APPENDIX

D TRANSPORTATION AND TRAFFIC STUDY

APPENDIX

D-1 TRAFFIC ANALYSIS REPORT

City of Brampton

Traffic Analysis of Arterial Roads Within Highway 427 Industrial Secondary Plan Area (Area 47)

B000590

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B000590

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1. Introduction

1.1. Overview

The City of Brampton (City) has initiated a Schedule C Municipal Class Environmental Assessment Study of Arterial Roads within the Highway 427 Industrial Secondary Plan Area (Area 47). The project scope is to develop a safe, efficient, and sustainable multi-modal transportation network in support of the proposed land use with consideration of pedestrians, cyclists, transit, autos and trucks while also providing access to major regional and provincial corridors to facilitate goods movement. In 2009, the City completed a Transportation and Transit Master Plan (TTMP) which was initiated to assess existing and future transportation services within and around the city, including the Area 47. The recently completed Area 47 Transportation Master Plan Study has supplemented the TTMP and the Peel-Highway 427 Extension Area Transportation Master Plan and recommended an arterial road network within Secondary Plan Area 47.

As a sub consultant to Wood, CIMA+ was retained by the City to undertake transportation and traffic analysis in support of the Environmental Assessment Study for the five corridors. This Traffic Analysis Report has been prepared in accordance with the EA Act and the Area 47 Transportation Master Plan Study to address short-and long-term transportation needs related to planned growth within these corridors to the year 2041. This report outlines the detailed existing traffic operations and future operations analysis conducted as part of the Environmental Assessment Study while reviewing the opportunities to better facilitate the movement of vehicles.

It should be noted that the Environmental Assessment for the GTA West was dormant at the time of this study as the provincial government stopped the process. For that reason, the consultant team were directed to go forward on the basis of there being no GTA-West in the future.

1.2. Study Area

The study area of Area 47 is bounded by Castlemore Road to the south, the Gore Road to the west, Mayfield Road to the north and Regional Road 50 to the east. The study area is shown in **Figure 1**.

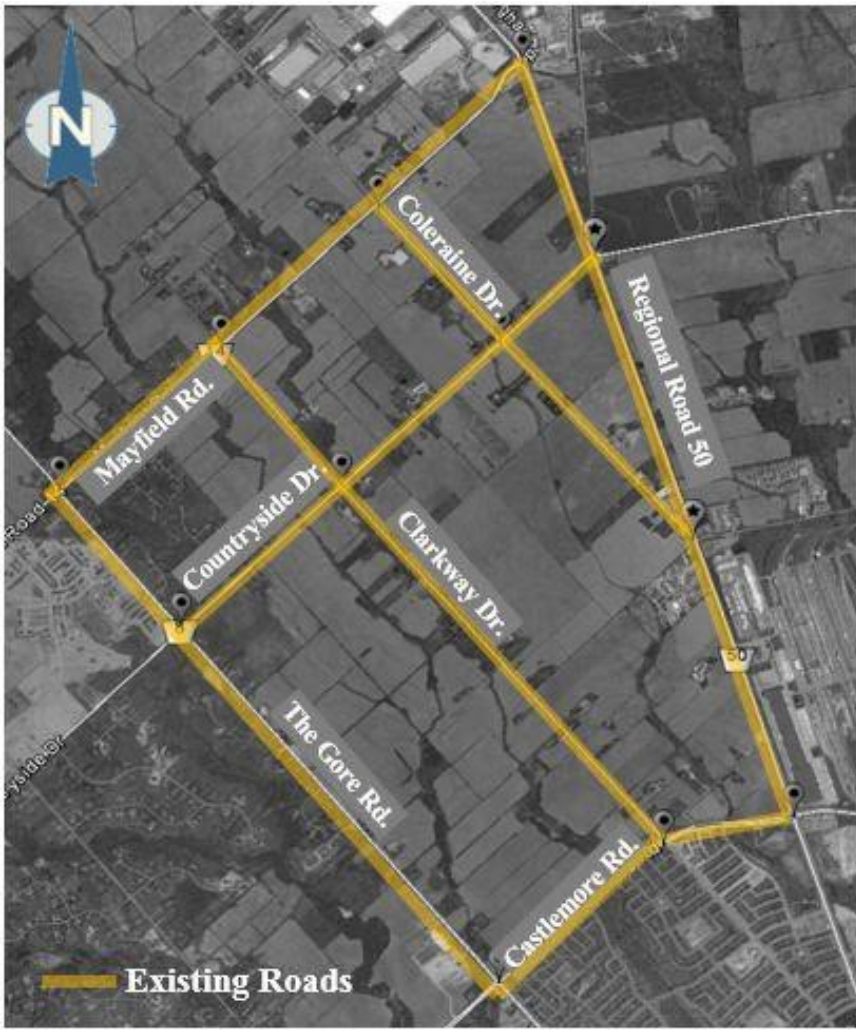


Figure 1: Study Area

2. Existing Transportation Conditions

This section documents the current traffic conditions, operational deficiencies and constraints experienced by the public travelling on the roads and at the intersections within the Study Area. The constraints identified at this stage were vital to the process of defining future problems and opportunities, and establishing need and justification for any improvements to the road network.

2.1. Turning Movement Counts and Heavy Vehicle Percentages

The City provided available turning movement counts (TMC) for the intersections in the study area which was supplemented by counts from the Region. At the locations without counts and counts older than 3 years, new counts were conducted. The dates for each count are shown in **Table 1**. The TMCs, and adjusted truck percentages are provided in **Appendix A**.

Table 1: Dates for Turning Movement Counts

INTERSECTION	COUNT DATE
Mayfield Rd. – The Grove Rd.	2013/04/30
Mayfield Rd. – Clarkway Dr.	2013/05/07
Mayfield Rd. – Coleraine Dr.	2013/05/07
Mayfield Rd. – Hwy 50	2013/05/14
Countryside Dr. – The Gore Rd.	2013/04/25
Countryside Dr. – Clarkway Dr.	2014/06/24
Countryside Dr. – Coleraine Dr.	2015/06/17
Countryside Dr. /Nashville Rd. – Hwy 50	2016/01/26
Coleraine Dr. /Major Mackenzie Dr. – Hwy 50	2014/05/27
Castlemore Rd. – The Gore Rd.	2013/04/25
Castlemore Rd. – Clarkway Dr.	2015/06/17
Castlemore Rd. – Hwy 50	2016/01/26
Sears Entrance – Hwy 50	2016/01/26
Castlemore Rd. – Bloom Dr.	2016/01/26
Castlemore Rd. – Gardenbrooke Tr.	2016/01/26
Castlemore Rd. – Drummondville Dr.	2016/01/26
Castlemore Rd. – Apple Valley Way	2016/01/26

For TMC that were obtained from previous years, a compound annual growth rate of 2% was applied to forecast the 2016 conditions. The growth rate was based on a review of historical counts (2013 TMP Report, available TMC) and EMME modelling outputs. In addition, the 2016 counts were balanced to account for any major discrepancy between intersections. During the balancing process, the new 2016 counts were used as "anchors" and other upstream and downstream locations were adjusted if required. Through the balancing, a few synthetic traffic

generators and attractors were used. The resulting 2016 balanced network is illustrated in **Appendix B**.

2.2. Signal Timing Plans

Signal timing plans for all signalized intersections within the study area were received from the City (including those under Region's jurisdiction). They are provided in **Appendix C**. For each timing plan received, the project team reviewed core components of the plans such as cycle length, splits, offsets, and time-of-day schedules.

2.3. GIS Maps of the Study Area

GIS maps received from the City were used to identify signal heads, detector locations, crosswalk distances and intersection geometry. In addition, the GIS Maps/Aerials were used for the development of the Vissim Microsimulation model which is described in **Section 3.2**.

2.4. Synchro Models

The City provided AM and PM peak Synchro models that were developed during the 2013 TMP study. For each model received, CIMA confirmed the model scope and update all network elements to reflect 2016 traffic conditions (geometry, signal timing, volumes, etc.).

2.5. Field Investigation

CIMA+ conducted a field investigation for the entire study area. The field investigations were done on January 26, 2016 during AM and PM peak hours to observe existing traffic operations (queues, operating speeds, delays, driver behavior, lane utilization etc.,) at each signalized intersection and along roadway segments. In addition, the following geometric elements were also reviewed and noted:

- Confirmation of signal heads and placement
- Intersection lane configuration (including storage lengths)
- Turning restrictions; and
- Posted speed limits

2.5.1. Traffic Operation Observations during AM and PM Peak Periods

AM Peak Period

- Southbound Traffic on Regional Road 50 is higher due to commuter trips with a large proportion of trucks
- High truck percentage on Mayfield Road (especially on the eastern segment of the study area)
- Several roadways operated under capacity: Coleraine Drive, Clarkway Drive and Countryside Drive
- Residual queues were observed for the southbound through (as shown in **Figure 2**) and eastbound through movements at the intersection of Regional Road 50 and Coleraine Drive.

Figure 2: Queue Spillback - Southbound Direction Regional Road 50 and Coleraine Drive (Distance to the intersection approximately 500m)

PM Peak Period

- Regional Road 50 served higher demand than in the AM peak with most traffic destined northbound (commuter trips). Similar to the AM, there was a high proportion of trucks.
- Several roadways operated under capacity: Coleraine Drive, Clarkway Drive and Countryside Drive.
- During PM Peak period, Mayfield Road served higher number of trips than the AM Peak period in both directions.
- Residual queues were observed on the following intersections movements:
- Northbound left and through at Regional Road 50 and Mayfield Road
- Westbound through and Northbound through at Coleraine Drive and Regional Road 50
- Northbound through at Gore Road and Castlemore Road
- Northbound through at Coleraine Drive and Mayfield Road (as shown in **Figure 3**)

In general, during the PM Peak period, Northbound and Westbound directions served the highest demand which is aligned with the EMME 2016 forecasts and the 2013 TMP observations.

