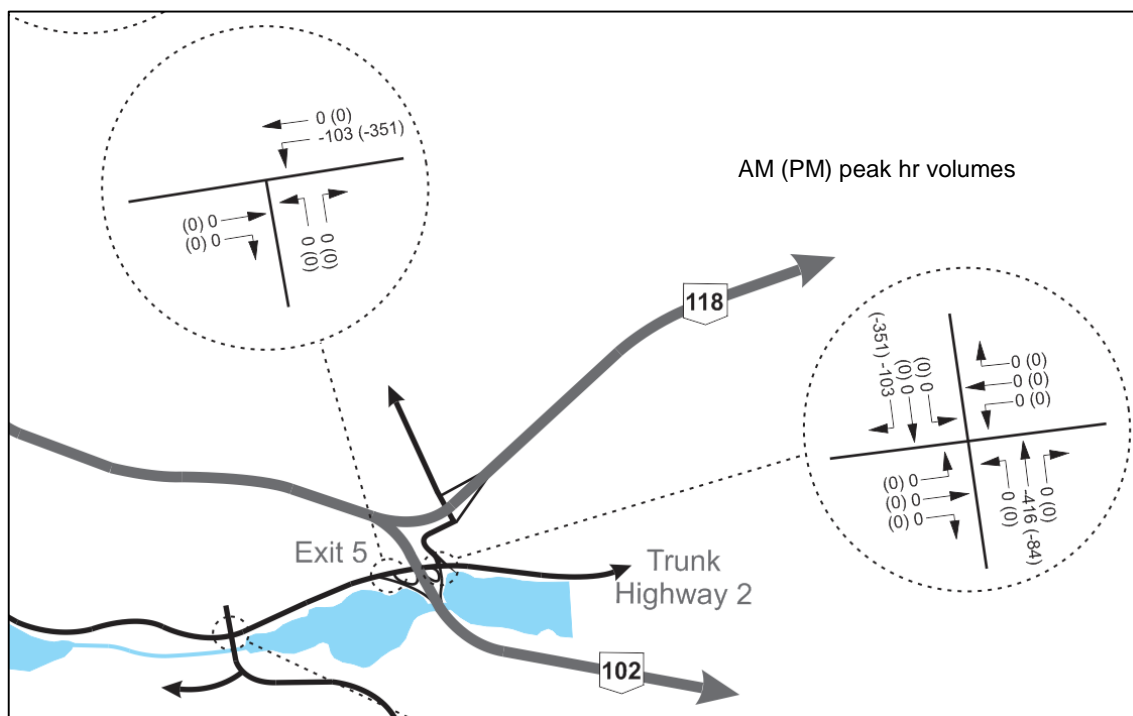


Figure 3: Exit 5 / Burnside Drive Peak Hour Traffic Diversion

Figures 1-7 and 1-8 in Appendix 1 show the percentage of existing traffic expected to divert to the new Aerotech Connector Road. Section 4.4 describes the additional traffic expected to be generated by new development along the road.

4.4 Aerotech Drive Induced Development Assumptions

The Aerotech Drive extension will connect Highway 102 (Exit 5A) to Trunk 2 in Wellington, likely in the vicinity of Sunnylea Road. This new section of roadway will offer access to large tracts of undeveloped land in the Wellington area as well as opportunities for new high-visibility lands immediately west of the Exit 5A interchange. Through discussions with representatives of NSTIR and HRM Planning, the project team prepared a set of likely development patterns that will result from the completion of the Aerotech Drive extension. Figure 4 provides an illustration of the assumed land use types that are expected to occur along this new corridor. The detailed development assumptions, including total trips generated in the study area, are provided in Table 4-5⁴.

