

REPORT

Traffic Study Report Argyle Street Bridge

Village of Caledonia, Haldimand County, Ontario

Presented to:

Tanya Cross, P. Eng.
Senior Project Engineer

Ministry of Transportation
Southwestern Region
Planning and Design Section
659 Exeter Road, 3rd Floor
London, Ontario N6E 1L3

Report No. 121040.00

October 16, 2006



TABLE OF CONTENTS

1.0	STUDY BACKGROUND.....	1
2.0	STUDY OBJECTIVES.....	2
3.0	SAFETY ASSESSMENT OF EXISTING CONDITIONS	3
3.1	INTRODUCTION	3
3.2	COLLISIONS ON ARGYLE STREET.....	3
3.3	COLLISIONS ON THE ARGYLE STREET BRIDGE.....	5
3.4	COLLISIONS ON THE HIGHWAY 6 CALEDONIA BY-PASS.....	8
4.0	LONG-TERM INFRASTRUCTURE NEEDS.....	10
5.0	OPERATIONAL ASSESSMENT OF BASELINE CONDITIONS.....	12
5.1	STUDY AREA	12
5.2	BASELINE TRAFFIC VOLUMES	13
5.3	LOS ANALYSIS FOR 'FUTURE DO-NOTHING' SCENARIO.....	14
6.0	STAGING DETOURS OPTIONS CONSIDERED	17
7.0	SCREENING OF DETOUR OPTIONS.....	18
8.0	OPERATIONAL ASSESSMENT OF SCREENED DETOUR OPTIONS.....	19
8.1	ALTERNATIVE A – WIDENING EITHER SIDE OF EXISTING BRIDGE	19
8.2	ALTERNATIVE 1 – VEHICLE DETOUR VIA CALEDONIA 6 BY-PASS	19
	8.2.1 Forecast Traffic Volumes	19
	8.2.2 Level of Service Analysis	20
8.3	ALTERNATIVES 2 AND 2B - TEMPORARY BRIDGE 100 METRES TO THE WEST	24
8.4	ALTERNATIVES 4 & 4B - 'S-DETOUR' TO THE WEST OF THE EXISTING BRIDGE	28
8.5	ALTERNATIVE 5 - MAINTAIN ONE LANE OF TRAFFIC AT EXISTING BRIDGE	29
	8.5.1 Detail Analysis of Alternative 5D – Level of Service Findings	30
	8.5.2 Detail Analysis of Alternative 5D – Emergency Service Provisions	35
9.0	THE PREFERRED OPTION.....	38
9.1	RELATIVE MERIT OF DETOUR OPTIONS & SELECTION OF THE PREFERRED OPTION	38
9.2	PEDESTRIAN & CYCLIST PROVISIONS.....	41
9.3	TEMPORARY SIGNING PLAN	42
9.4	IMPACT OF THE PREFERRED OPTION.....	44
10.0	CONCLUSIONS AND RECOMMENDATIONS.....	47



LIST OF APPENDICES

Appendix A Collision Analysis	A-1
Appendix B Baseline Conditions	B-1
Appendix C Operational Analysis of 'Future Do-Nothing' Scenario	C-1
Appendix D Operational Analysis of Alternative 1	D-1
Appendix E Operational Analysis of Alternative 2 & 2B	E-1
Appendix F Operational Analysis of Alternative 5D	F-1

LIST OF FIGURES

Figure 3.1 Argyle Street Bridge.....	6
Figure 4.1 Proposed Three-Lane Bridge Configuration	11
Figure 5.1 Study Area.....	12
Figure 7.1 Possible Detour Routes Within Caledonia	18
Figure 8.1 Proposed System for Emergency Service Vehicle Traffic Signal Pre-emption.....	37
Figure 9.1 Proposed Temporary Signing Plan.....	43

LIST OF TABLES

Table 3.1 Summary of Argyle Street Collisions (2000 to 2002)	4
Table 3.2 Expected vs. Actual Collisions at Signalized Intersections on Argyle Street.....	5
Table 3.3 Comparison of Actual and Expected Collisions on the Argyle Street Bridge	7
Table 3.4 Collisions on the Caledonia By-pass (1995 to 1999).....	8
Table 3.5 Caledonia By-pass: Expected Versus Actual Collisions.....	9
Table 4.1 Existing and Future Traffic Volumes on the Argyle Street Bridge	10
Table 5.1 Intersection Operations – 'Future Do-Nothing' Scenario, Unsignalized Intersections.....	15
Table 5.2 Warrant Analysis – 'Future Do-Nothing' Scenario	15
Table 5.3 Intersection Operations – 'Future Do-Nothing' Scenario, Signalized Intersections.....	16
Table 8.1 Intersection Operations – Alternative 1, Unsignalized Intersections	21
Table 8.2 Warrant Analysis – Alternative 1	22
Table 8.3 Intersection Operations – Alternative 1, Highway 6 By-pass / Greens Road West.....	22
Table 8.4 Intersection Operations – Alternative 1, Highway 6 By-pass / Argyle Street South	23
Table 8.5 Required Storage Lengths – Alternative 1, Highway 6 By-pass / Argyle Street South – WB LT.....	23
Table 8.6 Intersection Operations – Alternative 1, Signalized Intersections	24
Table 8.7 Intersection Operations – Alternative 1, Highway 6 / Argyle Street N / Greens Road E	24
Table 8.8 Intersection Operations – Alternatives 2 & 2B, Signalized Intersections.....	25
Table 8.9 Required Storage Lengths – Alternatives 2 & 2B, EB LT at Caithness Street / Argyle Street.....	25
Table 8.10 Developments Adjacent to Parking Lot, Just West of Argyle Street	26
Table 8.11 Assumed Vehicle Trips Associated with Existing Parking Lot	27
Table 8.12 Intersection Operations – Alternatives 2 & 2B, Caithness Street / Parking Lot	28
Table 8.13 Intersection Operations – Unsignalized Intersections.....	33
Table 8.14 Intersection Operations – Signalized Intersections.....	34
Table 9.1 Relative Potential and Merit of Detour Options	39
Table 9.2 Number of Pedestrians Crossing the Argyle Street Bridge.....	41
Table 9.3 Key Issues and Potential Mitigation Measures.....	44

1.0 STUDY BACKGROUND

Caledonia is one of three urban areas in the Town of Haldimand County. It has an attractive rural/small town character and quality of life. In recent years, the combined areas of Hamilton-Wentworth, Haldimand-Norfolk and Niagara have been termed the Greater Bay Area (distinct from the Greater Toronto Area).

The current population of Caledonia is just under 10,000 and it is expected to experience considerable growth over the next 25 years.

The Argyle Street South Bridge crosses the Grand River, a Canadian Heritage River, and provides a link between the north and south parts of Caledonia on either side of the river. The bridge is the only in-town crossing and serves mainly local traffic. It was originally part of Highway 6 until the Caledonia By-pass was constructed. The By-pass has a crossing over the Grand River approximately 2 km upstream of the town.



2.0 STUDY OBJECTIVES

This project involves the rehabilitation or replacement of the Argyle Street South Bridge over the Grand River in Caledonia. The bridge has two lanes of traffic, as well as pedestrian sidewalks on each side. The bridge is considered a local landmark and many residents feel it represents the heritage of the town.

The assessment of the bridge rehabilitation or replacement involves a multi-disciplinary approach to address all issues. Factors such as safety, heritage, cost, life cycle cost and durability will all be considered when evaluating different alternatives related to the preliminary design for the rehabilitation / replacement of the Argyle Street Bridge. This operational review report of the possible detour routes during construction will feed into the multi-criteria evaluation process.

3.0 SAFETY ASSESSMENT OF EXISTING CONDITIONS

3.1 Introduction

As part of the preliminary design for the rehabilitation / replacement of the Argyle Street Bridge in Caledonia, a collision review was carried out. The review was conducted to identify:

- Potential opportunities to improve safety on the Argyle Street Bridge
- Locations with higher than expected collisions that may require remedial measures to serve as traffic detour routes during the construction period

Accordingly, the analysis was focused on three main areas:

- Collisions on Argyle Street
- Collisions on the Argyle Street Bridge
- Collisions on the Highway 6 Caledonia By-pass

In general, no locations were found with significantly higher than expected collisions. On the Argyle Street Bridge itself, the observed collision rate was found to be comparable to collision rates on similar facilities. However, it was noted that the narrow width of the bridge may be contributing to collisions, and that improving the cross-section of the bridge may potentially reduce collision rates.

3.2 Collisions on Argyle Street

Collision data for Argyle Street was obtained from Haldimand County for the years 2000 to 2002. Data for previous years was unavailable. The collision data was reviewed to assess the number of collisions on Argyle Street north and south of the Argyle Street Bridge. Table 3.1 presents the results of the analysis. In total, there was one fatal collision over the three year period examined. Over this same time period, 44 collisions resulted in a non-fatal injury, and 107 collisions caused property damage only.

Table 3.1 Summary of Argyle Street Collisions (2000 to 2002)

Closest Intersection	General Impact Location	Collision Classification			Total
		Fatal Injury	Non-fatal Injury	Property Damage Only	
Alabastine Avenue ³	Intersection		2	2	4
Orkney Street	Intersection		5	2	7
Sutherland Street	Intersection		1	9	10
Caithness Street	Intersection		2	8	10
Argyle Street	Non Intersection		1	9	10
Forfar Street	Intersection		2	2	4
Argyle Street	Non Intersection		1		1
Renfrew Street	Intersection			1	1
Argyle Street	Non Intersection		1	1	2
Sterling Street	Intersection		2	4	6
Kinross Street	Intersection		2	6	8
Haddington Street	Intersection			1	1
Argyle Street	Non Intersection		2	5	7
Celtic Drive	Intersection			5	5
Argyle Street	Non Intersection	1		2	3
Highway 6 South	Intersection			1	1
Argyle Street	Non Intersection		1	5	6
TOTAL		1	44	107	152

¹ Excludes thefts (1) and collisions that occurred in parking lots (26). Also excludes 2 collisions with an impact location of "Other"

² Includes 3 collisions at "Highway 6", which could be either north or south of Caledonia

³ Assumed to be located in the Industrial Area north of Caledonia

As shown in Table 3.1, the locations with the greatest number of intersection / intersection-related collisions include: Orkney Street (7), Caithness Street (10), Sterling Street (6), and Kinross Street (6). Locations with the greatest number of non-intersection collisions include road sections adjacent to: Orkney Street (10), Sutherland Street (6), Caithness Street (10), Sterling Street (8), Kinross Street (7), and Haddington Street (7).

Since traffic volumes vary along Argyle Street, it is impossible to compare the relative safety of different locations based solely on the number of observed collisions. To gain an appreciation of the relative safety at key locations, the number of expected versus actual collisions was assessed at signalized intersections along the corridor. Table 3.2 presents the results of the analysis. At

each of the four intersections examined, actual collisions appear to be in line with expected collisions. However, it should be noted that the analysis was based on collision relationships developed for the Toronto area, and as such, may not be directly comparable to conditions in Caledonia. Moreover, no effort was made to adjust the observed collision data to account for random fluctuations in collision events. Accordingly, the results in Table 3.2 should be interpreted with caution.

Table 3.2 Expected vs. Actual Collisions at Signalized Intersections on Argyle Street

Location	Average Annual Daily Traffic (AADT) ¹		Expected Collisions per Year	No. of Observed Collisions	No. of Years ²	Actual Collisions per Year
	Major Road	Minor Road				
Argyle Street North & Caledonia By-Pass	12,600	3,300		9	5	
Argyle Street & Caithness Street	13,400	7,200		10	3	
Argyle Street & Kinross Avenue	9,600	1,600		6	3	
Argyle Street & Braemar Avenue	8,400	3,400		5	3	

1. Based on Ph.D. thesis by D. Lord, 2000.

2. Collision data from 2000, 2001, and 2002 (except for the north junction with the Caledonia By-pass, for which collision data from 1995 to 1999 was used)

3. Based on AM and PM peak hour traffic counts from Haldimand County / MTO

Due to the nature of the collision data provided, it was not possible to calculate collision rates for non-intersection locations on Argyle Street. In general, the number of non-intersection collisions is impacted by both the segment length and traffic volume. However, the collision records only indicate the closest intersection to a given collision, and not the road segment on which the collision occurred. As a result, it was not possible to calculate collision rates for different road segments.