Figure 3: Queue Spillback - Northbound Direction at Regional Road 50 and Coleraine Drive

3. Existing Operations Analysis

3.1. Intersection Capacity and LOS Analysis

Signalized intersection traffic operations were analyzed with the Synchro-9 Traffic Signal Coordination Software, which employs methodologies of the *Highway Capacity Manual*. Synchro is used to analyze intersections in a road corridor or network, considering intersection interactions, including spacing, queues and signal operations.

The intersection analysis considers two separate performance measures: (a) the volume-to-capacity (v/c) ratio; and (b) the level of service (LOS), which is a qualitative measure based on the control delay per vehicle. For signalized intersections, the control delay is measured for the individual movements and for the overall intersection. The LOS criteria for are illustrated in **Table 2**, which also indicates a typical evaluation scheme for each LOS.

Table 2: LOS Criteria for Signalized Intersections

LOS	Control Delay (seconds/vehicle)	Traffic Flow Characteristics
A	0– 10	Very Good
B	>10 – 20	Good
C	>20 – 35	Typically preferred planning objective
D	>35 – 55	Typically, acceptable
E	>55 – 80	Undesirable; potentially unstable traffic flow
F	>80	Failing movements may impede traffic flow

The results of this analysis were used to assist in the identification of the network's needs and opportunities for improvement.

3.1.1. Existing Signalized Intersection Capacity Analysis

The existing signalized intersection capacity analysis for both AM and PM peak hours was conducted utilizing the balanced 2016 traffic demand and current signal timing plans obtained from the City. The results from the analysis all intersection movements (including overall) are summarized in **Table 3**. Detailed, Synchro reports are provided in **Appendix D**.

Table 3: Intersection Analysis Results

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Regional Road 50 at Castlemore Road						
Overall	**0.90**	**49.9**	**D**	**0.99**	**53.5**	**D**
Eastbound Left	0.39	29.9	C	0.57	48.2	D
Eastbound Through	0.89	54.9	D	0.98	86.7	F
Eastbound Right	0.17	35.6	D	0.06	47.1	D
Westbound Left	0.77	55.5	E	0.61	39.3	D
Westbound Through	0.56	39.9	D	1.07	101.2	F
Westbound Right	0.11	33.5	C	0.31	41.0	D
Northbound Left	0.32	38.0	D	0.63	31.4	C
Northbound Through	0.53	43.3	D	0.74	34.6	C
Northbound Right	0.07	36.6	D	0.12	23.2	C
Southbound Left	0.58	29.3	C	0.97	95.6	F
Southbound Through	0.99	61.8	E	0.46	25.5	C
Southbound Right	0.06	27.0	C	0.10	20.6	C

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Regional Road 50 at Sear's Driveway						
Overall	**0.77**	**11.6**	**B**	**0.69**	**10.1**	**B**
Westbound Left	0.42	51.3	D	0.53	51.6	D
Westbound Right	0.02	48.2	D	0.02	47.0	D
Northbound Through	0.37	5.3	A	0.72	9.4	A
Northbound Right	0.06	4.0	A	0.10	4.2	A
Southbound Left	0.05	3.3	A	0.07	7.4	A
Southbound Through	0.83	10.0	B	0.49	6.2	A
Regional Road 50 at Major Mackenzie Road						
Overall	**0.81**	**36.6**	**D**	**1.95**	**89.0**	**F**
Eastbound Left/Through/Right	0.60	37.6	D	0.18	29.2	C
Westbound Left/Through/Right	0.56	40.6	D	0.49	35.7	D
Northbound Left	0.87	104.4	F	1.29	199.1	F
Northbound Through/Right	0.53	21.7	C	0.98	47.9	D
Southbound Left	0.41	20.9	C	2.98	972.6	F
Southbound Through/Right	0.95	42.5	D	0.61	23.1	C
Regional Road 50 at Countryside Drive						
Overall	**0.79**	**22.3**	**C**	**0.86**	**24.0**	**C**
Eastbound Left/Through/Right	0.57	44.5	D	0.64	46.6	D
Westbound Left	0.87	78.0	E	0.26	40.1	D
Westbound Through	0.35	41.2	D	0.55	43.1	D
Westbound Right	0.11	39.0	D	0.0	52.4	D
Northbound Left	0.23	11.9	B	0.20	10.3	B
Northbound Through/Right	0.42	11.7	B	0.78	18.2	B
Southbound Left	0.35	7.0	A	0.91	60.2	E
Southbound Through	0.83	20.4	C	0.58	13.6	B
Southbound Right	0.01	8.7	A	0.03	8.8	A
Regional Road 50 at Mayfield Road						
Overall	**0.96**	**56.4**	**E**	**0.71**	**25.9**	**C**
Eastbound Left	0.55	45.7	D	0.76	53.8	D
Eastbound Through	0.63	55.5	E	0.81	59.3	E

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Eastbound Right	0.08	46.2	D	0.05	39.6	D
Westbound Left	1.38	225.2	F	0.78	57.7	E
Westbound Through	0.69	48.9	D	0.71	52.1	D
Westbound Right	0.01	37.2	D	0.02	39.3	D
Northbound Left	0.51	19.3	B	0.52	16.9	B
Northbound Through	0.39	13.5	B	0.52	14.0	B
Northbound Right	0.08	10.6	B	0.48	14.4	B
Southbound Left	0.02	14.7	B	0.06	14.3	B
Southbound Through	0.74	26.0	C	0.68	23.0	C
Southbound Right	0.11	15.6	B	0.14	14.7	B
Coleraine Road at Mayfield Road						
Overall	**0.48**	**25.8**	**C**	**0.38**	**25.7**	**C**
Eastbound Left	0.38	7.1	A	0.32	6.6	A
Eastbound Through/Right	0.16	6.5	A	0.22	6.6	A
Westbound Left	0.08	11.6	B	0.03	10.1	B
Westbound Through/Right	0.24	12.9	B	0.26	12.0	B
Northbound Left	0.24	54.3	D	0.45	55.5	E
Northbound Through/Right	0.32	53.7	D	0.67	58.4	E
Southbound Left	0.10	43.7	D	0.23	45.8	D
Southbound Through/Right	0.74	54.4	D	0.38	47.3	D
The Gore Road at Mayfield Road						
Overall	**0.68**	**22.5**	**C**	**0.73**	**21.8**	**C**
Eastbound Left/Through/Right	0.60	15.3	B	0.69	16.6	B
Westbound Left/Through/Right	0.62	8.0	A	0.68	6.9	A
Northbound Left/Through/Right	0.26	35.5	D	0.86	59.2	E
Southbound Left/Through/Right	0.82	53.0	D	0.24	36.7	D
The Gore Road at Countryside Drive						
Overall	**0.48**	**30.0**	**C**	**0.45**	**25.6**	**C**
Eastbound Left/Through/Right	0.86	57.4	E	0.62	37.1	D
Westbound Left/Through/Right	0.48	38.4	D	0.80	45.8	D
Northbound Left	0.03	7.2	A	0.13	7.5	A

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Northbound Through/Right	0.08	7.4	A	0.32	9.1	A
Southbound Left	0.04	7.2	A	0.02	6.8	A
Southbound Through/Right	0.34	9.7	A	0.08	7.2	A
The Gore Road at Castlemore Road						
Overall	**0.67**	**19.4**	**B**	**0.67**	**18.5**	**B**
Eastbound Left	0.07	10.7	B	0.42	20.3	C
Eastbound Through	0.56	15.3	B	0.45	13.3	B
Eastbound Right	0.33	13.0	B	0.14	10.5	B
Westbound Left	0.25	14.5	B	0.16	11.6	B
Westbound Through	0.44	13.6	B	0.62	15.8	B
Westbound Right	0.02	9.9	A	0.05	9.8	A
Northbound Left	0.87	32.7	E	0.77	40.3	D
Northbound Through	0.06	24.4	C	0.31	27.2	C
Northbound Right	0.04	24.3	C	0.07	25.2	C
Southbound Left	0.14	25.2	C	0.10	25.5	C
Southbound Through	0.39	27.4	C	0.06	25.1	C
Southbound Right	0.03	24.2	C	0.03	24.8	C
Clarkway Drive at Castlemore Road						
Overall	**0.45**	**10.6**	**B**	**0.34**	**11.5**	**B**
Eastbound Left	0.06	1.4	A	0.17	4.7	A
Eastbound Through	0.44	3.7	A	0.29	4.2	A
Eastbound Right	0.04	2.3	A	0.05	3.2	A
Westbound Left	0.06	4.4	A	0.07	3.7	A
Westbound Through	0.20	4.6	A	0.30	4.5	A
Westbound Right	0.01	3.9	A	0.06	3.5	A
Northbound Left	0.30	45.0	D	0.56	66.0	E
Northbound Through	0.04	41.2	D	0.21	56.4	E
Northbound Right	0.02	41.1	D	0.02	54.8	D
Southbound Left	0.50	48.2	D	0.25	58.0	E
Southbound Through	0.33	43.7	D	0.22	56.5	E
Southbound Right	0.02	41.1	D	0.01	54.7	D