Table 4-5: Development Induced by Aerotech Drive and Generated Trips during the PM Peak Hour

Name	Total Land Area	Expected Land Use	Trip Rate	2020 Total Trips ^B	2030 Total Trips ^B
Highway Commercial & Light Industrial	170 acres	Highway Commercial: 12,000 ft ²	ITE Code 945 ^C (rate = 97.47)	585 (50%)	1,170 (100%)
		Light Industrial: 170 acres	ITE Code 110 (rate = 7.26)	115 (10%)	288 (25%)
Residential ^A	300 acres	Residential (suburban) 150 units	ITE Code 210: 1.0 trip/unit	38 (25%)	75 (50%)
Residential ^A	550 acres	Residential (suburban) 275 units	ITE Code 210: 1.0 trip/unit	69 (25%)	138 (50%)

A – All residential development in this area is assumed to be unserviced at 0.5 units/acre and develops at an approximate rate of 25-30 units per year.

B – It was assumed that only a portion of the available lands would be developed by the two planning horizons. For example, 25% of all residential units will be complete by the 2020 planning horizon.

C – ITE Code 945 (Gas station and convenience market) was used as a representative trip rate for all potential highway commercial businesses. This rate is close to the average between a typical fast food restaurant and a Tim Horton's coffee business.

⁴ The trip generation information was taken from the Institute of Transportation Engineers *Trip Generation, 9th Edition* document.

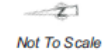


Figure 4: Development Assumed to be Induced by New Aerotech Drive Extension

Following Institute of Transportation Engineers (ITE) guidelines, further adjustments were made to the base trip generation rates shown in Table 4-5. For this study, it was considered appropriate to account for the impacts of pass-by trips and some internal shared trip making associated with the highway commercial land use types at Exit 5A. The trip rate adjustments included the following:

- Pass-by trip making for highway commercial developments:
 - All pass-by trips were explicitly included in the analysis process and assumed to originate from Highway 102. These trips were assigned through both Exit 5A ramp terminal intersections.
 - Using ITE guidelines, a 25% rate was applied to the AM peak hour and a 50% rate was applied to the PM peak hour.
- Internal trip making for mixed-use developments:
 - It was assumed that this phenomenon would occur between the highway commercial and light industrial land use types at Exit 5A. As such a 10% internal shared trip making factor was applied to the highway commercial total trips. It was not applied to the other land use types so as not to “double count” the impact of this phenomenon.

The distribution of the new trips generated by the induced development along the Aerotech Drive corridor followed the same process as discussed in Section 2. The distribution assumptions associated with the traffic generated by the residential, light industrial, and highway commercial developments shown in Figure 4 are presented in the following table.

Table 4-6: Induced Aerotech Drive Developments – Trip Distribution

Direction	To/From Gateways Via	Residential Percent Split	Light Industrial Percent Split	Hwy Commercial Percent Split
North	Highway 102	5%	20%	35%
	Trunk 2 (Enfield)	2%	5%	0%
South	Highway 102	10%	30%	25%
	Trunk 2 (Waverley)	5%	5%	0
	Highway 118	50%	30%	15%
East	Aerotech Dr.	5%	5%	22%
West	Fall River Rd.	12%	5%	2%
	Sunnylea Rd.	1%	0%	1%
Internal to Study Area		10%	0%	0%
TOTAL		100%	100%	100%

As with the traffic generated by the background development, the trip distribution also accounted for vehicle trips originating and ending within the study area (eg. a home-to-grocery store trip). For the purposes of this study, all internal trips have been assigned to/from the retail shopping centre located at the Trunk 2 / Fall River Road intersection.

4.5 Aerotech Connector Traffic Forecast Summary

Figures 1-1 through 1-8, attached as Appendix 1, present the peak hour traffic volume estimates that resulted from the analyses and assumptions described in the previous sections for each of the six scenarios plus additional figures showing the volumes of existing traffic expected to divert to the new road.

Figures 1-3, 1-5 and 1-6 contain the forecasted vehicle demand for the proposed Aerotech Drive extension for the 2020 and 2030 planning horizons, respectively. It is anticipated that the volumes will be significantly higher at the eastern end of the connector, in the vicinity of the Exit 5A interchange, compared to the western end near Trunk 2. The increased demand is associated with the expected highway commercial and light industrial development in close proximity to the interchange. Traffic volumes generated by these land uses will likely use the Exit 5A / Highway 102 corridor to move to/from the study area and therefore the volumes between Sky boulevard and the Exit 5A ramps are anticipated to be highest.