3.3 Collisions on the Argyle Street Bridge

A more detailed assessment of the collisions on the Argyle Street Bridge was conducted to identify potential improvement measures which could be implemented during the rehabilitation / replacement of the bridge. The Argyle Street Bridge is a two-lane structure with no dividing barrier. 1.8 m sidewalks are provided on both sides, separated from vehicle traffic by concrete arches (refer to Figure 3.1). Currently, the bridge has no shoulders and relatively narrow 3.5 m lanes, resulting in a total width of pavement of 7.0 m.



Figure 3.1 Argyle Street Bridge

According to the collision data, there have been 6 collisions on the Argyle Street Bridge between 2000 and 2002. Of these collisions, 2 occurred in 2000 and 4 occurred in 2001. A detailed review of the collision data revealed the following:

- Three of the six of the collisions on the Argyle Street Bridge involved a driver who lost control of the vehicle. Of these three collisions, two can be attributed to icy/wet surface conditions.
- In three of the six collisions, a vehicle struck a bridge support.
- Two of the collisions were classified as “rear-end”, two were classified as “approaching”, one involved a sideswipe collision, and one involved a single motor vehicle. Of the two approaching collisions, one involved a driver who “failed to yield the right-of-way”, implying that the driver was impinging on the opposing lane.
- Driver actions at the time of the collision include: “lost control” (3), “speed too fast for conditions” (1), “failed to yield right-of-way” (1), and “other” (1).
- Three of the collisions that occurred on the bridge occurred during the daylight. The remaining three collisions occurred at night.
- Two of the collisions occurred in the rain (on wet pavement), one of the collisions occurred in the snow (icy surface), and three of the collisions occurred when it was clear (dry pavement).
- All of the collisions on the bridge involved property damage only.

- No pedestrians were involved in any of the collisions.
- None of the drivers was impaired or fatigued at the time of the collision.

To assess the relative safety of the bridge, collision rates for similar facilities were obtained from the Transportation Association of Canada (TAC) research report, *Safety Analysis of Roadway Geometry and Ancillary Features*, published in 2000. The collision rates in the TAC report are based on a 1983 study of narrow bridge sites on North American highways, and are considered by TAC to be "probably the best available".

The following bridge characteristics were used to derive the "expected" number of fatal, injury, and property damage collisions per 100 million vehicle kilometers of travel:

- Bridge Category = Single Structure, Undivided
- No. of Lanes on Route Segment = 2
- Bridge Width = 7.0 m
- Bridge Length = 200 m
- Approach Width > Bridge Width
- AADT = 16,900

The AADT was estimated from peak hour traffic counts at the intersection of Caithness Street and Argyle Street. The data was adjusted to 2001 conditions to represent the average AADT over the 2000 to 2002 time period for which collision data was available.

Table 3.3 presents the observed collision rate on the Argyle Street Bridge versus the expected collision rate based on collision data for similar facilities. As this table shows, the Argyle Street Bridge had a higher than expected collision rate in 2001. However, the collision rate in 2000 and 2002 was lower than expected, as is the average collision rate for the time period from 2000 to 2002.

Table 3.3 Comparison of Actual and Expected Collisions on the Argyle Street Bridge
(collisions per 100 million vehicle kilometers of travel)

Collision Classification	Actual Collision Rate				Expected Collision Rate Per Year
	2000	2001	2002	Collisions Per Year	
Property Damage	162	324	0	162	157
Injury	0	0	0	0	84
Fatal	0	0	0	0	6
TOTAL	162	324	0	162	247

* Travel estimate based on Haldimand County traffic counts

From the results of the collision analysis, it does not appear that there is a significant collision problem on the Argyle Street Bridge, despite the relatively narrow lane width and substandard clearance. However, the width of the bridge could be a contributing factor to the collisions that were observed. As noted above, three of the six collisions that occurred between 2000 and 2002 resulted in a vehicle striking a bridge support. One of the collisions on the bridge involved a driver who failed to yield the right of way to traffic in the opposing lane, while a second collision involved two vehicles sideswiping each other under icy conditions. Both of these collisions could

be attributed, at least in part, to the narrow bridge width which encourages drivers to cross the centre line. Thus, there may be potential to reduce collisions by providing wider lanes and a "recovery zone" for drivers. However, regardless of whether or not such improvements are made, the collision rate appears to be within normal limits based on historical collision records.

Appendix A contains a detailed summary of the collisions on the Argyle Street Bridge over the three year period from 2000 to 2002.

3.4 Collisions on the Highway 6 Caledonia By-pass

In addition to reviewing collision data for Argyle Street, data for the Highway 6 Caledonia By-pass was examined as well. This data was obtained from the Ministry of Transportation, and covers the five years from 1995 to 1999. Table 3.4 provides a summary of the collision data.

Table 3.4 Collisions on the Caledonia By-pass (1995 to 1999)

Facility Type	Location	Fatal	Injury	Property Damage	Total
Intersection ¹	South Junction with Argyle Street	0	4	6	10
	On By-Pass	0	5	7	12
	North Junction with Argyle Street	0	2	7	9
Non-Intersection ²	Argyle Street South to Argyle Street North	1	14	23	38

¹ Intersection and Intersection-related collisions only

² Includes collisions at private drive-ways

According to MTO, the average collision rate on the By-pass in 1999 was 0.7 incidents per million vehicle kilometers traveled, which is identical to the 1999 Provincial Collision Rate for Kings Highways.

A more detailed analysis was conducted using the safety conscious procedures outlined in the *Science of Highway Safety* guidebook, prepared in 1999 for the Ministry of Transportation of Ontario. The guidebook describes the use of Operational Performance Functions (OPFs) which relate the amount of traffic on a particular type of road to the expected collision frequency. Operational Performance Functions have the following general form:

$$\text{Expected Collision Frequency (collisions / year)} = a (\text{AADT})^b \times (\text{Section Length})$$

In the above equation, "a" and "b" are estimated from collision data-sets using common statistical procedures.

Operational Performance Functions for the Ontario Provincial Highway Network have been calibrated, and are included in the technical appendices of the *Science of Highway Safety* guidebook. For King's Highways, two sets of OPF's are applicable, corresponding to:

- Non-intersection collisions

- Total collisions, excluding those at signalized intersections

The OPF's for King's Highways were used to compute the expected number of collisions on the Caledonia By-pass. These expected collisions were then compared with the actual number of collisions to assess the relative safety. In carrying out such a comparison, it is important to first adjust the observed data to account for the randomness in annual collision occurrence. The resulting "long-run collision mean" simply reflects the actual number of collisions per year smoothed to remove random fluctuations from one year to the next.

Table 3.5 presents a comparison of expected collisions (as determined from the Operational Performance Functions) versus actual collisions (smoothed to eliminate random effects). The collision rates were determined based on a section length of 6.5 km, and an average AADT of 6,300.¹

Table 3.5 Caledonia By-pass: Expected Versus Actual Collisions

Collisions Included in Analysis	Classification	Expected Number of Collisions Per Year ¹	Actual Number of Collisions Per Year ²
Non-Intersection Collisions	Fatal	0	0
	Injury	3	3
	Property Damage	7	5
Road Sections & Unsignalized Intersections	Fatal	0	0
	Injury	4	5
	Property Damage	9	7

¹ From Operational Performance Functions

² Based on the long-run collision mean

As indicated in Table 3.5, the actual number of collisions on the Caledonia By-pass is generally less than the expected number of collisions for similar facility types, implying that safety improvements are not warranted at the present time.

¹ Based on MTO AADT data from 1995 to 1999.



4.0 LONG-TERM INFRASTRUCTURE NEEDS

The rehabilitation / replacement of the Argyle Street Bridge provides an opportunity to modify the bridge to meet long-term infrastructure needs in the Caledonia community. Accordingly, Haldimand County commissioned a traffic study to examine existing and future conditions on the bridge and to assess the need for future improvements. The full details of this study are documented in the draft report, *Argyle Street Bridge Traffic Study*, prepared by Paradigm Transportation Solutions Ltd., dated November, 2004.

Table 4.1 presents existing and future traffic volumes on the bridge as presented in the Traffic Study.

Table 4.1 Existing and Future Traffic Volumes on the Argyle Street Bridge

Time Period	Morning Peak Hour		Afternoon Peak Hour	
	Northbound	Southbound	Northbound	Southbound
Existing	710	515	615	1110
10-year horizon	1165	695	915	1515
Build-out	N/A	N/A	1045*	1935*

* Unconstrained demand – Since this demand cannot be accommodated in the corridor, it is anticipated that the actual "constrained" traffic volumes that would utilize the bridge would be lower.

The traffic study concludes that the bridge should be widened from a two-lane cross-section to a three-lane cross-section, with two lanes southbound and one lane northbound (refer to Figure 4.1). This configuration, combined with the introduction of certain parking and turning restrictions, was found to be adequate to accommodate traffic over a ten-year horizon at a level of service similar to what is experienced today.

Widening to a three-lane cross-section does not provide sufficient river-crossing capacity to accommodate longer-term traffic growth associated with the full build-out of the designated development areas in the town. However, further expansion of the bridge is not considered feasible due to right-of-way restrictions on Argyle Street north of the bridge through the Central Business District.

In light of the above findings, it is recommended that the preliminary design of the Argyle Street bridge incorporate a three-lane cross-section. Through-out the remainder of this report, any staging and detour requirements during construction have been assessed assuming a three-lane bridge will be provided.