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Clarkway Drive at Mayfield Road						
Overall	**0.61**	**30.1**	**C**	**0.71**	**22.4**	**C**
Eastbound Left/Through/Right	0.54	5.8	A	0.68	10.7	B
Westbound Left/Through/Right	0.55	13.2	B	0.71	18.5	B
Northbound Left/Through/Right	0.38	56.5	E	0.80	72.5	E
Southbound Left/Through/Right	1.09	146.0	F	0.62	63.7	E
Apple Valley Way at Castlemore Road						
Overall	**0.40**	**2.5**	**A**	**0.42**	**2.5**	**A**
Eastbound Through	0.42	1.3	A	0.27	1.6	A
Eastbound Right	0.01	0.5	A	0.02	1.1	A
Westbound Left	0.02	1.5	A	0.07	1.3	A
Westbound Through	0.26	1.9	A	0.43	2.1	A
Northbound Left	0.15	51.5	D	0.16	65.4	E
Northbound Right	0.02	50.4	D	0.01	63.9	E
Drummondville Drive at Castlemore Road						
Overall	**0.42**	**4.6**	**A**	**0.32**	**3.2**	**A**
Eastbound Through	0.42	3.4	A	0.30	2.1	A
Eastbound Right	0.02	2.0	A	0.03	1.5	A
Westbound Left	0.03	2.1	A	0.03	0.8	A
Westbound Through/Right	0.20	2.2	A	0.30	1.0	A
Northbound Left	0.50	52.3	D	0.56	70.7	E
Northbound Through/Right	0.02	46.9	D	0.01	60.8	E
Gardenbrooke Drive at Castlemore Road						
Overall	**0.40**	**3.0**	**A**	**0.43**	**2.4**	**A**
Eastbound Through	0.41	0.9	A	0.31	1.1	A
Eastbound Right	0.02	0.0	A	0.02	0.4	A
Westbound Left	0.07	2.4	A	0.06	0.6	A
Westbound Through	0.30	2.7	A	0.43	1.5	A
Northbound Left	0.26	50.4	D	0.36	70.4	E
Northbound Right	0.02	47.5	D	0.01	63.8	E

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS

Intersection	AM Peak Period			PM Peak Period		
	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Bloom Drive at Castlemore Road						
Overall	**0.40**	**4.1**	**A**	**0.43**	**3.4**	**A**
Eastbound Through	0.41	2.9	A	0.31	2.1	A
Eastbound Right	0.01	1.7	A	0.03	1.4	A
Westbound Left	0.02	1.8	A	0.03	1.4	A
Westbound Through	0.31	2.4	A	0.44	2.2	A
Northbound Left	0.34	51.0	D	0.38	66.7	E
Northbound Right	0.02	48.3	D	0.01	63.0	E

Based on the results turning movements generally are operating under capacity during both the AM and PM peak hours except for the following intersections:

- *The intersection of Regional Road 50 at Castlemore Road* is close to capacity during the AM peak hour and at capacity during the PM peak hour. The southbound through movement is experiencing a v/c ratio of 0.99 during the AM peak hour while the eastbound through, westbound through, and southbound left-turn movements experiences v/c ratios of 0.98,1.07,0.97 respectively during the PM peak hour;
- *The intersection of Regional Road 50 at Major Mackenzie Road* is operating over capacity during the PM peak hour with an overall v/c ratio of 1.95. The southbound and northbound through movements in particular are experiencing v/c greater than 1.0.
- *The intersection of Regional Road 50 at Mayfield Road* is experiencing a v/c ratio greater than 1.0 for the westbound left turn movement during the AM; and
- The southbound through movement at the intersection of Clarkway Drive and Mayfield Road is experiencing v/c ration greater than 1.0

Based on the field investigation, the traffic operations observed were similar to the results reported in the existing conditions Synchro model. The overall intersection LOS during AM and PM peak hours is illustrated in **Figure 4**. In general, most of the study area intersections are operating at LOS D or better in both the AM and PM peak hours. High delays are being experienced at the intersection of Regional Road 50 and Mayfield Road during the AM peak hour. During the PM peak hour, the intersection of Regional Road 50 and Major Mackenzie Road is experiencing poor level of service as well.

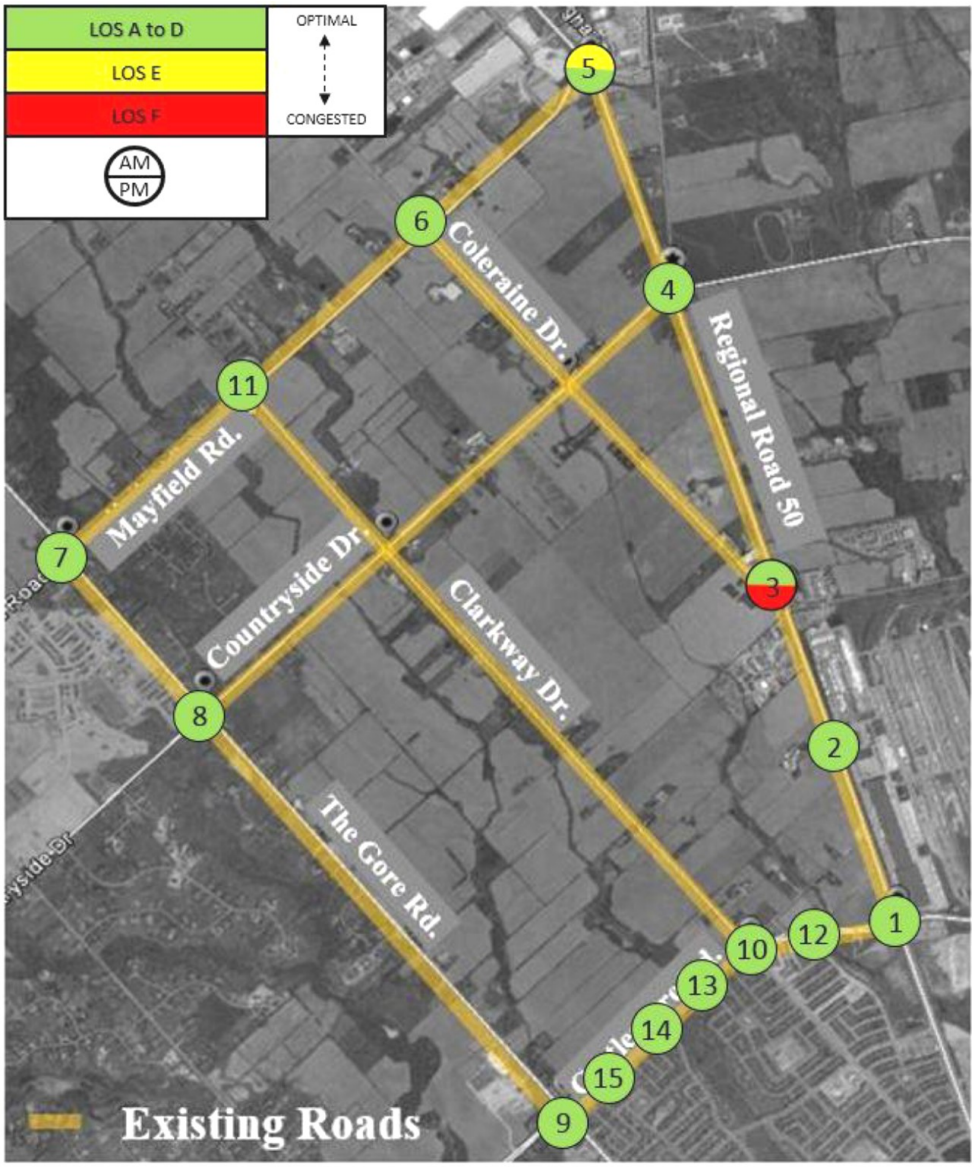


Figure 4: Overall Intersection LOS

In comparing these results to findings from existing conditions Synchro analysis undertaken in the Highway 427 Industrial Secondary Plan[1], the results are very similar. In both models the AM peak hour reported acceptable LOS for most intersections, with increased delay for the intersection of Regional Road 50 and Mayfield Road. For the PM peak hour both models also reported acceptable LOS for most intersections, with the exception Regional Road 50 and Major Mackenzie Road intersection which showed more capacity constraints in the CIMA+ analysis. This could be attributed to the increase in trips from new development and background growth.

3.2. VISSIM Microsimulation Analysis

A VISSIM microsimulation model of the study area (**Figure 1**) was developed which will be used to evaluate all future traffic operations and proposed recommendations within the network. The initial phase of the VISSIM model development is the calibration to existing conditions, which is outlined in this report.

The microsimulation model is a vital tool to assess the operations of vehicles in the study area. It is important to note that microsimulation does not address network alternatives or network-wide impacts as those were studied in the Macro Modelling report.

3.2.1. Model Network Development

The model was developed utilizing aerial images provided by the City which ensured spatial accuracy of the network. After developing the base geographic layout of the network, the key network attributes that were coded included the following:

Table 4: Network Attributes

Link characteristics	Node characteristics / Traffic Control
• Number of lanes	• Signals
• Lane width	• Stop signs
• Storage lengths	• Yield signs
• Link and turning speeds	• Turning restrictions
• Speed profile	• Detectors

The model comprised of 15 signalized intersections and 2 un-signalized intersections as shown in **Figure 5**. In addition to geometric attributes, transit lines and stops, pedestrians at signalized intersections, and vehicle composition were coded.

The Ring Barrier Controller (RBC) module in VISSIM was used to model fixed, fully-actuated or semi-actuated signal controllers as outlined in the timing plans provided by the City/Region of Peel.

The Vissim model limit is shown in **Figure 6**. In addition, simulation sinks and sources were coded in the existing model to reflect unbalancing due to small residential accesses.