The forecast traffic volumes along the remainder of the proposed Aerotech Drive corridor (i.e. between Sky Boulevard and Trunk Highway 2) will be comprised of traffic generated by the following:

- Assumed residential development occurring on lands adjacent to the corridor; and
- Traffic in the study area diverting from other routes due to the convenience of the new Aerotech Drive roadway (see Figures 1-7 and 1-8 in Appendix 1).

If we add these two separate sets of volumes together we obtain an estimate of the peak hour vehicle demand between Sky Boulevard and Trunk Highway 2, or the “through” trips on the new roadway. These new corridor trips have been summarized in Table 4-7.

Table 4-7: Forecast Aerotech Drive “Through” Trips (vph)

Scenario	AM Peak Hour Two-way Volume	PM Peak Hour Two-way Volume
Scenario 3 – Midterm 2020	468 vph	840 vph
Scenario 5 – Long Term 2030 without a new access to Fletcher Lake	634 vph	1,138 vph
Scenario 6 – Long Term 3030 with a new access to Fletcher Lake	800 vph	1,374 vph

The results in Table 4-7 suggest that a two-lane, two-way roadway will have sufficient capacity to accommodate the forecast vehicle demand on Aerotech Drive between Trunk Highway 2 and the proposed Sky Boulevard intersection. Impacts on traffic control, lane requirements, and operations are identified in the following section.

5 Future Roadway Infrastructure Needs

5.1 Overview

Once the future year AM and PM peak hour traffic volumes were established for Scenarios 2 through 6, a traffic operational analysis was completed for the study area intersections. The purpose of this step was to identify the roadway lane configurations and traffic control required to adequately accommodate the forecasted volumes. The specific analyses undertaken included:

- The Transportation Association of Canada traffic signal warrant procedure applied to the stop-controlled intersections to identify the need for upgrades to either traffic signals or a roundabout;
- Auxiliary turn lane warrant procedures applied to the stop-controlled intersections to identify the need for left and right turning lanes; and
- Intersection capacity analyses at the all of the study area intersections to determine additional lanes necessary to accommodate demand.

Through discussions with the NSTIR it was understood that a connection location for the proposed Aerotech Connector was likely to occur in the vicinity of the Trunk 2 / Sunnylea Road intersection. It was also determined that there are topographical and roadway geometry challenges that exist in this area – the details of which are further discussed in Section 6.1 of this report. Based on the project team discussions, intersection planning best practices, and the constraints reviewed, it was determined that the following two intersection options would be evaluated:

- A combination of two off-set T-intersections that would include the existing Trunk 2 / Sunnylea Road intersection (#5a) and a new Trunk 2 / Aerotech Drive intersection (#5b) located north of Sunnylea Road.
- A 4-leg intersection that would have the new Aerotech Drive connect opposite the existing Sunnylea Road (#5c).

The analysis results for the study area, including the two options for the Aerotech Connector/Trunk 2 intersection, are discussed in the sections below. Figures showing the required lane configurations and traffic control for each of the six analysis scenarios are presented in Appendix 2.

5.2 Warrant Analyses

5.2.1 Traffic Signal / Roundabout Warrant

Traffic signal warrant analyses were completed at the study area intersections for all six traffic volume scenarios to identify the need for traffic control upgrades from stop-control to either traffic signal or roundabout control. The analysis process followed the Transportation Association of Canada (TAC) signal warrant methodology which is widely used by road agencies across Canada, including the NSTIR. The TAC procedure uses a set of average intersection volumes measured over the six highest hours of a typical day. The results are presented as priority points to indicate whether a traffic signal is warranted. When the number of priority points exceeds 100, the traffic signal warrant is met. The

detailed signal warrant analysis reports are contained in Appendix 5 and a summary of the results is provided in Table 5-1.