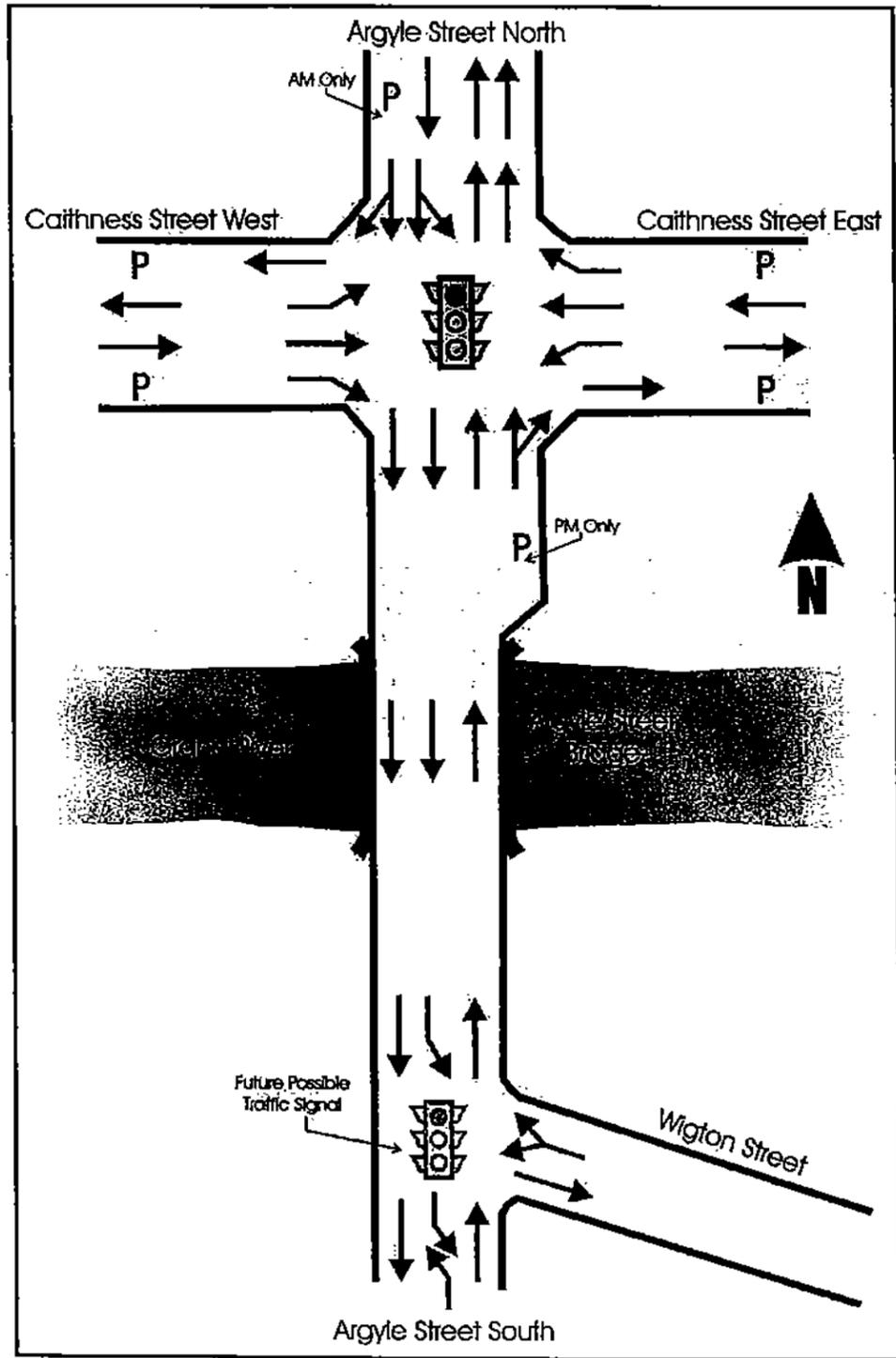


Figure 4.1 Proposed Three-Lane Bridge Configuration



5.0 OPERATIONAL ASSESSMENT OF BASELINE CONDITIONS

5.1 Study Area

The Study Area for this Operational Review, as shown in Figure 5.1 below, consists of Argyle Street from the northern intersection with the Highway 6 By-pass to the southern intersection with the Highway 6 By-pass as well as the By-pass itself. The Operational Review examined the levels of service and associated delays at all of the major intersections within the Study Area.

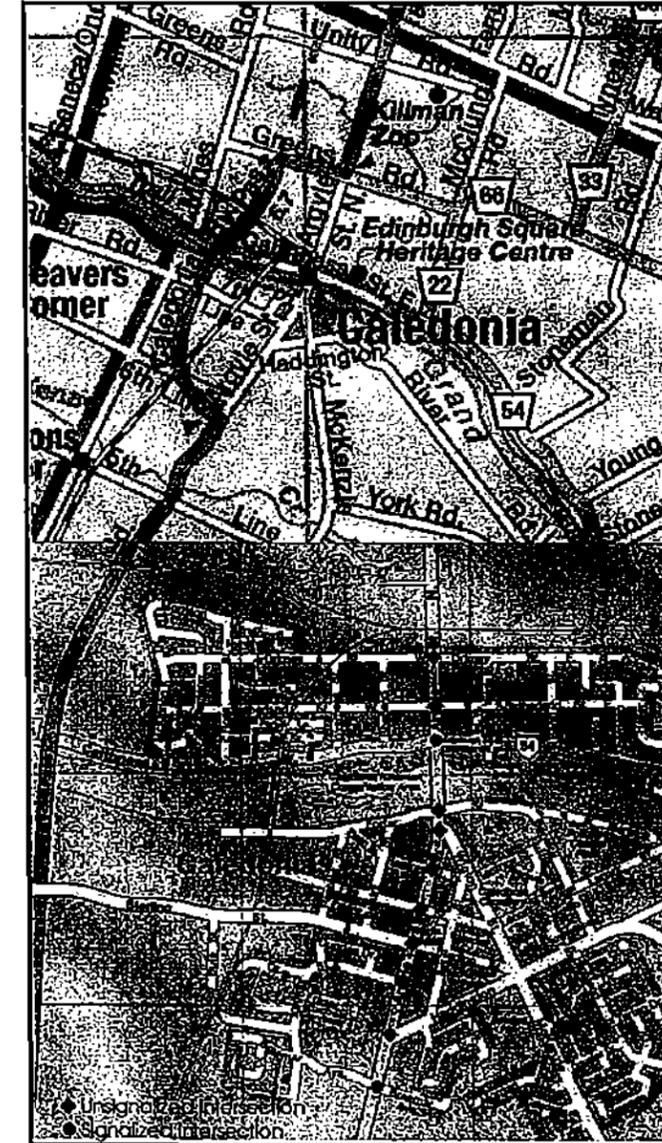


Figure 5.1 Study Area



Specifically, the following intersections were assessed:

<u>Intersection</u>	<u>Existing Control</u> ²
Highway 6 / Argyle Street N / Greens Road E	Signalized
Highway 6 By-pass / Greens Road W	Two-Way Stop ³
Highway 6 By-pass / Argyle Street S	Two-Way Stop ⁴
Orkney Street / Argyle Street N	Two-Way Stop
Sutherland Street / Argyle Street N	Two-Way Stop
Caithness Street / Argyle Street N	Signalized
Forfar Street / Argyle Street S	Two-Way Stop
Wigton Street / Argyle Street S	Two-Way Stop
Renfrew Street / Argyle Street S	Two-Way Stop
Fife Street / Argyle Street S	Two-Way Stop
Sterling Street / Argyle Street S	Two-Way Stop
Kinross Avenue / Argyle Street S	Signalized
Haddington Street / Argyle Street S	Two-Way Stop ⁵
Braemar Avenue / Argyle Street S	Signalized

Appendix B contains exhibits that show the existing lane configuration at each of these intersections.

5.2 Baseline Traffic Volumes

Appendix B also contains exhibits showing the baseline traffic volumes used for this analysis. The base conditions for this traffic analysis were the morning (AM) peak hour and afternoon (PM) peak hour volumes during the year of construction – expected to be in 2007. Appendix B also contains a listing the original traffic counts that were obtained from the County of Haldimand as well as the Ministry of Transportation of Ontario (MTO). An average traffic volume was derived at each intersection by applying the appropriate AADT factor to the raw data. The AADT factor takes into account the day of the week and the time of the year the traffic counts were conducted.

The average traffic volumes were then expanded to represent an average day in the year 2007 by applying a growth factor. A review of historical traffic counts on the Highway 6 By-pass indicated that there was an average growth of 4% per year on this facility. The rate was therefore applied to all major movements onto and off of the By-pass. Population and housing projections for Caledonia (produced in 2000 by Clayton Research) were used to determine an appropriate growth rate within Caledonia. Using housing projections from 2001 and 2006 and

² During the course of this project, which has extended over multiple years (3), there have been a number of changes in intersection control and configuration. Generally speaking, these changes are reflected in any analysis conducted after MH was made aware of the change; analysis conducted prior to this generally reflects the initial intersection control and configuration as confirmed by MH at the outset of the study in 2003.

³ This intersection was signalized subsequent to MH's 2003 site visit.

⁴ This intersection was signalized subsequent to MH's 2003 site visit.

⁵ During the course of the study, it was learned that permanent traffic signals will be installed at this intersection in the future.

standard trip rates from the *Institute of Transportation Engineers*, it was estimated that vehicle trips would grow approximately 2.7 % per year, whereas the growth in population from the year 2001 to 2006 would be approximately 2.2% per year. The Clayton Research report estimates that the growth in employment within Caledonia would be approximately 55 jobs per year – which was considered to be negligible for the purposes of this analysis. As Caledonia is a 'bedroom community' (most employment is outside of Caledonia), the growth in employment outside of Caledonia was assumed to be captured in the growth of households. Therefore, a conservative value of 2.5% growth per year was applied to all turning movements within Caledonia.

Traffic projections at the link and intersection locations were found to be comparable to those presented to the town of Caledonia in a number of local Traffic Impact studies. Engineering judgment was also used to factor traffic volumes at certain intersections where data was not available. A review of the projected volumes reveals that during the AM peak hour the predominant direction of travel is towards the north, whereas the predominant direction of travel is towards the south in the PM peak hour. This is consistent with the concept that Caledonia is a 'bedroom community' and most of the employment is north of the Community.

5.3 LOS Analysis for 'Future Do-Nothing' Scenario

An analysis was first undertaken of all the intersections within the Study Area under the 'Future Do-Nothing' Scenario as a basis for comparison. This scenario represents the condition that no detour is in place but the traffic has grown to 2007 conditions. The Level of Service (LOS) was analyzed for each of the intersections, using the HCS software, which is based on the methods described in the *Highway Capacity Manual 2000*.

The results of the LOS analysis for the unsignalized intersections are presented in Table 5.1. Detailed summary sheets as well as a description of the various Levels of Service values are provided in Appendix C.

Table 5.1 Intersection Operations – ‘Future Do-Nothing’ Scenario, Unsignalized Intersections

Intersection	AM Peak Hour LOS on minor street		PM Peak Hour LOS on minor street	
	WB	EB	WB	EB
Orkney Street / Argyle Street N	C	F	F	F
Sutherland Street / Argyle Street N	C	E	C	D
Forfar Street / Argyle Street S	D	–*	F	–*
Wigton Street / Argyle Street S	D	–*	C	–*
Renfrew Street / Argyle Street S	C	C	D	E
Fife Street / Argyle Street S	C	C	E	E
Sterling Street / Argyle Street S	–	B	–	C
Haddington Street / Argyle Street S	C	C	F	F
Intersection	AM Peak Hour LOS		PM Peak Hour LOS	
Highway 6 By-pass / Greens Road W	A (WB)	B (NB)	A (WB)	B (NB)
Highway 6 By-pass / Argyle Street S	A (EB)	C (SB)	A (EB)	E (SB)

* These intersections are either T-intersections or act as T-intersections because of one-way restrictions.

As can be seen in the summary table above, most intersection will operate at acceptable levels of service with relatively minor delays. The minor approaches will fail at Orkney Street, Forfar Street, and Haddington Street. In all cases, the minor streets are failing due to the significant volume opposing it on the major street. In the case of Orkney Street this situation is exasperated by a relatively high left turn volume from the minor street. If the current shared-through-right turn lane in the eastbound direction were redesignated to a left turn and a shared through-right lane, the overall delay on the eastbound approach would diminish in the AM peak hour but the approach would still fail. In the PM peak hour, if both the eastbound and westbound approaches were redesignated to left turns and share through-right turns, each approach delay would also diminish but remain at a failing condition. These intersections were assessed to determine if they would meet the warrants for all-way stop controls or traffic signalization. The results of this analysis are shown in Table 5.2. Detailed summary sheets are available in Appendix C.

Table 5.2 Warrant Analysis – ‘Future Do-Nothing’ Scenario

Intersection	TAC Warrant for All-Way Stop Control ¹	MTO Warrant for All-Way Stop Control ²	MTO Warrant for Intersection Signalization ³		
			Warrant 1	Warrant 2	Warrant satisfied
Orkney Street / Argyle Street N	May be warranted ⁴	No	57%	112%	No
Forfar Street / Argyle Street S	May be warranted ⁴	No	3%	32%	No
Haddington Street / Argyle Street S	May be warranted ⁴	No	81%	76%	No

¹ Based on 1996 Edition of the manual, Uniform Traffic Control Devices for Canada

² Based on Book 5 of the Ontario Traffic Manual (Regulatory Signs), March 2000

³ Warrant criteria when peak hour volumes used to estimate compliance: Single Warrant – 120%, Combined Warrant – 100%

⁴ Multi-Way stops may be warranted under TAC guidelines if only condition is met. These intersections are meeting the condition that the average delay to minor street vehicular traffic entering the intersection exceeds 30 seconds per vehicle during the peak hour.