As with any model development stage, a detail quality control review was conducted to ensure all elements were accurate and no anomalies were present in the model that could lead to erroneous results.

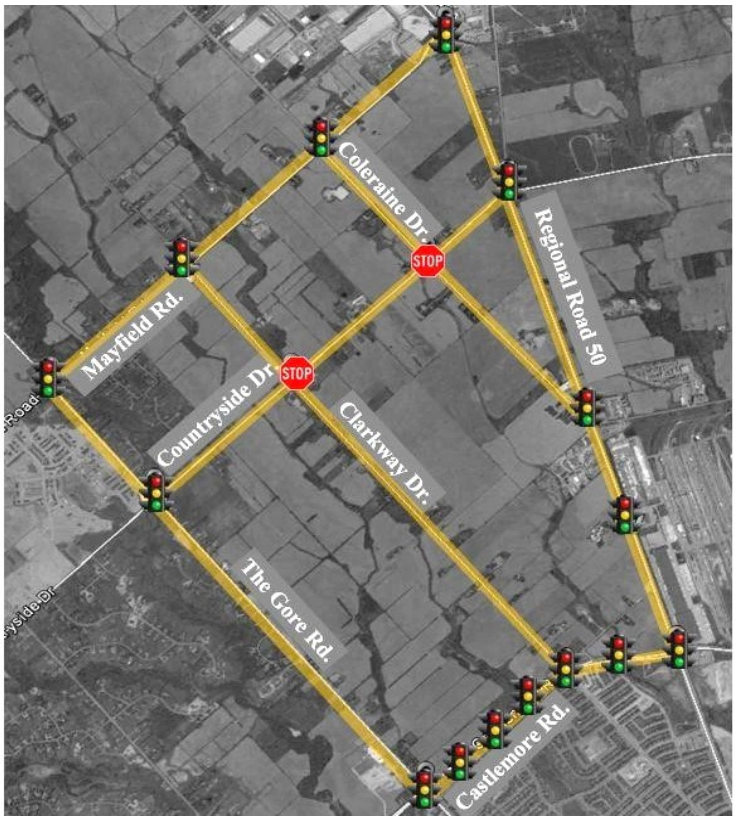


Figure 5: Signalized and Un-signalized Intersections within the Microsimulation Study Network

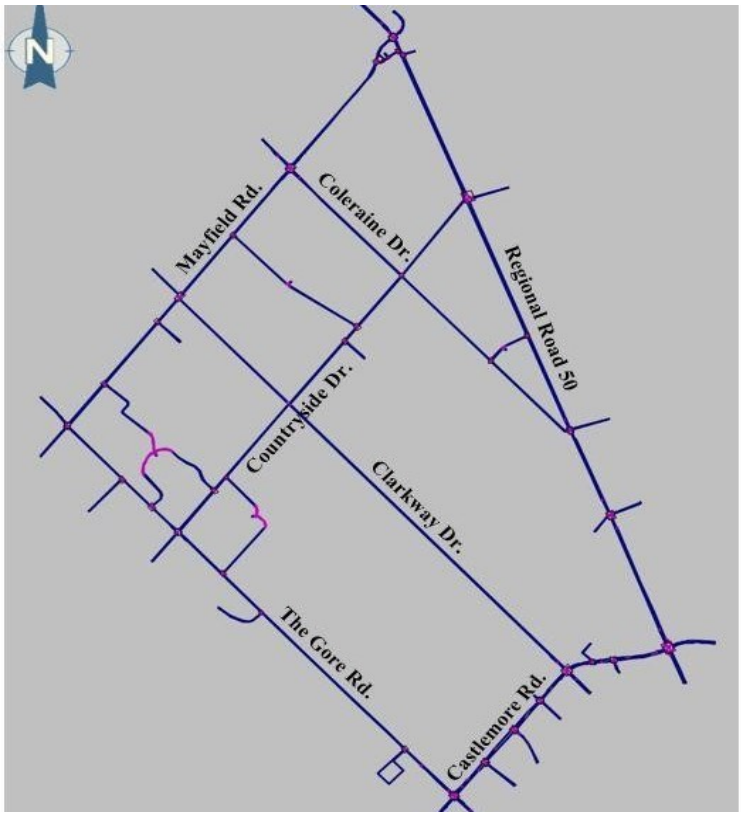


Figure 6: The VISSIM Network

In terms of simulation time period, the analysis considered PM peak hour occurring between 4:00 PM – 5:00 PM while AM Peak hour occurring between 7:00 AM – 8:00 AM. The microsimulation model also included a 30-minute warm up period which was used to seed the network before start of peak hour simulation.

3.2.2. Travel Demand

The 2016 travel demand for the study area was generated using the City of Brampton's 2011 base updated EMME model. Detail documentation on the calibration of the existing 2016 EMME model is documented in the Macro Modelling Report. The calibrated 2016 subarea traversal OD matrix was used as the demand input for the microsimulation model. Before the OD could be translated to Vissim, minor manual adjustments were conducted to account for detail travel patterns apparent at the turning movement count level. The manual refinement of the OD matrix to match the observed origin and destination volumes ensured forecasted patterns from EMME were maintained.

A dynamic assignment approach was utilized in the microsimulation model to realistically distribute the traffic demand among the various paths in the road network. Two separate OD demands were considered for Autos and Trucks in the microsimulation model, where the truck percentages were obtained from the observed volumes.

Within the microsimulation study area, there are 9,938 vehicle trips generated during the weekday PM peak hour and 9,074 during the weekday AM peak hour.

3.2.3. Model Calibration and Validation

It is essential that the VISSIM model be calibrated and validated to as high a standard as possible to ensure that the model is robust and reliable. The criteria used for the calibration and validation of the VISSIM model are detailed below and are based on FHWA microscopic simulation guidelines[1].

Calibration

The simulation of all turning movement volumes in a microsimulation model is often challenging, particularly when an origin / destination matrix extracted from a demand model and dynamic assignment have been used to estimate modelled volumes at intersection level.

While the typical criteria of comparing model to observed volumes used in many travel demand modelling and forecasting studies are sufficient, the GEH statistic used in microsimulation studies is a form of the Chi-squared statistic that incorporates both relative and absolute errors and is better at indicating model performance for low-volume roads. The statistic consists of the following formula:

[1] Traffic Analysis Toolbox, Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software, June 2004, FHWA-HRT-04-040.

$$GEH = \sqrt{\frac{(M-C)^2}{(0.5(C+M))}}$$

where *GEH* is the GEH statistic, C is the Observed Flow and M is the Modelled Flow.

The detail calculations of the GEH statistic for all individual turning movements within the study area was developed and the results are shown in **Appendix E**. Based on the GEH statistic, observed and simulated traffic demand, the scatter plots (**Figure 7** and **Figure 8**) for AM and PM peak period were developed. As shown in **Figure 7** and **Figure 8**, the model fit the observed quite well with a R^2 of 0.99 for both peak periods. The plots also highlight the GEH 5 envelope which shows the critical demands (high traffic demand) within the envelope. In addition to the scatter plot, a summary of the GEH calculation and reference to FHWA target guidelines are shown in **Table 5** and **Table 6** for the AM and PM peak hours respectively. Overall, the results showed that the simulated model is loading the observed traffic demand with high degree of accuracy.

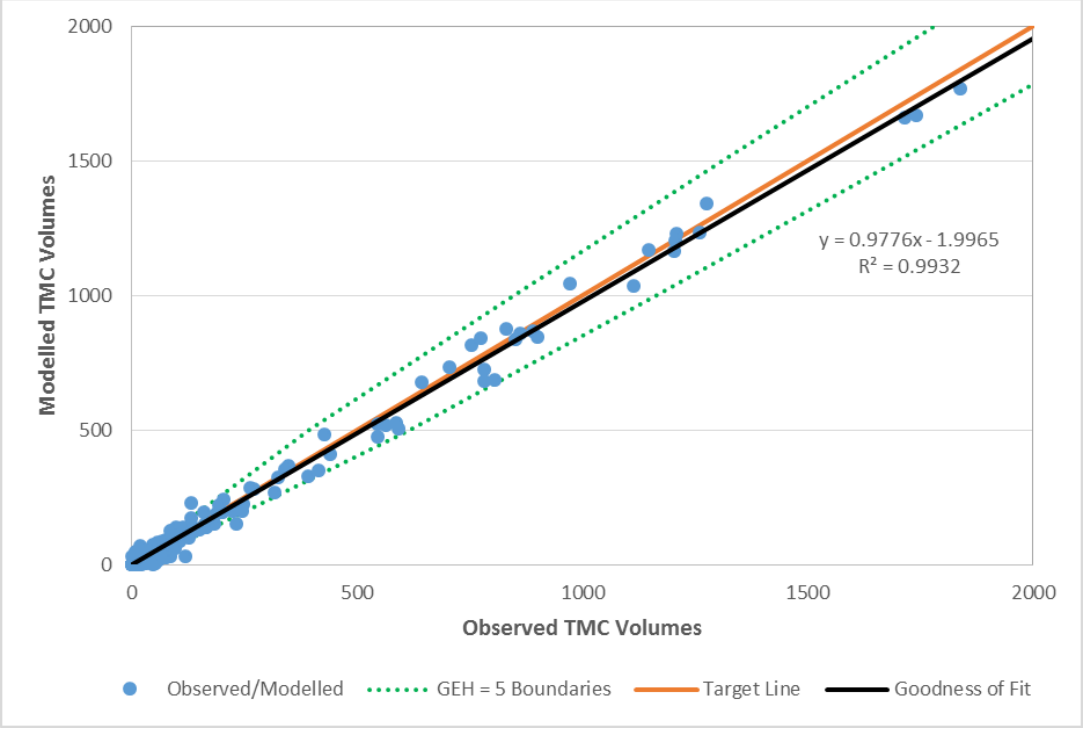


Figure 7: AM Peak Hour Modelled/Observed Volume Scatter Plot - Turning Movement

Table 5: PM Peak Hour GEH Summary of Turning Movement Calibration Results

AM Peak Hour GEH – Turning Movements	Modelled	FHWA Target	Check
Percentage of Turns with GEH <= 5	90%	85%	OK
Percentage of Turns with GEH <= 10	99%	90%	OK
Percentage of Turns with GEH > 10	1%	2%	OK