Table 5-1: Signal Warrant Analysis Results for Study Area Intersections

Intersection	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	Existing 2014	No Aerotech 2020	Aerotech 2020	No Aerotech 2030	Aerotech 2030	Aerotech 2030
1. Trunk 2 Exit 5 NB Ramps	<i>existing modern roundabout</i>					
2. Trunk 2 Exit 5 SB Ramps	167	124	85	188	135	117
3. Trunk 2 / Fall River Rd	<i>existing signalization</i>					
4. Trunk 2 / Holland Rd	28	34	41	45	54	53
5a. Trunk 2 / Sunnylea (3-leg) ^A	15	19	38	25	51	93
5b. Trunk 2 / Aerotech (3-leg) ^A			91		137	173
5c. Trunk 2 / Sunnylea / Aerotech (4-leg)			102		164	238
6. Trunk 2 Exit 7 SB Ramps	36	41	32	51	38	39
7. Trunk 2 Exit 7 NB Ramps	78	91	65	112	77	78
8. Aerotech Exit 5A NB Ramps	11	16	196	23	422	478
9. Aerotech Exit 5A SB Ramps	4	8	200	14	461	502
10. Aerotech / Sky Blvd			115		339	394

A - Both 5a. And 5b. intersections work together as an off-set intersection option, under Scenarios 3 and 5.

	- priority points are approaching the 100 point threshold.
	- priority points exceed the 100 point threshold.
	- intersection does not exist under this scenario.

The signal warrant analysis indicated that stop-controlled intersections at both ends of the proposed Aerotech Connector will be inadequate to accommodate the forecast volumes by the 2030 planning horizon (i.e. Scenarios 5 and 6). Following NSTIR policy, under circumstances where the priority points exceeded 100, a roundabout was first considered and evaluated in the remaining assessments. Roundabouts are also shown at these two locations in Appendix 2.

5.2.2 Auxiliary Lane Warrants

The provision of exclusive left or right turn auxiliary lanes at intersections can improve traffic operations and reduce road safety risk. These benefits can be measured in the form of reduced travel delay for drivers traversing the intersection or minimizing conflicts between vehicles. Following NSTIR practices, the following turn lane warrant methodologies were applied to this study:

- *Left turn lanes:* the Ontario Ministry of Transportation's (MTO) procedure.
- *Right turn lanes:* The Ohio Department of Transportation's (ODOT) procedure.

These warrant procedures were applied to the unsignalized intersections in the study area for Scenarios 2 through 6. The required auxiliary turn lanes identified by the analysis are shown in the Figures in Appendix 2 and detailed calculations are provided in Appendix 6.

5.3 Intersection Operational Analysis

5.3.1 Overview

An intersection capacity analysis was conducted for each study area intersection using the forecasted peak hour traffic volumes for Scenarios 1 through 6. The analysis followed the NSTIR traffic impact study guidelines. The software tools applied included Trafficware's Synchro 8 for signalized and stop-controlled intersections and TRL's Arcady 8 for the analysis of the roundabout intersections.

Documentation of the intersection analysis is contained the Appendices as follows:

- Appendix 1 – Existing and forecast peak hour traffic volumes;
- Appendix 2 – Lane configurations and traffic control;
- Appendix 3 – Summary of the operational performance of each intersection critical movement; and
- Appendix 4 – Detailed capacity calculation reports for each intersection.

5.3.2 Trunk 2 Connection Options

A sensitivity analysis was undertaken to provide a better understanding of the traffic operational performance of the two options for connecting the proposed Aerotech Connector road to Trunk 2, i.e. a t-intersection north of Sunnylea Rd, or a 4-leg intersection with Sunnylea Rd. The analysis results indicate that both intersection configurations can accommodate the forecast peak hour traffic volumes at acceptable levels of service and that there is residual capacity available for both options well beyond the 2030 planning horizon. Therefore, the geometric design and infrastructure cost assessments will play an important role in selecting one option over another. Specific geometric design considerations for both intersection configurations are further discussed in Section 6.2.