As the table above describes, the intersections do not meet all the conditions to warrant an All-Way Stop control or traffic control signalization. In the case of the TAC warrant, all three intersections are meeting the condition related to delay on the minor street however none of the other conditions are met.

The results of the Level of Service analysis for the signalized intersections are presented in Table 5.3. All signalized intersections will operate at acceptable Levels of Service or better, with very minor delays. Detailed summary sheets of the analysis as well as a description of the various Levels of Service values are provided in Appendix C.

Table 5.3 Intersection Operations – ‘Future Do-Nothing’ Scenario, Signalized Intersections

Intersection	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Highway 6 / Argyle Street N / Greens Road E	B	15.3	B	15.4
Caithness Street / Argyle Street N	B	15.1	B	18.4
Kinross Avenue / Argyle Street S	A	7.2	A	10.5
Braemar Avenue / Argyle Street S	B	11.7	B	11.8

6.0 STAGING DETOURS OPTIONS CONSIDERED

Several alternative locations for a new bridge, including both maintaining the same alignment or considering new alignment options, were initially considered as part of this assignment.

However, through preliminary discussions with the community and major stakeholders such as the Town of Haldimand, the Six Nations, the First Nation and the local business association, it was established that whether replacement or rehabilitation, the bridge had to stay in its current location. It was also established that a detour has to be made somewhere for cars and pedestrians to cross the river.

7.0 SCREENING OF DETOUR OPTIONS

Of all the various alternatives that were once considered, the following options remained (refer to Figure 7.1):

- *Alternative A*: Widening either side of existing bridge (always maintaining one lane in each direction open)
- *Alternative 1*: Vehicle detour via the Caledonia By-pass (Highway 6)
- *Alternatives 2 & 2B*: Temporary bridge 100 metres to the west through an existing parking lot
- *Alternatives 4 & 4B*: 'S-detour' just to the west of the existing bridge
- *Alternatives 5A - 5D*: Maintain one lane of traffic at existing bridge location with the Caledonia By-pass as alternative detour

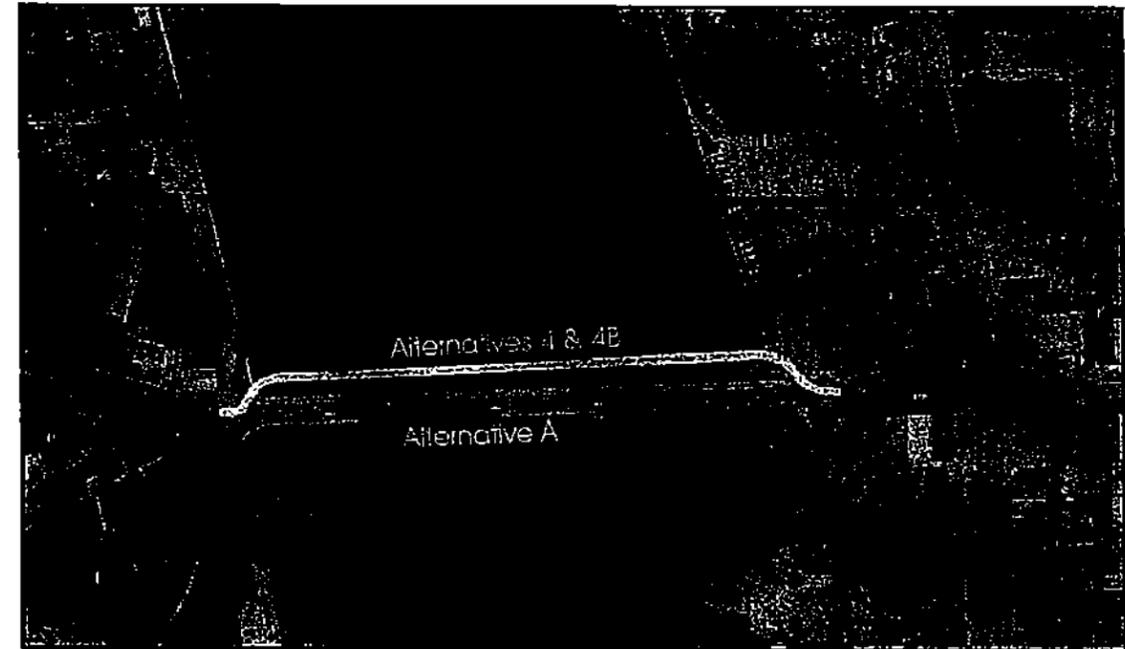


Figure 7.1 Possible Detour Routes Within Caledonia

8.0 OPERATIONAL ASSESSMENT OF SCREENED DETOUR OPTIONS

8.1 Alternative A – Widening Either Side of Existing Bridge

This detour option affects traffic only in the immediate area of the Argyle Street Bridge, as it follows the existing bridge alignment with a widening on either side of the existing structure, always maintaining one lane in each direction open. As a result, the impacts are relatively minor. This detour alternative provides a direct link to the business district, promotes traffic dispersion (without encouraging cut-through traffic), supports the intended function of the road and will not increase turning movements or vehicle conflicts at any of the intersections within the Study Area.

8.2 Alternative 1 – Vehicle Detour via Caledonia 6 By-pass

8.2.1 Forecast Traffic Volumes

This detour option completely removes the capability of crossing the Grand River within Caledonia. All vehicles would be required to travel beyond the limits of Caledonia, cross the river using the Highway 6 By-pass and then back-track towards their original destination.

A bridge inspection took place in November 2002. During that inspection, the southbound lane was closed to traffic causing delays and queues in both directions. It was estimated that the delay experienced during the inspection was approximately 15 minutes. It was also estimated that taking the By-pass as an alternative route would add 15 minutes to the trip time as compared to the direct route.

The initial step undertaken in order to assess this detour alternative was to redistribute all the traffic destined to the Argyle Street Bridge. An origin-destination (OD) study was conducted in 1988 for the *Caledonia Transportation Needs Study* to determine the extent and type of use of the by-pass, the amount of through traffic on Argyle Street, and the amount of traffic from south of the river traveling to north of the river.

Traffic using the bridge would be composed of 4 components:

- Travel between Highway 6 south and a point north of the by-pass;
- Travel between Highway 6 south and a point within Caledonia north of the river;
- Travel between a point north of the by-pass and a point within Caledonia south of the river;
- Travel within Caledonia between a point north of the river and a point south of the river.

The percentage that each component forms of the total traffic on the bridge had to be assumed in order to divert the traffic accordingly. The results of the OD survey were used as a basis for the development of these assumptions. The diversion of the PM peak hour southbound traffic is presented below as an example of the process used to assess potential traffic diversion.

1. Starting at the intersection of Argyle Street south and Highway 6, it was possible to estimate how many vehicles destined to Highway 6 south came through Caledonia directly from north of the by-pass, based on the results of the OD survey. These vehicles would make the detour north of Caledonia to take the by-pass directly to eventually continue south on Highway 6.
2. The remaining vehicles originally proceeding from Argyle Street south to travel south on Highway 6 would be made up of a portion from Caledonia north of the river (using the bridge) and a portion from Caledonia south of the river. Based on a conservative estimate that 75% of the households would be located south of the river in 2007, it was assumed that 25% of the trips from Caledonia and destined to Highway 6 south came from north of the river.
3. The remaining traffic traveling southbound on the bridge was removed from the turning movements directed to the bridge proportionally through each intersection. The sum of this 'removed' traffic provided the total number of vehicles from Caledonia, north of the river, using the bridge. The portion directed to Highway 6, which had been previously determined, was subtracted out to reveal the portion of traffic from Caledonia north of the river destined to Caledonia south of the river.
4. The remaining portion of traffic on the bridge (from north of the by-pass to Caledonia south) was determined by simply subtracting the other three portions of traffic on the bridge (1- from north of by-pass to Highway 6 south, 2- from Caledonia north to Highway 6 south and 3- from Caledonia north to Caledonia south) from the total traffic value.
5. All the diverted traffic was added to the opposing turning movements directed away from the bridge and added to the southbound traffic on the Highway 6 by-pass. At the intersection of Argyle Street south and Highway 6 the traffic was added to the various turning movements based on the original destination (Caledonia south or Highway 6 south). Traffic originally destined to Caledonia south was processed through the various intersections and added to the turning movements proportionally based on original destinations.

The diversion of the northbound traffic on the bridge followed the same approach. The diversion of the traffic in the AM peak hour followed the same assumptions of the proportions of each component but following the peak directions (i.e. the assumptions for northbound traffic in the PM peak hour were followed for the southbound traffic in the AM peak hour). Exhibits showing the turning volumes for this scenario are contained in Appendix D.

8.2.2 Level of Service Analysis

The initial assessment of this detour option included an assessment of the link Level of Service (LOS) of the Highway 6 By-pass as a substantial amount of traffic has been diverted to this facility. Under the loading conditions of this alternative, the Highway 6 By-pass would experience a LOS of E, which is considered acceptable. A summary of the calculations can be found in Appendix D.

The traffic operations at each intersection were then assessed under the loading conditions of this detour alternative. The results of the analysis for the unsignalized intersections are presented in Table 8.1. Detailed summary sheets are provided in Appendix D.

Table 8.1 Intersection Operations – Alternative 1, Unsignalized Intersections

Intersection	AM Peak Hour LOS on minor approach		PM Peak Hour LOS on minor approach	
	WB	EB	WB	EB
Orkney Street / Argyle Street N	B	E	D	F
Sutherland Street / Argyle Street N	B	C	C	E
Forfar Street / Argyle Street S	A	–	A	–
Wigton Street / Argyle Street S	B	–	B	–
Renfrew Street / Argyle Street S	B	A	B	B
Fife Street / Argyle Street S	B	B	C	B
Sterling Street / Argyle Street S	–	B	–	A
Haddington Street / Argyle Street S	C	B	F	C
Intersection	AM Peak Hour LOS		PM Peak Hour LOS	
Highway 6 By-pass / Greens Road W	A (WB)	F (NB)	F (WB)	F (NB)
Highway 6 By-pass / Argyle Street S	B (EB)	F (SB)	F (EB)	F (SB)

As can be seen in the summary table above, most intersection will operate at acceptable levels of service with relatively minor delays. In some cases, there would be minor improvements to the delay and overall level of service as the diversion has decreased the through volumes in the peak directions and increased the through volumes in the off-peak directions, creating a better balance of traffic in both directions. The minor approaches will fail at Orkney Street, Haddington Street, the Highway 6 By-pass / Greens Road west intersection and the Highway 6 By-pass / Argyle Street south intersection. Delays on minor approaches at the unsignalized intersections through Caledonia have somewhat declined while delays at minor approaches at the unsignalized intersections with Highway 6 By-pass have increased. All intersections exhibiting failure conditions were assessed to determine if they would meet the warrants for all-way stop controls or traffic signalization. The results of this analysis are shown in Table 8.2. Detailed summary sheets are available in Appendix D.

Table 8.2 Warrant Analysis – Alternative 1

Intersection	TAC Warrant for All-Way Stop Control ¹	MTO Warrant for All-Way Stop Control ²	MTO Warrant for Intersection Signalization ³		
			Warrant 1	Warrant 2	Warrant satisfied
Orkney Street / Argyle Street N	May be warranted ⁴	No	56%	108%	No
Haddington Street / Argyle Street S	May be warranted ⁴	No	81%	92%	No
Highway 6 By-pass / Greens Road W	N/A ⁵	N/A ⁵	17%	70%	No
Highway 6 By-pass / Argyle Street S	N/A ⁵	N/A ⁵	187%	42%	Yes

¹ Based on 1996 Edition of the manual, Uniform Traffic Control Devices for Canada

² Based on Book 5 of the Ontario Traffic Manual (Regulatory Signs), March 2000

³ Warrant criteria when peak hour volumes used to estimate compliance: Single Warrant – 120%, Combined Warrant – 100%

⁴ Multi-Way stops may be warranted under TAC guidelines if only condition is met. These intersections are meeting the condition that the average delay to minor street vehicular traffic entering the intersection exceeds 30 seconds per vehicle during the peak hour.