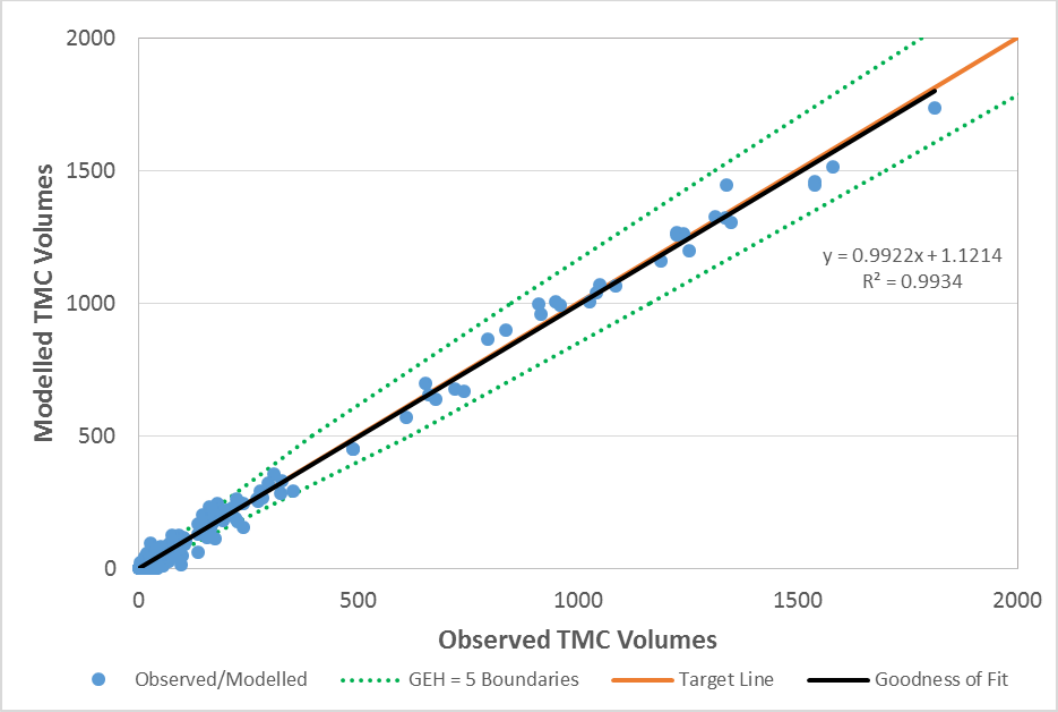


Figure 8: PM Peak Hour Modelled/Observed Volume Scatter Plot - Turning Movement

Table 6: PM Peak Hour GEH Summary of Turning Movement Calibration Results

PM Peak Hour GEH – Turning Movements	Modelled	FHWA Target	Check
Percentage of Turns with GEH <= 5	86%	85%	OK
Percentage of Turns with GEH <= 10	99%	90%	OK
Percentage of Turns with GEH > 10	1%	2%	OK

Travel Time Validation

In addition to calibration, the model was validated to travel time runs along surrounding existing arterials (Mayfield Road, Regional Road 50, Castlemore Road and Gore Road). Observed travel time data were collected on 26 January 2016 using GPS prove vehicles. Before the data were used, a detail review of the observed travel time runs was done to ensure no erroneous data points. Based on the FHWA guidelines, a summary of the comparison between modelled travel times and observed travel times was done. The results are shown in

Table 7 and **Table 8** for each peak period which demonstrate that the Vissim model could attain validation of the travel time for the road sections.

Table 7: AM Peak Hour - Travel Time Validation Results

Travel Time Validation Check	Modelled	FHWA Target	Check
Percentage of Sections with TT dif. <= 15% **OR 100% 85%** **Percentage of Sections with TT dif. <= 60 sec**			OK

Table 8: PM Peak Hour - Travel Time Validation Results

Travel Time Validation Check	Modelled	FHWA Target	Check
Percentage of Sections with TT dif. <= 15% **OR 100% 85%** **Percentage of Sections with TT dif. <= 60 sec**			OK

In addition to the FHWA check, the travel time comparison plots for each of the main surrounding arterials within the study area is shown in **Figure 9** through **Figure 12** (for AM peak period) and **Figure 13** through **Figure 16** (for PM peak period) which further highlights how the model is operating. For most individual segments, the modelled travel times are quite close to observed travel times. There were a few instances where the model either overestimated or underestimated travel times but the errors are within acceptable reporting range.

Detailed results for travel time validation is available in **Appendix F**.

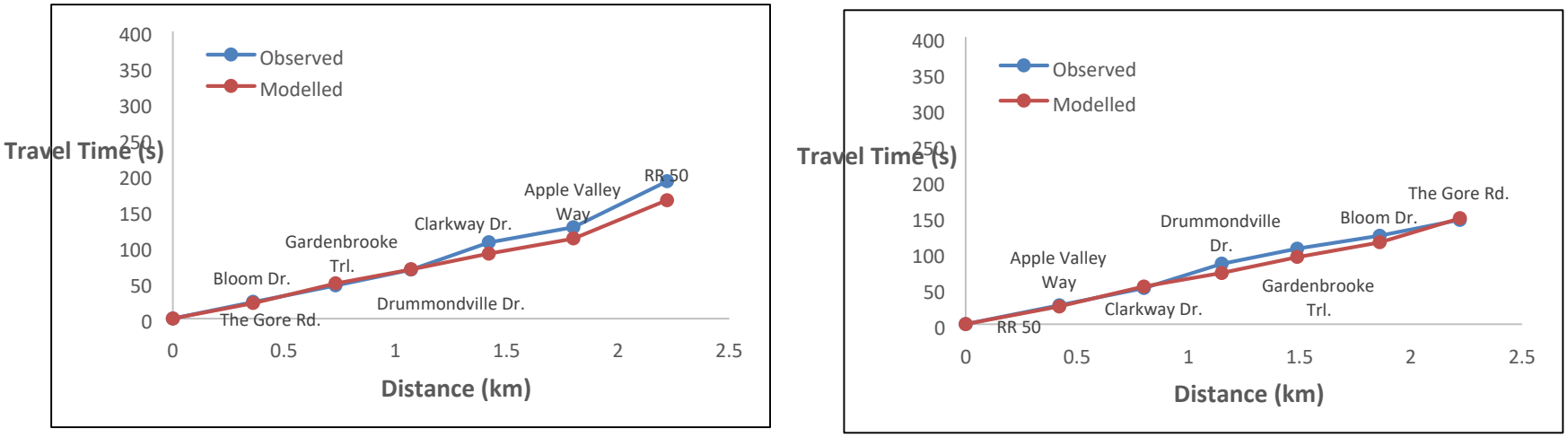


Figure 9: AM Peak Castlemore Road - EB (Left) and WB (Right) - Travel Time Comparison