5.3.3 Summary of Intersection Upgrades

Table 5-2 contains a summary of intersection upgrades required to accommodate traffic in 2030 with and without the Aerotech Connector Road. It is based on the results of the analyses described in this Section. These intersection upgrades are also illustrated in figures contained in Appendix 2.

Table 5-2: 2030 Horizon Intersection Upgrades

Intersection	2030 Long Term without Aerotech (Scenario 4)	2030 Long Term with Aerotech and existing access to Fletcher Lake (Scenario 5)	2030 Long Term with Aerotech and new access to Fletcher Lake (Scenario 6)
1. Trunk 2 Exit 5 NB Ramps	<ul style="list-style-type: none"> A second westbound entry lane will be required to accommodate the PM Peak period traffic, in addition to a 4-lane cross-section between the two ramp terminal intersections. 	<ul style="list-style-type: none"> The completion of Aerotech will minimize queues and delays relative to Scenario 4. The existing lane configuration can accommodate forecast volumes although with lengthy queues on the westbound approach during the PM peak period. 	<ul style="list-style-type: none"> The addition of a new north access to the Fletcher Lake development area will divert some traffic away from Exit 5 and the existing roundabout lane will operate with acceptable levels of service and delay times.
2. Trunk 2 Exit 5 SB Ramps	<ul style="list-style-type: none"> The warrant for signals/roundabout is met and will require two through lanes entering the roundabout in the north and south directions. 	<ul style="list-style-type: none"> The completion of Aerotech will allow for a deferred implementation of signals/roundabout, and will only require localized widening and two through lanes entering in the northbound direction. 	<ul style="list-style-type: none"> With reduced volumes relative to Scenario 5, only single through lanes are required.
3. Trunk 2 / Fall River Rd	<ul style="list-style-type: none"> Significant intersection upgrades are required including a 5-lane cross-section along Trunk 2 (south to Exit 5) and a 4-lane cross-section on Fall River Road. 	<ul style="list-style-type: none"> Significant intersection upgrades are required including a 3-lane cross-section on Trunk 2 and a 4-lane cross-section on Fall River Road. 	<ul style="list-style-type: none"> Although the volumes are reduced relative to Scenario 5, a similar intersection lane configuration is required.
4. Trunk 2 / Holland Rd	<ul style="list-style-type: none"> The intersection can operate under stop-control with a new northbound right turn lane. 	<ul style="list-style-type: none"> The increase in volumes on Trunk 2 requires both northbound right turn and southbound left turn lanes. 	<ul style="list-style-type: none"> The Scenario 5 intersection traffic control and lane configuration is required to accommodate the forecast volumes.
5a. Trunk 2 / Sunnylea (3-leg)	<ul style="list-style-type: none"> This t-intersection can operate under stop-control with a new northbound left turn lane. 	<ul style="list-style-type: none"> This t-intersection can operate under stop-control with a new northbound left turn lane. 	<ul style="list-style-type: none"> The Scenario 5 intersection traffic control and lane configuration is required to accommodate the forecast volumes.
5b. Trunk 2 / Aerotech (3-leg)	<ul style="list-style-type: none"> This intersection does not exist under this Scenario. 	<ul style="list-style-type: none"> The warrant for signals/roundabout is met at this new intersection and can operate as a single lane roundabout. 	<ul style="list-style-type: none"> The warrant for signals/roundabout is met at this new intersection and can operate as a single lane roundabout.
5c. Trunk 2 / Sunnylea / Aerotech (4-leg)	<ul style="list-style-type: none"> This intersection does not exist under this Scenario. 	<ul style="list-style-type: none"> The warrant for signals/roundabout is met at this new intersection and can operate as a single lane roundabout. 	<ul style="list-style-type: none"> Despite an increase in volumes relative to Scenario 5, a single lane roundabout can accommodate the demand.
6. Trunk 2 Exit 7 SB Ramps	<ul style="list-style-type: none"> No changes are required and the existing lane configuration/ traffic control can remain. 	<ul style="list-style-type: none"> No changes are required and the existing lane configuration/ traffic control can remain. 	<ul style="list-style-type: none"> No changes are required and the existing lane configuration/ traffic control can remain.