⁵ Due the high speeds associated with the Highway, all-way stop controls would not be appropriate.

The intersection of Highway 6 By-pass / Greens Road west does not meet the warrant for traffic signalization. However, due to the substantially high volume making the westbound left turn from Greens Road West onto the By-pass, and the need to maintain the free flow characteristic of this movement, consideration should be given to controlling the conflicting movements in the eastbound direction for safety reasons. If these movements were controlled with a traffic stop, the LOS of service of these movements are expected to be failing, just as the northbound left turn is failing under the current configuration. Since all the minor movements would likely be failing under simple stop controls, consideration should be given to signalize the intersection – even though not warranted. Table 8.3 provides a summary of the LOS at this intersection if it were to be signalized.

Table 8.3 Intersection Operations – Alternative 1, Highway 6 By-pass / Greens Road West

Configuration	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Existing configuration	B	19.3	F	182.4
With redesignation of westbound through lane to shared through-left turn lane	–	–	C	30.7

As demonstrated in the table above, redesignating the existing westbound through lane to a shared through left turn lane would significantly improve the LOS in the PM peak hour from an F to a C due to the high westbound left turn volume. This would require a minor widening on the By-pass to accommodate the two left turns. The widening could merge back to one lane shortly after the intersection depending on design standards. The storage requirements on the westbound left turn lane should not be an issue as the next access is approximately 600 metres to the east. However, the current left turn lane may have to be lengthened.

As indicated in Table 8.2, the intersection of Highway 6 By-pass and Argyle Street south would meet the warrants for traffic signalization based on the warrant for minimum vehicular volumes. This is due to the high number of vehicles that have been rerouted via the by-pass and have to pass through the intersection to get to their original destination. If the right turns from Argyle Street onto the Highway 6 (northbound) was channelized (i.e. the traffic was removed from the intersection), this intersection would no longer meet the warrants for traffic signalization. A detailed summary sheet of this analysis is also contained in Appendix D. However, even with the right turn channelization in place, the intersection would continue to operate at LOS F in both the AM and PM peak hours if it remained unsignalized. Detailed summary sheets of the Level of Service analysis are also contained in Appendix D. Tables 8.4 and 8.5 present the operational analysis undertaken of the intersection if it were to be signalized.

Table 8.4 Intersection Operations – Alternative 1, Highway 6 By-pass / Argyle Street South

Configuration	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Existing configuration	F	168.4	F	320.1
With SB RT channelization (from Argyle Street)	C	25.3	F	186.4
With an additional EB LT (from Hwy 6)	F	94.7	F	169.7
With SB RT channelization and an additional EB LT	B	19.5	E	58.4

As the table above indicates, the combination of traffic control signalization, a right turn channelization in the southbound direction (i.e. from Argyle Street) and the provision of a second eastbound left turn lane (from Highway 6 southbound) would enable the intersection to operate at an acceptable Level of Service in both the AM and PM peak hours. However, as Table 8.5 indicates, the available storage for the eastbound left turn would have to be extended even with these proposed modifications as this movement is significantly heavy in the PM peak hour.

Table 8.5 Required Storage Lengths – Alternative 1, Highway 6 By-pass / Argyle Street South – WB LT

Configuration	Time-frame	Volume (veh/hr)	Cycle Length (s)	Average Arrival Rate	Required Storage (m)*	Available Storage (m)
Existing configuration	AM	361	120	12.0	126	130
	PM	1014	120	33.8	245+	130
With SB RT channelization	AM	361	80	8.0	91	130
	PM	1014	120	33.8	245+	130
With additional EB LT	AM	181	120	6.0	70	130
	PM	507	120	16.9	168	130
With SB RT channelization and additional EB LT	AM	181	60	3.0	42	130
	PM	507	100	14.1	140	130

* Required Storage = 7.0 m/veh x # of vehicles that will arrive 95% of the time – based on average arrival rate.

The results of the Level of Service analysis for the existing signalized intersections within the Study Area are presented in Table 8.6. Detailed summary sheets of the analysis are provided in Appendix D.

Table 8.6 Intersection Operations – Alternative 1, Signalized Intersections

Intersection	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Highway 6 / Argyle Street N / Greens Road E	F	104.2	F	113.9
Caithness Street / Argyle Street N	B	13.0	B	14.2
Kinross Avenue / Argyle Street S	A	9.1	B	11.2
Braemar Avenue / Argyle Street S	B	12.5	B	12.9

As shown in the above table, most intersections would operate overall at or above an acceptable Level of Service. In most cases, the overall delay at each intersection has increased slightly. In the case of the intersection of Highway 6 / Argyle Street N / Greens Road E, the delays have increased significantly since all diverted traffic must now pass through this intersection, and this intersection would fail in both the AM peak hour and the PM peak hour.

Additional Level of Service analysis was therefore conducted at this intersection with some suggested modifications as highlighted in Table 8.7.

Table 8.7 Intersection Operations – Alternative 1, Highway 6 / Argyle Street N / Greens Road E

Intersection	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Highway 6 / Argyle Street N / Greens Road E	D	46.4	E	75.7
With second EB LT lane				
Highway 6 / Argyle Street N / Greens Road E	D	36.4	D	42.6
With second EB LT lane and second NB LT lane				

The intersection of Highway 6 / Argyle Street N / Greens Road E would operate at a LOS F in both the AM and PM peak hours without modifications due to the significantly large volumes – especially the eastbound left turn and the northbound left turn which have volumes greater than 300 vehicles per hour in a single lane. Providing a second eastbound left turn lane would improve the LOS from an F to a D in the AM peak hour and from an F to E in the PM peak hour. The existing storage lengths would be sufficient to accommodate the queues from the northbound left turn and the eastbound left turn if this modification were implemented. However, the northbound left turn would still be failing. Providing a second northbound left turn lane in addition to a second eastbound lane would improve the LOS from an F to a D in the AM peak hour and from an F to a D in the PM peak hour.

8.3 Alternatives 2 and 2B - Temporary Bridge 100 metres to the West

These alternatives consist of a temporary bridge approximately 100 metres to the west of the existing bridge with the connecting roadway passing through an existing parking lot.



Two possible connections at the south end are being considered – Alternative 2: the temporary bridge makes a “T-intersection” with Forfar Street and Alternative 2B: the end of the bridge would connect directly into the Forfar / Argyle Street intersection.

The intersections of Caithness Street / Argyle Street and Forfar Street / Argyle Street, as well as the new intersection created on Caithness street at the existing parking lot are the only intersections within the Study Area that are affected by this proposed detour alternative. Operationally, all of the other intersections within the Study Area would have similar loading and performance levels as in the ‘Future Do-Nothing’ Scenario. The turning movements at the intersection of Caithness Street / Argyle would exhibit different demand levels. More specifically, movements to/from the existing bridge would become movements to/from Caithness Street West. An exhibit showing the modified traffic volumes after diversion can be found in Appendix E.

The Level of Service of the intersection under these new loading conditions was assessed and is summarized in Table 8.8. Detailed summary sheets are contained in Appendix E.

Table 8.8 Intersection Operations – Alternatives 2 & 2B, Signalized Intersections

Intersection	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Caithness Street / Argyle Street	C	24.9	C	25.8

The intersection would operate at or above acceptable Levels of Service in both the AM peak hour and the PM peak hour. The signal timings used in the assessment of the LOS were optimized for the southbound right turn. That is, the LOS presented are not necessarily the best that could be achieved but they favor the southbound right turn so that the queue does not extend into the next intersection. However, the eastbound left turn is also a very significant movement and the queues from this movement would be an issue, as highlighted in Table 8.9.

Table 8.9 Required Storage Lengths – Alternatives 2 & 2B, EB LT at Caithness Street / Argyle Street

Intersection configuration	Time Period	Volume (veh/hr)	Cycle Length (s)	Average Arrival Rate	Required Storage (m)*	Available Storage (m) (approx. distance btw intersections)
Existing Configuration	AM	649	80	14.4	147	74
	PM	470	65	8.5	98	74
Redesignation of EB TH to shared TL	AM	325	65	5.9	70	74
	PM	235	60	3.9	49	74

* Required Storage = 7.0 m/veh x # of vehicles that will arrive 95% of the time – based on average arrival rate.

As Table 8.9 demonstrates, the queues from the eastbound left turn lane could not be supported if the intersection maintained its current configuration. However if two left turns were provided, the storage requirements for the eastbound left turn would no longer interfere with the next intersection. Two left turns could be provided by redesignating the existing through lane to a

shared through and left turn lane. In order to accommodate the two left turn lanes, the parking on the north side of the intersection, in the northbound direction would have to be banned. The required length of the ban would have to be determined by design criteria related to merging the two lanes back to one lane. If this modification were implemented, the LOS would remain C in both the AM and PM peak hours, as the intersection timings would still have to be optimized for the southbound right turns.

To minimize the general congestion of this intersection, consideration could be given to banning parking in the southbound direction as well. Parking would only have to be banned to a point, as the queues from the southbound right turn could line up in the current through lane as the volume in this lane would be negligible due to the temporary closure of the bridge, as long as access to the southbound left turn lane was still available. Queues from the southbound left turn would extend approximately 28 metres in both the AM and PM peak hours. Therefore if parking was banned at least 28 metres back from the intersection, the queues from the southbound right turn would not interfere with the southbound left turn movements.

The new intersection created at the existing parking lot was also assessed. As no traffic counts were available at this location, assumptions of the existing travel patterns were based on the traffic count at Caithness Street and the surrounding land uses. Developments adjacent to the parking area are shown in Table 8.10.

Table 8.10 Developments Adjacent to Parking Lot, Just West of Argyle Street

Development	Approximate # of Parking Spaces*
Low rise apartment building	24
Library	45
Post Office	17
Bank	32

*as scaled off an aerial photo of the area.

As no data was available on the size of these various developments, assumptions were made with respect to the possible trip characteristics of each development based on the approximate number of parking spaces provided on the site. Table 8.11 summarizes the assumptions made.

Table 8.11 Assumed Vehicle Trips Associated with Existing Parking Lot

Land Use	Parking Rate	Assumed Size of Development	AM Peak Hour Trip Rate ²		PM Peak Hour Trip Rate ²	
			In	Out	In	Out
Low rise apartment building	1.04 spaces / dwelling unit ¹	24 dwelling units	0.09 / du	0.38 / du	0.38 / du	0.20 / du
Library	0.33 spaces / 100 ft ^{2,3}	13, 636 ft ²	0.76 / 1000 ft ²	0.3 / 1000 ft ²	3.4 / 1000 ft ²	4.5 / 1000 ft ²
Post Office	N/A	5,000 ft ^{2,4}	4.17 / 1000 ft ²	3.84 / 1000 ft ²	5.50 / 1000 ft ²	5.29 / 1000 ft ²
Bank	4.23 spaces / 1,000 ft ^{2,3}	7,565 ft ²	10.74 / 1000 ft ²	10.74 / 1000 ft ²	21.01 / 1000 ft ²	21.01 / 1000 ft ²

¹ From Parking, by Robert A Weanland and Herbert S. Levinson, 1990
² From ITE Trip Generation Manual, 6th Edition
³ From Parking for Institutions and Special Events, by Edward M. Whitlock, 1982
⁴ Average size of Post Offices studied in ITE Trip Generation Manual, 6th Edition

The Level of Service Analysis was undertaken for the new intersection at the parking lot with the redistributed traffic originally destined to and from the Argyle Street Bridge. The access from the parking lot is currently stop controlled. A summary of the analysis follows (additional details can be found in Appendix E):

- The redistributed volumes at the intersection are significant
- The northbound approach (from the parking lot) would fail in both the AM and PM peak hours primarily due to the significant turning volumes on Caithness Street
- This intersection would meet the TAC and the MTO warrant for an all-way stop control
- This intersection would meet the MTO warrant for traffic signalization (warrant 1 = 227% , warrant 2 = 129%). However, this intersection is approximately 75 metres away from the existing intersection of Caithness Street and Argyle Street. This distance is less than the recommended 250 metres between traffic control signals.
- A significant queue of vehicles would be expected in the westbound left turn direction from all the vehicles redistributed from the bridge. (i.e. approximately 900 veh/hour in the PM peak hour). Not only is the accommodation of such a queue difficult, but it will also negatively affect the operation of the Argyle Street / Caithness Street intersection.