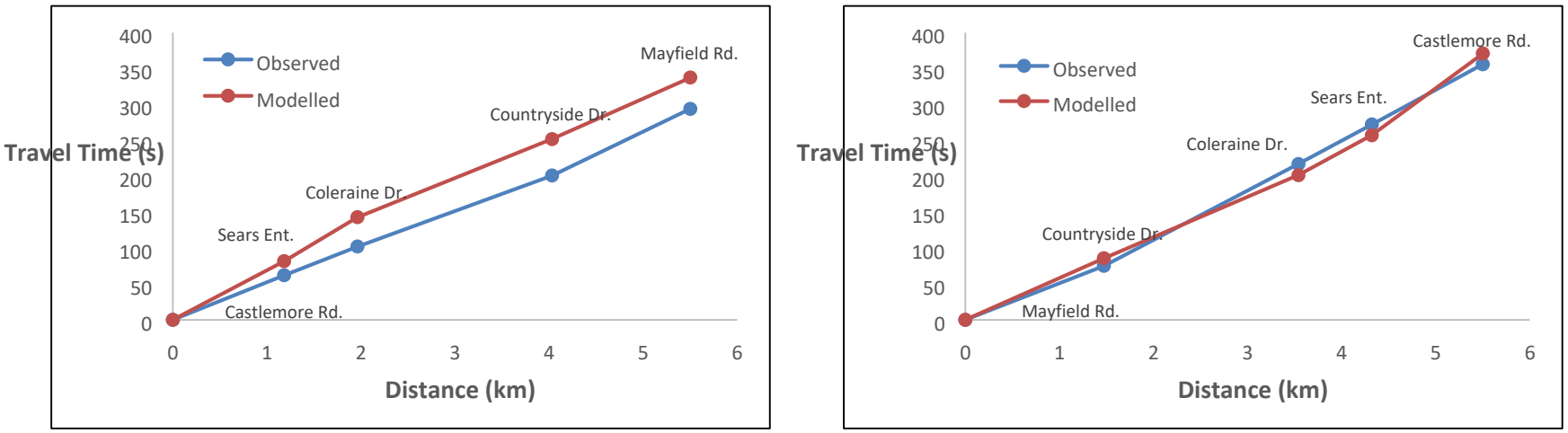


Figure 10: AM Peak - RR50 - NB (Left) and SB (Right) - Travel Time Comparisons

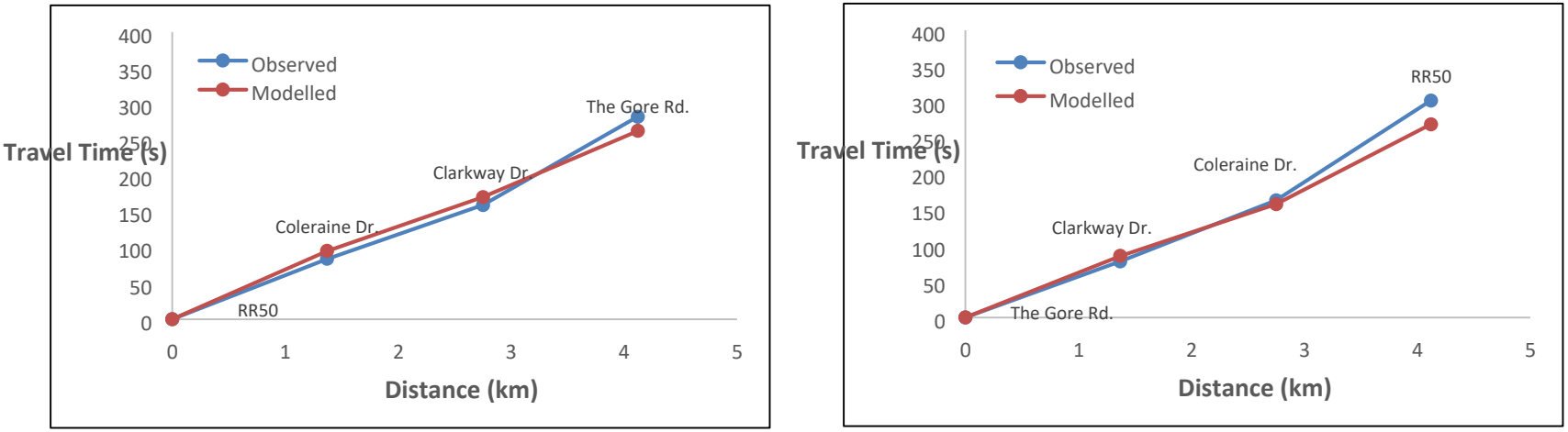


Figure 11: AM Peak - Mayfield - WB (Left) and EB (Right) - Travel Time Comparison

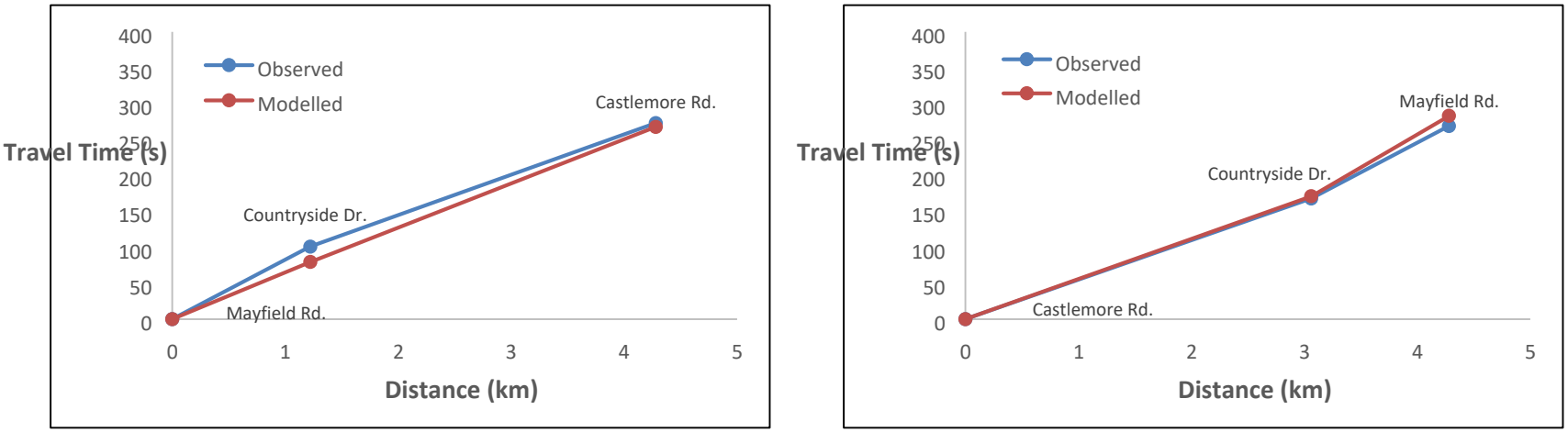


Figure 12: AM Peak - The Gore Road - SB (Left) and NB (Right) - Travel Time Comparison

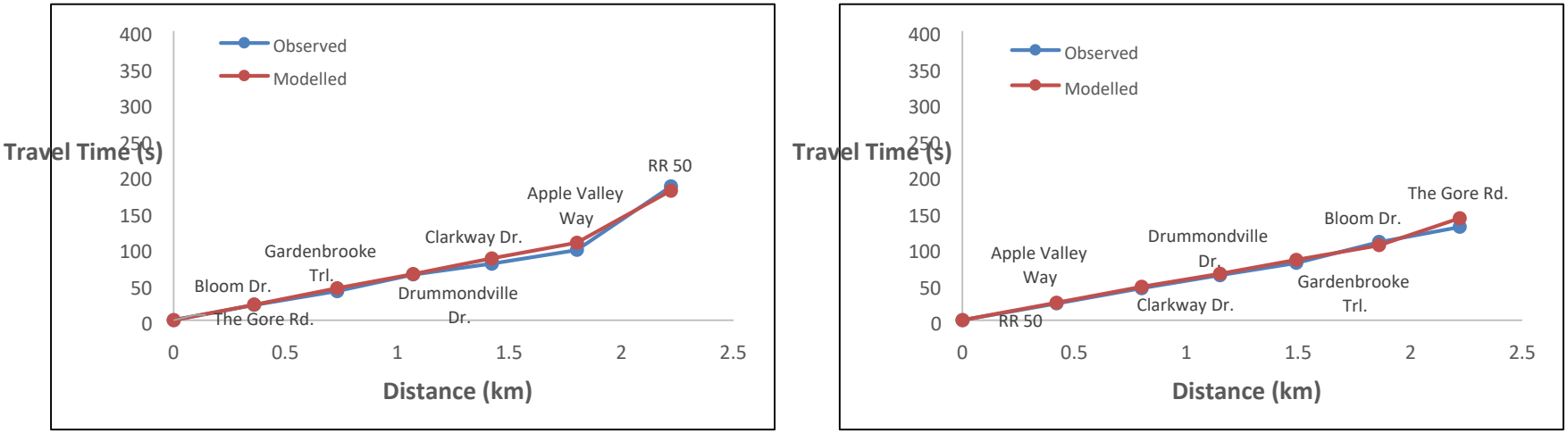


Figure 13: PM Peak - Castlemore Road - EB (Left) and WB (Right) - Travel Time Comparison