Intersection	2030 Long Term without Aerotech (Scenario 4)	2030 Long Term with Aerotech and existing access to Fletcher Lake (Scenario 5)	2030 Long Term with Aerotech and new access to Fletcher Lake (Scenario 6)
7. Trunk 2 Exit 7 NB Ramps	<ul style="list-style-type: none"> The warrant for signals /roundabout is met and can operate as a single lane roundabout. 	<ul style="list-style-type: none"> The slight reduction in volume on Trunk 2 reduces demand and the intersection can remain as stop-controlled. 	<ul style="list-style-type: none"> The Scenario 5 intersection traffic control and lane configuration are required to accommodate the forecast volumes.
8. Aerotech Exit 5A NB Ramps	<ul style="list-style-type: none"> The existing stop-controlled intersection can remain. 	<ul style="list-style-type: none"> The warrant for signals/roundabout is met and a roundabout will require widening for two through lanes entering in the westbound direction. 	<ul style="list-style-type: none"> Despite an increase in volumes relative to Scenario 5, the same roundabout lane configuration can accommodate the demand.
9 Aerotech Exit 5A SB Ramps	<ul style="list-style-type: none"> The existing stop-controlled intersection can remain. 	<ul style="list-style-type: none"> The warrant for signals/roundabout is met and a roundabout with a two-lane westbound entry plus right turn slip lanes can accommodate the demand. 	<ul style="list-style-type: none"> The increase in volumes relative to Scenario 5 increases queue lengths and requires a two-lane southbound entry.
10 Aerotech / Sky Blvd	<ul style="list-style-type: none"> This intersection does not exist under this Scenario. 	<ul style="list-style-type: none"> The warrant for signals/roundabout is met at this new intersection and can operate as a single lane roundabout. 	<ul style="list-style-type: none"> The increase in volumes relative to Scenario 5 requires a two-lane southbound entry and a 4-lane cross-section between Sky Boulevard and Exit 5A.

5.4 Aerotech Connector Road Climbing Lane Review

A warrant review was completed to assess the need for climbing lanes along the Aerotech Connector Road. The Transportation Association of Canada (TAC) does not specifically have a climbing lane warrant, although it does reference an example warrant provided by AASHTO. A search of warrants across Canada resulted in two published warrants, from British Columbia Ministry of Transportation and Infrastructure (BCMoTI) and Alberta Transportation. These two warrants were very similar, and apparently developed using the AASHTO warrant as a template. Since the BC and AASHTO warrants were the closest in terms of criteria, the BCMoTI warrant was chosen to represent an NSTIR roadway. All warrants suggest that a heavy vehicle with a power to weight ratio of 180 g/W is the best representation of the heavy vehicle fleet.

The results of the warrant analysis indicate that climbing lanes will be required at both uphill locations based on the 2030 volume estimates in Scenarios 5 and 6. The extent of these climbing lanes will need to be developed at the detailed design stage.

Table 5-3: Climbing Lane Warrant Analysis

Criteria		Measurement	Criteria Met
Speed Reduction \geq 15km/h	For 180 g/W heavy vehicle:	First uphill location:	Yes
	<ul style="list-style-type: none"> • 2% Grade \geq 550m • 3% Grade \geq 340m • 4% Grade \geq 260m • 5% Grade \geq 210m • 6% Grade \geq 160m • 7% Grade \geq 120m 	<ul style="list-style-type: none"> • > 2% Grade > 850m • > 4% Grade > 710m • 6% Grade > 440m Second uphill location: <ul style="list-style-type: none"> • > 2% Grade > 1300m • > 4% Grade > 845m • 6% Grade > 500m 	Yes
Uphill Volume \geq 200 veh		419 to 618 veh (2030 AM) 403 to 546 veh (2030 PM)	Yes Yes
Uphill Heavy Vehicle Volume \geq 20 veh		21 to 31 veh (2030 AM) 20 to 27 veh (2030 PM)	Yes Yes
Warrant Met:			Yes

6 Geometric Design Considerations

This section identifies geometric design considerations for the new Aerotech Connector Road that will need to be addressed in future planning and design phases.