Table 8.12 describes the LOS analysis of this intersection if traffic control signals were installed.

Table 8.12 Intersection Operations – Alternatives 2 & 2B, Caithness Street / Parking Lot

Intersection Configuration	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Existing configuration	F	194.4	F	446.5
With an exclusive NBRT, an exclusive EB RT , an exclusive WB LT (in addition to the shared WB TL)	B	19.4	C	28.1

As Table 8.12 describes, simply adding traffic control signals to the existing configuration would not be enough to enable the intersection to operate at an acceptable LOS. The proposed modifications would certainly improve the LOS dramatically. However, the queue from the westbound left turn is expected to reach approximately 70 metres in the AM peak hour and 119 metres in the PM peak hour – even with the proposed modifications. This is an impact that cannot be mitigated.

Depending on how the south end ties in with the intersection of Forfar Street / Argyle Street (i.e. alternative 2 or alternative 2B), there is a potential for sight distance problems and some turning movements may have to be restricted for safety reasons such as the westbound through movement and the northbound left turn movement. However, the impact would only be minor as these volumes are quite minor. The turning restrictions would result in some cut-through traffic on the local streets south of the intersection.

8.4 Alternatives 4 & 4B - 'S-detour' to the West of the Existing Bridge

This detour option affects traffic only in the immediate area of the Argyle Street Bridge at the intersection of Forfar Street / Argyle Street, as it follows the existing bridge alignment with a 'S-detour' just to the west of the existing structure. Two possible 'shapes' are being considered (i.e. Alternative 4B follows much more of an 'S' shape around the existing bridge than Alternative 4). However, both options would connect directly into the Forfar / Argyle Street intersection. As a result, the impacts are relatively minor. This detour alternative provides a direct link to the business district, promotes traffic dispersion (without encouraging cut-through traffic), supports the intended function of the road and will not increase turning movements or vehicle conflicts at any of the intersections within the Study Area. From a traffic operations point of view, there would be no difference between this detour alternative and the 'Future Do-Nothing' Scenario at most intersections within the Study Area. Depending on how the south end ties in with the intersection of Forfar Street / Argyle Street, there is a potential for sight distance problems and some turning movements may have to be restricted for safety reasons, such as the westbound through movement and the northbound left turn. However, the impact would only be minor as these volumes are quite minor. The turning restrictions would require some cut-through traffic on the local streets south of the intersection.



8.5 Alternative 5 - Maintain One Lane of Traffic at Existing Bridge

A qualitative review was undertaken of the traffic operations that would be associated with the closing of the Argyle Street Bridge to one direction of traffic, with the other direction being diverted to the Highway 6 By-pass. The review also assessed which direction of travel would be optimal to keep on the bridge and whether the direction of travel should remain in one direction all day or if it should switch at one point during the day.

The following detour objectives and considerations were reviewed in determining the preferred option:

- Minimize delays to the travelling public.
- Safety of the travelling public is of the utmost importance.
- Emergency response times must not be increased

Currently, the directional split of traffic is as follows:

- AM peak hour – 64% northbound (approx. 740 veh)
- Midday peak – 50/50 split
- PM peak hour – 63% southbound (approx. 1020 veh)

The extent of 'cut-through' traffic on the bridge is relatively small (approximately 12%), indicating that the vast majority of vehicles on the bridge either begin or end in the local Caledonia community.

Four options under this alternative were reviewed as follows:

- **Alternative 5A - Use the one lane and signals to share the lane in both directions.** This alternative is deemed unacceptable due to the resulting very low level of service.
- **Alternative 5B - Maintain one lane of traffic over the bridge switching the direction of traffic to match the peak directional flows.** This alternative, while being the most efficient in terms of traffic operations, is not acceptable due to the resulting confusion and safety issues.
- **Alternative 5C - Use the one lane to maintain northbound traffic and divert southbound traffic to the Caledonia By-pass.** The distance to the bridge from the point of diversion is quite long with many intersections in between. Due to this fact, it is difficult to sign and control traffic.
- **Alternative 5D - Use the one lane to maintain southbound traffic and divert northbound traffic to the Caledonia By-pass.** It is our opinion that this alternative is slightly more desirable than the above as it is the least confusing to the travelling public, is safe, and provides an acceptable level of service. It also supports the peak directional flow over the bridge, since the peak traffic in the southbound direction (which occurs during the PM peak hour) is greater than the peak traffic in the northbound direction (which occurs during the AM peak hour). This sub-alternative was carried forward for detail analysis.

8.5.1 Detail Analysis of Alternative 5D – Level of Service Findings

The Level of Service analysis undertaken assessed the traffic operations of all the intersections along Argyle Street within Caledonia under AM and PM peak hour conditions with the diversion of the northbound Argyle Street bridge traffic. The diversion of traffic assumed the closure of Wigton Street at the north end as well as the redesignation of Forfar Street to one-way away from Argyle Street on each side. The overall diversion also assumed that the preferred detour route within Caledonia would be Renfrew Street to Wigton Street to Haddington Street.

In general, all of the intersections within Caledonia will operate at acceptable Levels of Service with minor delays (see Tables 8.13 and 8.14) under the northbound only diversion scenario. At some of the unsignalized intersections, the minor streets would fail due to the significant volume on Argyle Street. However, the same conditions would prevail under the 'Baseline' scenario (i.e. year 2007 with no diversion). In some cases the overall Level of Service of the intersection would be better as compared to the 'Baseline' scenario as there would be significantly less traffic in the NB direction creating better gaps for the minor street approaches.

Temporary Signal Warrant Analysis

The warrants for traffic Control Signals at the intersection of Renfrew Street and Argyle Street were assessed under two conditions. The first condition represents the diversion of traffic at some point after the initial closure when most motorists would know the detour requirements. The second condition represents some point immediately after closure (such as in the first week) when many vehicles may not be aware of the closure and proceed all the way to Renfrew before realizing that they must turn south to cross the river. The difference between the two conditions was assumed to amount to 20% of the diverted traffic which would travel northbound toward Renfrew Street and have to back track to the Highway 6 By-pass/Argyle Street South intersection.

Under both conditions, the warrants for traffic control signals were not met based on vehicular volumes alone. However, the westbound approach would have a level of service F under the PM peak hour. Therefore, consideration should be given to installing a temporary signal at this intersection during the construction period. This would help prevent illegal and unsafe maneuvers just south of the bridge construction zone.

Traffic Operations on Highway 6

The initial assessment on the Highway 6 By-pass included an assessment of the link Level of Service of the By-pass, as a substantial amount of traffic has been diverted to this facility. Under the loading conditions of the northbound diversion scenario, the By-pass would experience a LOS of D during the AM peak hour and E during the PM peak hour – both acceptable LOS results.

The traffic operations of each intersection was then assessed under the loading conditions of the northbound diversion scenario. As anticipated, the greatest impact of the diversion of the Northbound Argyle Street Bridge would be felt at the three Highway 6 intersections.

Highway 6 By-pass / Argyle Street S

Vehicles wishing to travel northbound on the bridge have been diverted to northbound on Highway 6 by making either a southbound right turn from Argyle Street or a westbound through from Highway 6 South. This diversion causes less than desirable Levels of Service at this intersection under both the AM and PM peak hours (E and D respectively) because of the significant southbound right turn volumes and the westbound through volumes.

Currently, the intersection is configured such that the southbound approach has one lane shared for both the left and right turn movements.⁶ Simply widening the approach to provide for separate southbound right turn and left turn lanes would improve the Levels of Service from E (72.5 sec/veh delay) to D (36.1 sec/veh delay) during the AM peak hour and from D (54.6 sec/veh delay) to C (29.7 sec/veh delay) during the PM peak hour.

Highway 6 By-pass / Greens Road W

Vehicles originally travelling northbound on the bridge have been diverted to travel northbound on Highway 6 by making a right turn onto Greens Road W. This diversion causes the northbound approach to fail during both the AM peak hour and the PM peak hour. The demand for the northbound right turn under both time frames would be approximately 1000 to 1050 vehicles / hour.

Currently, the intersection is configured such that the northbound right turn is channelized and the northbound left turn is stop controlled. The vehicles making the right turn have to yield to the eastbound through vehicles to merge into the eastbound lane on Greens Road. However, the predominant movements at this intersection, even without the diversion of bridge traffic is to and from Highway 6. It would be beneficial to maintain the free flow of traffic on Highway 6.

There are not many easy solutions to improve the traffic operations of the northbound channelized right turn. It is difficult to fully ascertain the impact of the significant right turn volume on the other components of the intersection. In order to get an approximation of the intersection Level of Service, LOS analysis was undertaken assuming the intersection was signalized. It is not possible however to accurately assess the traffic operations of this intersection if it were signalized (as it is not possible to model a true channelized right turn with a signalized intersection). Nevertheless, it could be assumed that the intersection would operate better than the same intersection with simply a right turn lane instead of the channelized right turn. The Level of Service analysis of the intersection with a simple right turn lane yielded the following results: C (25.3 sec/veh delay) during the AM Peak hour and C (29.7 sec/veh delay) during the PM Peak hour. This would indicate that the current intersection (i.e. with the channelized right turn) would likely operate at a Level of Service of C or better.

A ramp junction analysis was also carried out to assess the impact of the significant right turn merging into the through movement on Greens Road. The *Highway Capacity Manual* does not provide a methodology for analyzing uncontrolled ramp junctions on roads with a single lane of

⁶ Note that the lane configuration at this intersection was confirmed by MH at the outset of this study. Since that time, the intersection has been signalized. For the purpose of this analysis, it has been assumed that the lane configuration at the intersection was not modified when the traffic signals were installed.

traffic per direction. The Manual does note that the procedures for freeway ramp junctions can be applied, "in an approximate manner, to completely uncontrolled ramp terminals on other types of facilities such as multilane and two-lane highways" (pg. 25-1). To analyze ramp junctions, the vehicle density⁷ in the merge influence area is calculated. Since vehicle density is used to define Level of Service categories for freeway operations, the density in the merge influence area provides a direct indication of the corresponding Level of Service experienced by drivers.

Accordingly, the methodology for ramp junctions on four-lane freeways was used to determine the vehicle density in the merge influence area during both AM and PM peak hours. This density was then modified to reflect a two-lane freeway, with one lane of travel per direction. The density in the eastbound merge area on Greens Road was estimated to be 7.5 and 7.4 passenger cars per kilometre per lane, assuming a four-lane freeway during the AM and PM peak hours respectively. With only a two-lane highway (i.e. one lane per direction), it is reasonable to expect the density to double, as all the vehicles are forced into a single lane of traffic. In this situation, the densities would become 15 and 14.8 passenger cars per kilometre per lane, which corresponds to Level of Service "C". The above approach for estimating Level of Service is considered to give only an approximation of the true operating conditions that can be expected. Level of Service "C" is generally considered acceptable for highway operations.