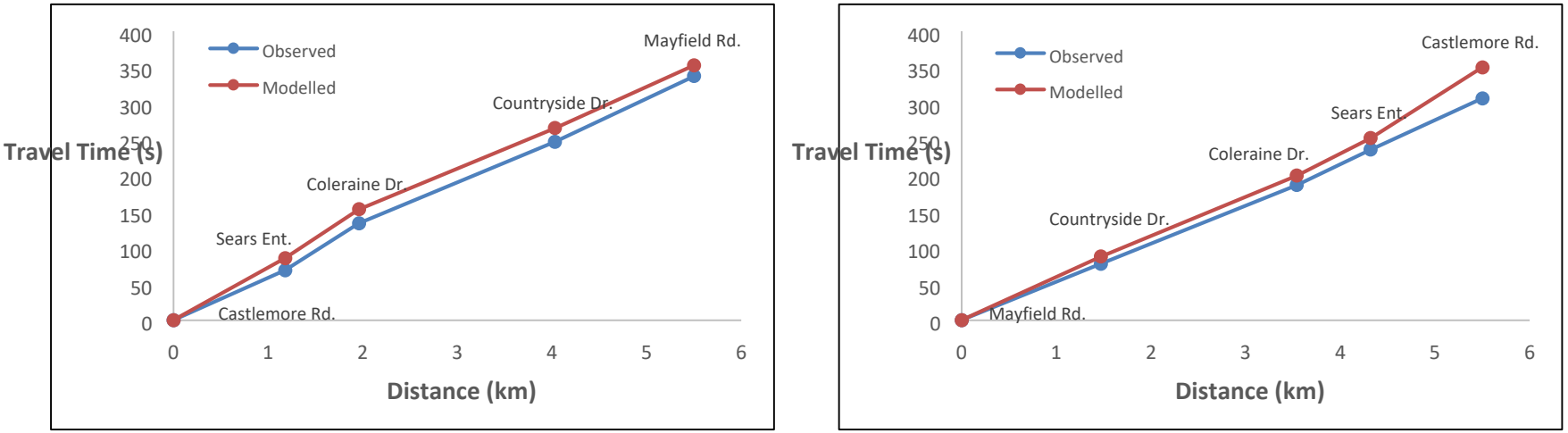


Figure 14: PM Peak - RR50 - NB (Left) and SB (Right) - Travel Time Comparison

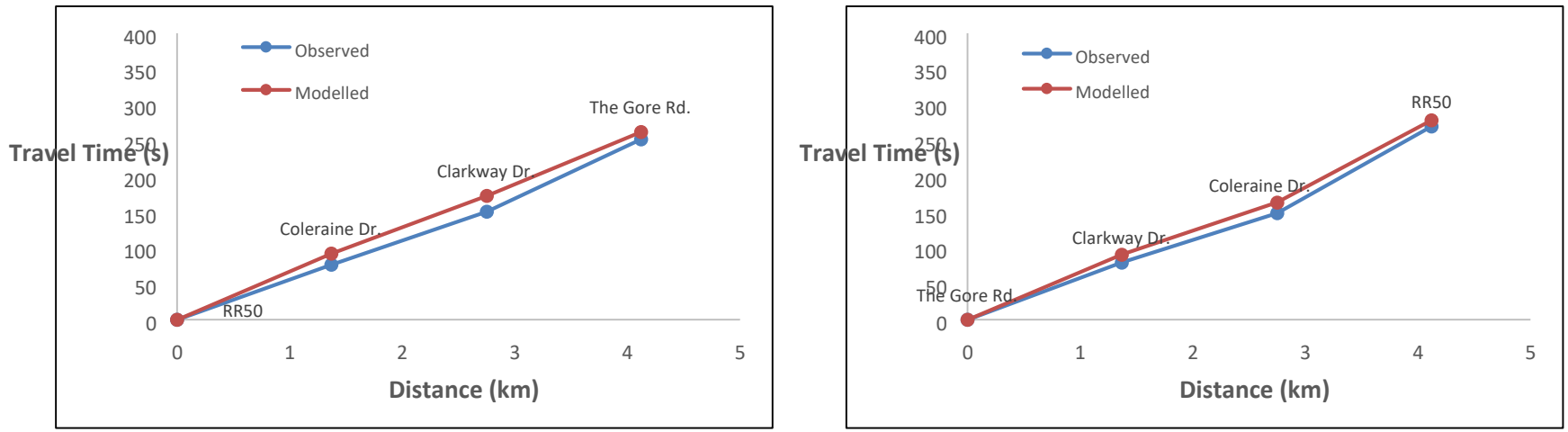


Figure 15: PM Peak - Mayfield Road - WB (Left) and EB (Right) - Travel Time Comparison

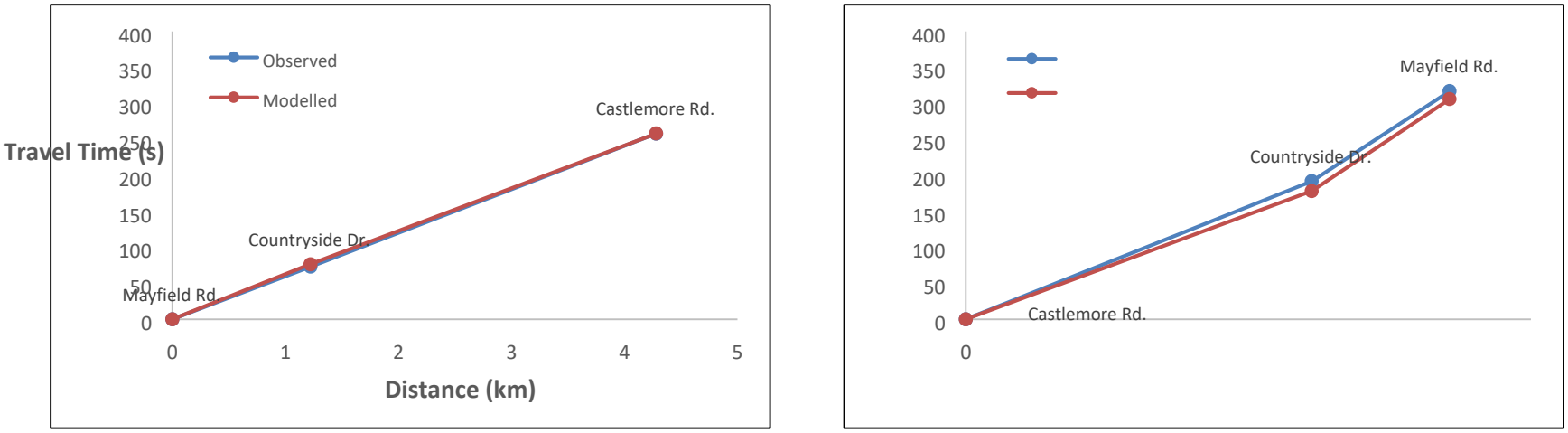


Figure 16: PM Peak - The Gore Road - SB (Left) and NB (Right) - Travel Time Comparison

4. Future Transportation Conditions

This section documents the 2031 and 2041 VISSIM Microsimulation modeling component. The 2013 TMP recommended an arterial and a collector road network to support accessibility needed for auto, transit and walking modes of travel. Analysis was based on the 2031 SP47 TMP-recommended road network, which is shown in **Figure 17**.

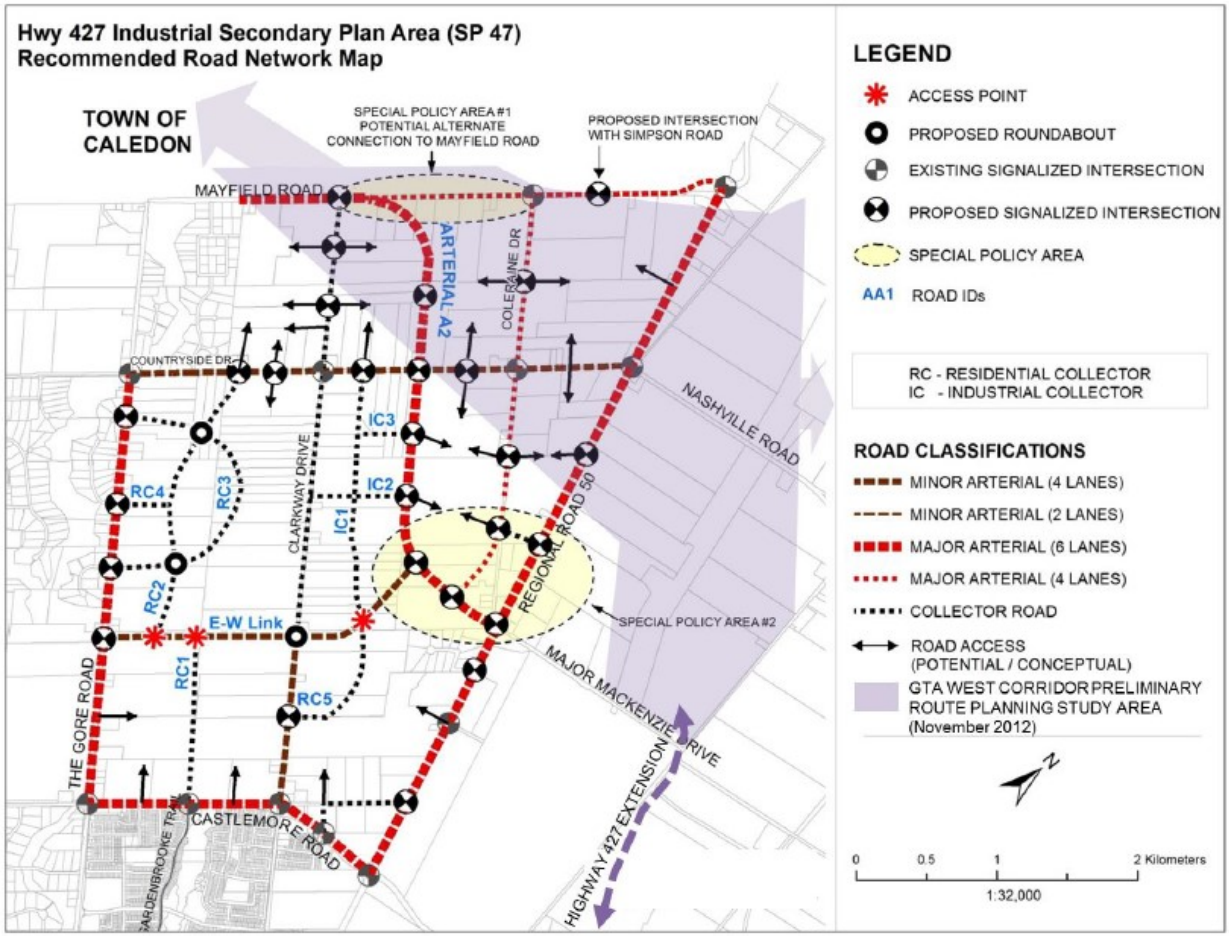


Figure 17: SP47 TMP Recommended Road Network

The recommended road network was evaluated under the updated 2031/2041 traffic demand in VISSIM. In addition, several alternative road alignments were evaluated at locations that were identified to perform with poor levels of service (high delays and long queues). The subsequent sections first outline the 2031/2041 traffic demand from the EMME modeling (**Section 4.1**) followed by a detail traffic operational analyses conducted using the VISSIM Microsimulation model in **Section 4.2**.

4.1. Traffic Forecasts – EMME Modeling

Utilizing the travel demand forecasted through the EMME model, 2031 and 2041 traversal matrices were developed which were modeled at the detail operational level in VISSIM (as outlined in **Section 4.2**).

The forecasted total number of trips within the SP47 sub-area for 2031 and 2041 are summarized in **Table 9**. Total trips within the SP47 area are expected to increase by 20% during AM peak and by 12% during PM peak.