6.1 Existing Trunk 2 and Sunnylea Rd Intersection

The existing intersection of Trunk 2 and Sunnylea Rd is located in a posted 70 km/h zone on the outside of a 160m radius curve in Wellington, NS. This relatively short roadway connecting Trunk 2 with Church St., is approximately 55 m long, and has an at grade crossing with a CN Rail line. There are currently single lane approaches in all directions for this stop controlled intersection.

One of the concerns at this location is the horizontal alignment of Trunk 2. Using a maximum superelevation ratio of 0.06m/m, a 160m radius is adequate for a 60km/h roadway according to current design guidelines. Since this segment of roadway is currently posted at 70km/h, it does not meet current geometric design guidelines. Furthermore, since Trunk 2 is classified as a Major Collector Class E, normally the design speed would be in the 80 to 90km/h range.

The possible relocation of Sunnylea further north along Trunk 2 was assessed during a recent field reconnaissance by the study team. As a result of significant grade differences between the CN Rail tracks and the parallel roadways on either side, and the relatively short distance between these roadways, it would be difficult to relocate this short segment of Sunnylea Rd further north without significant regrading of both parallel roadways. For this reason, Sunnylea will likely remain at its current location.



Figure 5: Sunnylea Rd Looking North along CN Tracks

6.2 Aerotech Intersection with Trunk Highway 2

There are two potential configurations for connecting the proposed Aerotech Drive with Trunk 2. The first is to align the new connector with Sunnylea and provide a four legged roundabout at that location. The other alternative is to bring the new connector to a tee with Trunk 2 offset to the north from Sunnylea. This new tee connection could either be signalized or a three legged roundabout. Each of these options is explored in Table 6-1. For all options, advanced signage and lighting would help to promote safety.

Table 6-1: Review of Options at Trunk 2

Criteria	Four Legged Roundabout	Offset Tee Intersections on Trunk Highway 2	
		Roundabout at Aerotech	Signals at Aerotech
Horizontal Geometry	A large diameter roundabout would likely be required due to the low angle approaches between Sunnylea and Trunk 2, and between the new connector and Trunk 2. As a result, some of the approach geometry may require adjustments and mitigation of the design speeds. Speed reduction techniques in advance of the intersection would need to be considered on the Trunk 2 approaches.	A large diameter roundabout would likely be required due to the likely offset of the circle given the proposed intersection's proximity to the CN rails. As a result, some of the approach geometry may require adjustments and mitigation of the design speeds. Speed reduction techniques in advance of the intersection would need to be considered on the Trunk 2 approaches.	A signalized intersection at the new connector and Trunk 2 would likely require little to no realignment along the Trunk 2 approaches. This option is expected to offer the best approach sight distance to the intersection.
Vertical Geometry	The southbound approach along Trunk 2 is on a crest curve. Maintaining appropriate intersection sightlines would need to be considered.	There is very little to no vertical curves on Trunk 2 from the north which would impede sightlines. There is a vertical crest to the south which could be mitigated with adequate grading of either intersection. Raising the existing roadway would also help accommodate the approach grade from the new connector.	
Right of Way Requirements	For this option, at least two residences will likely be impacted to provide acceptable approach geometry.	For this option, at least two residences would likely be impacted to provide acceptable approach geometry. Additional ROW may also be required to provide for the left turn lane to Sunnylea Road.	
Other road users	Sidewalks and additional bike lanes are not currently being proposed. As a result, pedestrians would use the roadway shoulders and cyclists would share use with the vehicle lanes.		
Additional Lane Requirements	No additional turning lanes would be required for this option.	The traffic analysis has shown that the addition of left turn lane would be required from Trunk 2 to Sunnylea Rd for both Scenarios 5 and 6. It may be difficult to provide this additional lane given the geometry of Trunk 2 at this location. All the approaches for both options would be single lane.	
Queues and Vehicle Storage	Queuing along Trunk 2 and the new connector is not expected to be an issue with this option. Careful placement of the roundabout would need to be considered for adequate storage along Sunnylea given its proximity with the CN rails.	There would likely be adequate room for vehicle storage between the offset tee intersections. Queuing along Trunk 2 and the new connector is not expected to be an issue with this option for both Scenarios 5 and 6. The side chosen for the left turn widening would need to be considered to provide adequate storage on the Sunnylea approach given its proximity with the CN rails, especially for Scenario 6.	