Highway 6 / Argyle Street N / Greens Road E

Vehicles wishing to travel northbound on the bridge have been diverted to eastbound on Greens Road E and making either a left turn to proceed north on Highway 6 or a right turn onto Argyle Street to a point within Caledonia north of the Grand River. The overall Levels of Service would be D under both the AM and PM conditions with failures on certain movements. The eastbound left turn demand is significant during both time frames. Providing a second eastbound left turn lane would improve the overall Levels of Service from D (52.8 sec/veh delay) to C (31.4 sec/veh delay) during the AM peak hour and from D (42.2 sec/veh delay) to C (33.5 sec/veh delay) during the PM peak hour.

⁷ Vehicle density is defined as the average number of vehicles observed on a one kilometre stretch of road.

Table 8.13 Intersection Operations – Unsignalized Intersections

Intersection	'Baseline' Scenario				Diversion of NB Only Scenario			
	AM Peak Hour LOS on Minor Street		PM Peak Hour LOS on Minor Street		AM Peak Hour LOS on Minor Street		PM Peak Hour LOS on Minor Street	
	WB	EB	WB	EB	WB	EB	WB	EB
Orkney Street / Argyle Street N	C	F	F	F	B	E	F	F
Sutherland Street / Argyle Street N	C	E	C	D	B	C	C	D
Forfar Street / Argyle Street S	D	-	F	-		not acting as a TWSC ²		
Wigton Street / Argyle Street S	D	-	C	-		not acting as a TWSC ²		
Renfrew Street / Argyle Street S	C	C	D	E	C	B	F	D
Fife Street / Argyle Street S	C	C	E	E	B	B	D	C
Sterling Street / Argyle Street S	-	B	-	C	-	-	-	C
Haddington Street / Argyle Street S	C	C	F	F		to be signalized		
Intersection	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS
Highway 6 By-pass / Greens Road W	A (WB)	B (NB)	A (WB)	B (NB)	A (WB)	F (NB)	A (WB)	F (NB)
Highway 6 By-pass / Argyle Street S	A (EB)	C (SB)	A (EB)	E (SB)		now signalized		

Notes:

¹These intersections are either T-intersections or act as T-intersections because of one-way restrictions.

²These intersections no longer act as two-way stop controlled due to restrictions (Fortar is one-way & Wigton is closed) during construction.



Table 8.14 Intersection Operations – Signalized Intersections

Intersection	'Baseline' Scenario				Diversion of NB Only Scenario			
	AM Peak Hour Delay (sec/veh)		PM Peak Hour Delay (sec/veh)		AM Peak Hour Delay (sec/veh)		PM Peak Hour Delay (sec/veh)	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
Caithness Street / Argyle Street N	B	15.1	B	18.4	B	12.3	B	19.9
Renfrew Street / Argyle Street S	temporary signal during construction only							
Kinross Avenue / Argyle Street S	A	7.2	A	10.5	A	9.2	B	15.1
Haddington Street / Argyle Street S	B	19.1	C	26.3	C	21.9	C	20.8
Braemar Avenue / Argyle Street S	B	11.7	B	11.8	B	17.9	B	12.3
Intersection	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS
Highway 6 / Argyle Street N / Greens Road E	B	15.3	B	15.4	D	52.8	D	42.2
Highway 6 By-pass / Argyle Street S	A	10.0	B	10.9	E	72.5	D	54.6



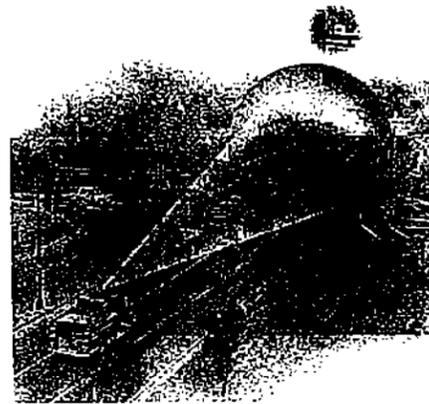
8.5.2 Detail Analysis of Alternative 5D – Emergency Service Provisions

Currently, the fire station in Caledonia is located north of the Grand River on Caithness Street west of Argyle Street, while the ambulance station is located south of the river on Kinross Street east of Argyle Street. Construction of a second fire station south of the Grand River has been proposed, but may not be completed before construction work on the Argyle Street Bridge commences. To improve response times during construction, it has been proposed that the Kinross Station be expanded to provide space to park a fire truck if needed.

Under Alternative 5D, access across the Grand River at the existing bridge would only be provided in the southbound direction during construction. To accommodate emergency service vehicles (ambulance and fire trucks) stationed south of the Grand River (i.e. at the Kinross Station), it is proposed that special traffic signals be installed at the bridge. When activated by a transponder, the signals would show an “all red” phase for regular traffic, allowing emergency service vehicles to travel north on the bridge.

The current system used by the Ministry is the 3M™ Opticom™ priority control system.⁸ Although the details of the system must be confirmed during the detail design phase, it is currently envisioned that the system would operate as follows:

- Existing signals, including those at Caithness and Argyle, will not be affected.
- Opticom controlled signals will be placed on each side of the bridge. The north signal will be located between the Caithness intersection and the bridge. This signal will be continuously green unless triggered by an EMS/OPP vehicle coming northbound, at which instance it will turn red. On the south side, the Opticom signal will be a special signal put right at the bridge entrance. This signal will have a “no-entry” cross light combined with an emergency vehicle signal above. The emergency vehicle signal would only be lit when the Opticom system is activated, i.e. when the bridge-north signal is showing red. This will give northbound EMS/OPP vehicles assurance that there is no car coming in the other direction when they cross the bridge.
- It is expected that under most circumstances, any southbound vehicle entering the bridge just after the Opticom signal turns red should still have sufficient time to clear the bridge before the northbound EMS vehicle reaches the bridge from the Kinross Station.
 - Once the ‘all red’ phase is activated at Caithness, it is expected that it would take approximately 40 seconds for the last vehicle to clear the length of the bridge.



- Once the emergency services vehicle has cleared the intersection of Argyle Street and Kinross Street (i.e. the location of station), it is expected that it would take approximately 55 seconds to reach the south end of the bridge.

A diagram illustrating the proposed implementation scheme can be found in Figure 8.1

⁸ All illustrations on this page were obtained from the 3M™ website.

9.0 THE PREFERRED OPTION

9.1 Relative Merit of Detour Options & Selection of the Preferred Option

Table 9.1 provides a summary of the key findings and issues related to each detour option.

Based on a review of Table 9.1, Alternative 5D is considered the preferred option. This option provides an acceptable level of service while limiting construction costs and throw away works.

Figure 8.1 Proposed System for Emergency Service Vehicle Traffic Signal Pre-emption

Table 9.1 Relative Potential and Merit of Detour Options

Option	Operational Impact	Potential Delays	Infrastructure Requirements / Costs
'Future Do Nothing'	<ul style="list-style-type: none"> Minor approaches will fail at: Orkney Street, Forfar Street and Haddington Street. These intersections do not meet MTO & TAC warrants for multi-way stop controls or MTO warrants for signalization All signalized intersections will operate at acceptable LOS or better. 	<ul style="list-style-type: none"> Delays on Argyle Street will be relatively minor Delays at Hwy 6 By-pass intersections will be relatively minor 	<ul style="list-style-type: none"> N/A
Alternative A Widen existing bridge	<ul style="list-style-type: none"> Will not alter turning movements or vehicle conflicts at any of the intersections no change in LOS from 'Future Do-Nothing' 	<ul style="list-style-type: none"> No changes from 'Future Do-Nothing' 	<ul style="list-style-type: none"> Only related to bridge structure Constructability of bridge is complex Construction costs very high
Alternative 1 Caledonia By-pass	<ul style="list-style-type: none"> Minor approaches would fail at Orkney Street and Haddington Street. These intersections would not meet MTO and TAC warrants for multi-way stop controls or MTO warrants for signalization. Signalized intersections along Argyle Street would operate at acceptable LOS or better (A to D) Link LOS on Caledonia By-pass would be an 'E' Minor approach would fail at the Hwy 6 By-pass / Greens Road West intersection. This intersection would not meet MTO warrant for signalization The Hwy 6 By-pass - Green Road West / Argyle Street approach would fail at the Hwy 6 By-pass / Argyle Street South intersection. This intersection would meet MTO warrant for signalization. The Hwy 6 By-pass - Green Road West / Argyle Street North intersection would operate at LOS 'E' in both AM and PM peak hours without improvements, but storage requirements could not be accommodated. 	<ul style="list-style-type: none"> Delays at the unsignalized intersections within Caledonia have declined Minor increase in delays to signalized intersections along Argyle Street Significant increase in delays to intersections with Hwy 6 By-pass 	<ul style="list-style-type: none"> The intersection of Hwy 6 By-pass / Argyle Street South requires traffic control signals and channelization of the SB RT as well as a second EB LT lane. Argyle Street South would require a minor widening to accommodate the two left turn lanes (all subject to design feasibility review) The Hwy 6 By-pass - Greens Road West / Argyle Street North intersection would require a second EB LT Lane. Both Greens Road and Hwy 6 would require minor widenings to accommodate the two left turn lanes. (all subject to design feasibility review)



Option	Operational Impact	Potential Delays	Infrastructure Requirements / Costs
Alternatives 2 & 2B Temporary Bridge 100 metres to west	<ul style="list-style-type: none"> Will not alter turning movements or vehicle conflicts at most intersections Will impact intersection of Caithness Street / Argyle Street and intersection between Public Library and Post Office on Caithness Street (into existing Parking Lot) At the intersection of Caithness Street / Argyle Street, there is not enough room to accommodate queues from the EB LT with the current configuration The new intersection at the parking lot would fail in both the AM and PM. This intersection would meet the TAC and the MTO warrant for an all-way stop control. This intersection would also meet the MTO warrant for traffic signalization. A significant queue of vehicles would be expected in the WB LT direction. Potential for sight distance restrictions at intersection of Forfar Street / Argyle Street - WB TH and NB LT may have to be restricted 	<ul style="list-style-type: none"> No change to most intersections 	<ul style="list-style-type: none"> Intersection of Caithness Street / Argyle Street requires the redesignation of existing EB TH lane to a shared EB TL turn lane and the banning on parking in the northbound direction (all subject to design feasibility review) The new intersection at the parking lot would require traffic signalization, an exclusive NB RT, an exclusive, EB RT and an exclusive WB LT as well as a shared WB TL lane. Even with these modifications the queues from the WB LT lanes will not be accommodated. This impact cannot be mitigated. Requires reconstruction of the intersection of Forfar Street / Argyle Street and depending on alternative, reconstruction of a portion of Forfar Street. Throwaway costs are very high.
Alternatives 4 & 4B 'S'-detour	<ul style="list-style-type: none"> Will not alter turning movements or vehicle conflicts at any of the intersections Potential for sight distance restrictions at intersection of Forfar Street / Argyle Street - WB TH and NB LT may have to be restricted 	<ul style="list-style-type: none"> No change to most intersections 	<ul style="list-style-type: none"> Related to temporary bridge structure Reconstruction of intersection of Argyle Street / Forfar Street Throwaway costs are very high.
Alternative 5 - Maintain one lane of traffic at existing bridge location - use Caledonia By-pass as alternative detour	<ul style="list-style-type: none"> Unacceptable level of service 	<ul style="list-style-type: none"> Major delays on Argyle street 	<ul style="list-style-type: none"> Signals at both ends of bridge. Opticom signal control system for use by emergency services
Alternative 6A share lane for both directions using signals	<ul style="list-style-type: none"> Good level of service Unacceptable due to safety concerns resulting from driver confusion 		<ul style="list-style-type: none"> Signals at both ends of bridge. Opticom signal control system for use by emergency services. Extensive signing
Alternative 6B switch direction of traffic on lane to match peak flows	<ul style="list-style-type: none"> Reduced level of service for southbound traffic with destinations north of Highway 6 / Argyle Street 	<ul style="list-style-type: none"> Longer average diversion with more intersections than Alternative 5D 	<ul style="list-style-type: none"> Signals at both ends of bridge. Opticom signal control system for use by emergency services. Detour signing and some minor intersection improvements
Alternative 6C use the one lane for northbound traffic - divert southbound traffic to Caledonia By-pass	<ul style="list-style-type: none"> Reduced level of service for northbound traffic with destinations south of Greens Road / Argyle Street 		<ul style="list-style-type: none"> Signals at both ends of bridge. Opticom signal control system for use by emergency services. Detour signing and some minor intersection improvements Providing a second eastbound left turn lane on Greens Road approaching Highway 6
Alternative 6D use the one lane for southbound traffic - divert northbound traffic to Caledonia By-pass			



9.2 Pedestrian & Cyclist Provisions

In assessing the various staging and detour options under consideration, pedestrian and cyclist needs during construction were carefully reviewed. A pedestrian count was conducted on May 22nd, 2003 to determine current usage of the bridge. The count shows significant pedestrian activity occurring throughout the day (refer to Table 9.2). From a review of the data, it is clear that a considerable amount of pedestrian traffic is generated by the local schools.

Table 9.2 Number of Pedestrians Crossing the Argyle Street Bridge

	7 am to 9 am	11 am to 2 pm	2:30 pm to 6 pm	Total 8-Hour Count
Child	6	12	20	38
Youth	44	16	103	163
Adult	15	46	49	110
Senior	9	16	20	45
Handicapped	0	0	0	0

* Excludes cyclists (33), people who walked their bike (2), and people on roller blades (2)

Three main options were identified for accommodating pedestrians during construction:

- Maintain pedestrian access on the existing bridge during construction
- Close the existing bridge to pedestrians and construct a temporary pedestrian bridge
- Close the existing bridge to pedestrians and provide a shuttle bus service over the bridge

Given the substantial cost of the latter two options, it was considered desirable to maintain pedestrian access on the existing bridge during construction, and staging and detour schemes were developed with this objective in mind.

The recommended option, Alternative 5D, provides for one pedestrian crossing over the length of the bridge during construction. To ensure a safe crossing environment, the following recommendations are made:

- Pedestrian barricades, fencing or handrails should be used to separate pedestrians from the work area.
- Pedestrians must never be diverted into a portion of the street concurrently used by moving vehicular traffic.
- Pedestrians approaching/leaving the bridge must be directed to/from the appropriate side of the street to where the pedestrian bridge crossing will be located (year 1 on the east side, year 2 on the west side). If the pedestrians need to cross Argyle street to access the bridge crossing, it must be done at a safe location:
 - On the north side of the bridge, the pedestrian crossing could occur at the Caithness Street intersection with the use of the existing crosswalk and signals.

- On the south side of the bridge, Renfrew Street would be the closest signalized intersection. It would not be realistic to expect pedestrians from Wigton Street and Forfar Street to first walk approximately 230 m south to cross the street at Renfrew Street and then proceed north on the other side of the street to reach the bridge. A safe pedestrian crossing should be provided immediately south of the bridge. This could be accommodated by providing a temporary walkway going under the bridge at the abutments (using the existing pathway and stairs).

- During peak pedestrian times, such as travel times for the local schools, using a qualified traffic control person could provide additional safety.
- Traffic control signs should not be placed where they would be an obstruction to pedestrians.

In terms of cyclist activity, it is not realistic to expect cyclists to take the Highway 6 By-pass detour. However, it is not safe for northbound cyclists to travel in the same lane as the southbound traffic, particularly within a construction zone. Moreover, if cyclists were allowed to use the bridge during construction with other vehicular traffic, debris within the construction zone could become a hazard, especially within a constricted area. As a result, it is recommended that consideration be given to using the following regulatory signs for both northbound and southbound cyclists:

- CYCLISTS USE SIDEWALK
- CYCLISTS DISMOUNT AND WALK

9.3 Temporary Signing Plan

Based on the recommended detour option, a preliminary signing plan was prepared showing the proposed detour route. It is anticipated that this signing plan will undergo additional refinement and modification during the detail design phase.

A copy of the temporary signing plan can be found in Figure 9.1.

9.4 Impact of the Preferred Option

The recommended option is believed to provide a safe and efficient traffic management strategy for the rehabilitation / reconstruction of the Argyle Street Bridge. To minimize negative impacts during construction, key issues associated with this option have been identified, and potential mitigation measures have been developed. Table 9.1 provides a summary of the main issues and recommendations.

Table 9.3 Key Issues and Potential Mitigation Measures

<i>Issue</i>	<i>Discussion & Potential Measures</i>
Impacts to drivers diverted to the Highway 6 By-Pass	<ul style="list-style-type: none"> From field observations during lane closures previously undertaken on the bridge, it was estimated that taking the By-pass as an alternate route would add 15 minutes to the trip as compared to the direct route. To minimize delay, intersection operations along the detour route have been assessed, and improvement measures have been developed to improve traffic flow (see next row).
Impacts to roads on the detour route	<p>The Highway 6 By-Pass</p> <ul style="list-style-type: none"> At a "link level", the Highway 6 By-pass is expected to operate at an acceptable level of service under the proposed option (LOS D during the AM peak hour and LOS E during the PM peak hour), indicating that it can handle the additional traffic. Diversion of NB bridge traffic will impact intersections on Highway 6 during both the AM and PM peak hours. As outlined in Section 8.5.1, modifications to these intersections will be needed to accommodate the additional traffic, including the provision of a channelized SB right turn lane at the intersection of Highway 6 and Argyle Street South, and the provision of a second EB left turn lane at the intersection of Highway 6, Argyle Street North, and Green's Road East. <p>Municipal Roads Within Caledonia</p> <ul style="list-style-type: none"> In general, all of the intersections within Caledonia will operate at a Level of Service comparable to that experienced under the Baseline scenario with no diversion (refer to Section 8.5.1 for more details). No detour plan has been proposed for drivers destined northbound over the bridge who begin their trip south of the Grand River but north of the Highway 6 By-Pass. Since drivers from Caledonia will be familiar with the bridge closure and the alternate bridge crossing at Highway 6, there is little need for a formal detour route. In fact, it is considered preferable to allow drivers to distribute themselves over the local road network rather than encourage use of a single route. However, this issue should be confirmed during the detail design stage and associated public consultation. Should there be a desire to provide a formal detour route within town, consideration should be given to the use of Wigton Street and Haddington Street, since these roads are better able to handle the diverted traffic than local roads such as Sterling Street. The additional flow on side streets should be monitored and additional measures could be implemented if required.
Impacts to pedestrians using the bridge	<ul style="list-style-type: none"> Only one pedestrian crossing will be available over the length of the bridge during construction. To enhance pedestrian safety, a number of measures have been proposed, as outlined in Section 9.2.

Figure 9.1 Proposed Temporary Signing Plan

<i>Issue</i>	<i>Discussion & Potential Measures</i>
Impacts to cyclists using the bridge	<ul style="list-style-type: none"> • It is not realistic to expect cyclists to use the Highway 6 By-pass. • It is not safe for northbound cyclists to travel in the same lane as southbound traffic, particularly within a construction zone. • Debris within the construction zone could become a hazard to both northbound and southbound cyclists if they travel on-road with vehicles, especially in a constricted area. • Given the above, it is recommended that cyclists be encouraged to dismount and use the sidewalk to cross the river during construction (refer to Section 9.2).
Impacts to Emergency Service Vehicles	<ul style="list-style-type: none"> • Since the preferred option only allows southbound traffic to use the bridge, it is recommended that special traffic signals be installed that would support emergency vehicle traffic signal pre-emption for the northbound direction. Once triggered, the pre-emption system would cause the light to go red for all southbound traffic, allowing northbound emergency vehicles to use the bridge. • Additional details can be found in Section 8.5.2.
Impacts to side roads	<ul style="list-style-type: none"> • Forfar Street should be one-way on either side of Argyle Street for safety reasons. On the east side, access from the utility building, parkland and few residences can be obtained via Renfrew Street. On the west side, the one-way designation would be consistent with existing conditions. • Turning movements to and from Forfar Street during the peak periods are very small so the disruption to this street would be minimal. • Wigton Street should be closed at its northern end. Ideally, for minimal impacts, certain movements could be allowed. However, it would be difficult to enforce the compliance for certain movements only – especially since it is a single lane approach. It would be much simpler to close the street. Access to/from Wigton Street can be obtained via Renfrew Street. • On the side streets south of Renfrew Street, signs should be posted informing motorists that NB travel is prohibited on the Bridge and that the Highway 6 By-pass should be used instead.
Impacts to the Argyle Street / Renfrew Street intersection	<ul style="list-style-type: none"> • As discussed in Section 8.5.1, a temporary traffic signal should be installed at this location to accommodate the additional turning movements that could occur when NB vehicles realize they cannot proceed any further. The signals would also help to prevent illegal and unsafe maneuvers just south of the bridge construction zone. • Signs should be posted indicating that NB traffic is prohibited beyond this point - except for local traffic (i.e. no through traffic, no right turn from WB Renfrew Street and no left turn from EB Renfrew Street).
Impacts to Argyle Street south of Caithness Street	<ul style="list-style-type: none"> • The NB through movements would be eliminated at the intersection of Argyle Street and Caithness Street. Since the only access to/from this section of Argyle Street will be blocked off (as discussed below), it will essentially act as a one-way street.
Impacts to parking on Argyle Street	<ul style="list-style-type: none"> • The existing parking available on both sides of Argyle Street north of the bridge should be eliminated south of Caithness Street. During the first year of construction, parking on the west side of the street will be eliminated (permanently) due to construction of the 3rd lane and parking on the east side would not be feasible due to construction activities. During the second year, parking on the east side would not be permitted due to construction activities. • Parking north of Caithness should not be impacted. • There is likely sufficient parking availability in the municipal lot to compensate for the loss of parking spaces.

<i>Issue</i>	<i>Discussion & Potential Measures</i>
Impacts to the municipal parking lot located north of the bridge	<ul style="list-style-type: none"> • The access to Argyle Street immediately north of the bridge should be closed as it could interfere with construction activity. Closing the access would also eliminate the potential for NB traffic on Argyle Street south of Caithness. Access to this parking lot would be maintained on Caithness Street. • The operations of this access should be reviewed when the bridge is widened to 3 lanes.

10.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis, Alternative 5D provides an acceptable level of service while limiting construction costs and throw away works. As a result, this alternative has been incorporated into the proposed construction strategy.

Under the proposed strategy, the replacement bridge will be constructed in 2 construction seasons. During the first year of construction, 2 lanes of traffic will continue to use the existing structure as in the current situation. However, one pedestrian sidewalk will be removed and all pedestrians will be required to use the remaining sidewalk. During the second construction season, only one traffic lane will be available at the crossing and will be dedicated to southbound vehicles only. The section of Argyle Street between Caithness and Renfrew will not be available for northbound vehicles except for local traffic, and northbound vehicles will not be able to cross the river at the bridge site. Instead, northbound vehicles will be required to detour to the Highway 6 By-pass, first traveling south on Argyle Street to reach the By-pass, then traveling north on the By-pass to cross the river in the northbound direction.

Although it is only necessary to close the northbound lane on the bridge for the second construction season, the lane closure could be implemented earlier during the first construction season if desired. This has the benefit of increasing driver familiarity with the traffic management scheme, but will also negatively impact local residents and businesses by restricting access and increasing trip times for northbound vehicles for an additional year. It is estimated that roughly 85% to 90% of the vehicles using the Argyle Street Bridge represent local trips that either begin or end in the Caledonia community. As a result, with sufficient advertising (including message signs posted at the bridge site several weeks prior to construction), many of the drivers using the bridge will be aware of the construction detour even before it is implemented, and closure of the northbound lane for an additional year may not be necessary. It is recommended that this issue be explored further during the detail design stage to assess whether the benefits of early lane closure outweigh the drawbacks.