6.3 Aerotech Intersection with Sky Boulevard

The current proposed location of the new connector intersection with Sky Boulevard may pose some challenges regarding turning sight distances caused by the horizontal geometry. For this reason, a stop controlled intersection is not considered feasible at this location.

Given the proposed design speed of 90km/h for the new connector, the proposed roundabout could be accommodated, provided that speed mitigation techniques are considered on the approaches. Advanced signage and lighting of the intersection would also help to promote safety.

6.4 Aerotech Access Roads

There are two large properties situated along the proposed new connector corridor which would require access to the connector for potential development opportunities. The two locations identified are at or near stations 62+000 and 64+170 on the provided alignment. The turning sight distances at 64+170 are adequate for 90 km/h as they exceed, or are at the upper end of the design domain of the TAC design guidelines. The one at station 62+000 is adequate for vertical geometry, however the horizontal geometry appears to be at the lower end of the design domain. While this would not be enough to prevent an access at this location, it would be desirable that the horizontal sight distances be increased by lengthening the horizontal tangent as much as practicable.

7 Findings and Conclusions

7.1 Conclusions

The following conclusions were developed based on the analysis results:

- The completion of the proposed Aerotech Connector road will have a noticeable impact on changes in travel behaviour and route choice in the Fall River / Wellington area. It has been determined through the study analyses that a two-lane, two-way cross-section, with truck climbing lanes can accommodate the forecast traffic demand out to the 2030 planning horizon.
- The proposed Aerotech Connector road will offer new opportunities by providing access to undeveloped lands that are in close proximity to the Highway 102 corridor (via the Exit 5A interchange). If an investment is made in this new roadway additional planning reviews should be undertaken in the Fall River / Wellington area to rationalize the location of all future residential development so as to minimize the amount of additional roadway infrastructure that would be required elsewhere in the study area.
- By the 2030 planning horizon a number of significant intersection improvements are required at the Trunk 2 / Fall River Road intersection with or without the proposed Aerotech Connector. This is a result of the future traffic volumes generated by the expected residential development west of Fletchers Lake, along the Fall River Road corridor.
- If the proposed Aerotech Connector road is not built by the 2030 horizon and residential development continues to occur as expected along Fall River Road (i.e. west of Fletcher Lake) then Trunk Highway 2 will require a 5-lane cross-section from Fall River Road to the Exit 5 interchange. Widening Trunk 2 would require a significant investment and encroach upon numerous existing commercial properties.
- The following geometric considerations will need to be addressed in future planning and design phases of the new road:
 - Provision of climbing lanes along the Aerotech Connector Road;
 - Locating and configuring the intersection between the Aerotech Connector Road and Trunk 2 given that the location of Sunnylea Road remains the same;
 - Providing adequate storage on Sunnylea Road given its proximity to the CN rails;
 - Selecting an intersection configuration and traffic control for the Aerotech Connector Road and Trunk 2 intersection that provides adequate intersection sightlines and approach geometry;
 - Provision of horizontal sight distance on the new Aerotech Connector Road for the property access near station 62+000.

Appendices of Traffic Study not included
(To obtain a copy of the Appendices, please
contact TIR)