Table 9: Predicted Total Trips for 2031 and 2041

	Total Number of Trips	
	AM	PM
2031	16,929	19,021
2041	20,346	21,391
Growth No.	3417	2370
Growth %	20%	12%

To better understand the travel pattern and the demand characteristics between the horizon years (2031 and 2041), the population and employment changes are shown in **Table 10** for the various internal traffic zones within the sub-area. Population is expected to grow by 3,139 (11%) in 2041, while employment is expected to grow by 5,062 (36%). There is a noticeable increase in employment land use planned for SP47 between the 2031 and 2041 planning horizons.

Table 10: Population and Employment Growth between 2031 and 2041

Internal Zones	Population		Employment		Population Growth (2031-2041)	Employment Growth (2031-2041)	Population Growth %	Employment Growth %
	2031	2041	2031	2041				
1744	939	1045	52	58	106	6	11%	12%
1745	20	20	2577	3268	0	691	0%	27%
1822	1635	1783	94	106	148	12	9%	13%
1823	19	20	966	1496	1	530	5%	55%
1824	1274	1405	1797	2756	131	959	10%	53%
1825	1979	2276	4207	6319	297	2112	15%	50%
1826	7258	8118	409	483	860	74	12%	18%
1827	7499	8677	513	865	1178	352	16%	69%
1828	2271	2689	1302	1628	418	326	18%	25%
Overall	**22894**	**26033**	**11917**	**16979**	**3139**	**5062**	**11%**	**36%**

Note: Red cells indicate largest change

The internal zones listed in **Table 10**, are depicted spatially in **Figure 18** with relation to the SP47 sub-area. The map shows that the major employment growth between 2031 and 2041 is associated with the central and north-east sections of the study area, while the major population growth between 2031 and 2041 is associated with the south-west section of the study area.

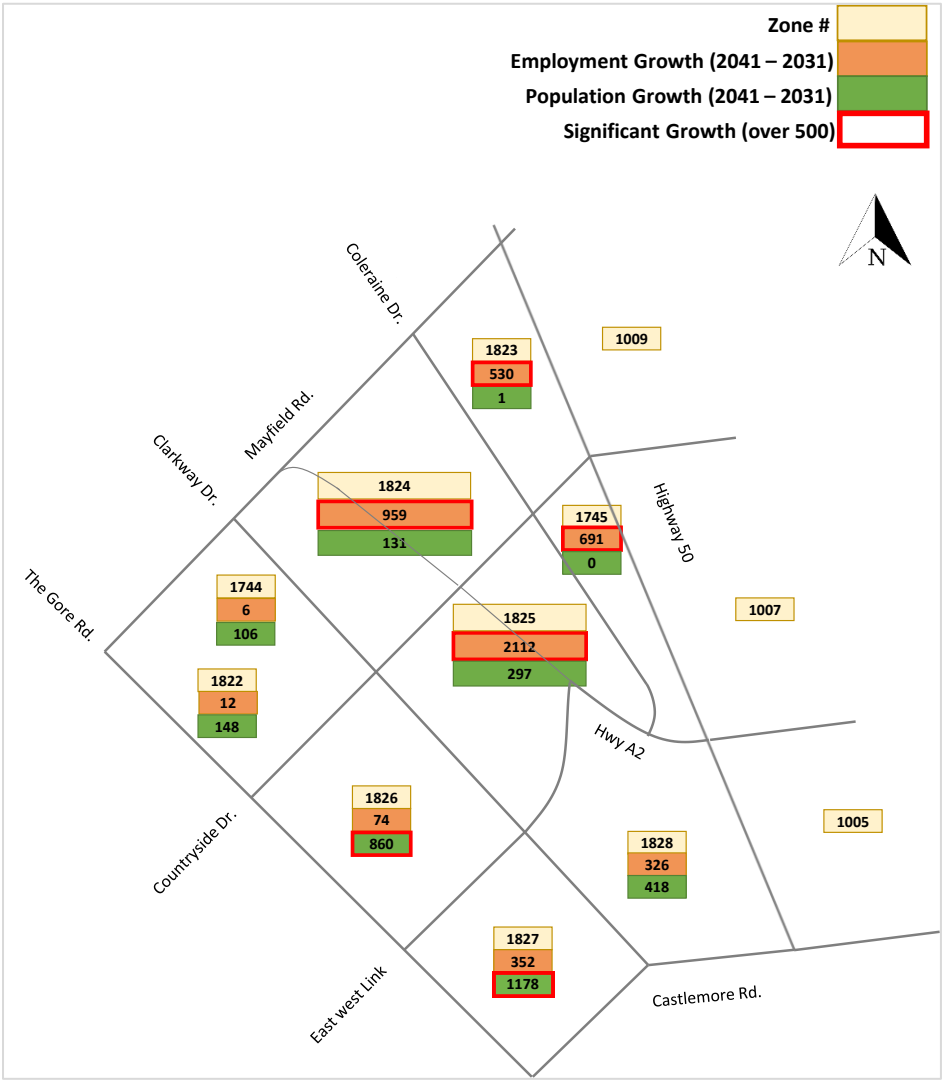


Figure 18: Zonal Locations of Population/Employment Growth between 2031 and 2041

The impact of the employment and population growth on total number of trips between 2031 and 2041 is illustrated in **Figure 19** for AM and PM peak periods**.** Based on the distribution of trips**,** the analysis shows that employment growth had the most impact on total number of trips (orange boxes), as opposed to the population growth (green boxes) that had minimal impact on total number of trips. An approximate increase of 1,000 trips is expected in the major employment areas located in the central and north-east sections of the network.

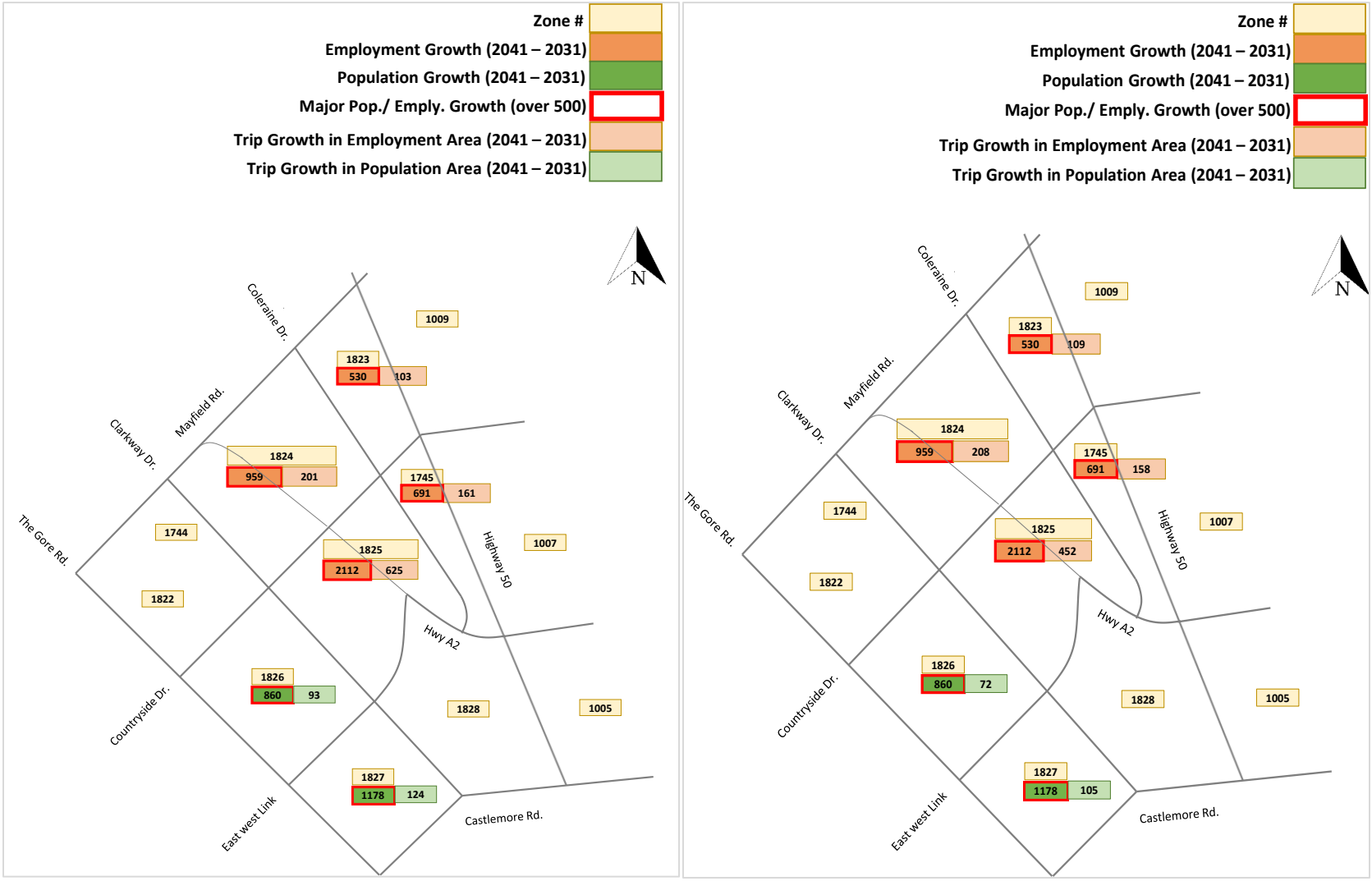


Figure 19: Impact of Employment/Population Growth between 2031 and 2041 on Number of Trips – AM (left) and PM (right)

Additionally, a further analysis was conducted to highlight how trips are distributed within the study area. The SP47 sub-area is defined with internal zones and external zones, as shown in **Figure 20**. The distribution of the trips between internal and external zones in 2031 and 2041 are illustrated in **Figure 21** and **Figure 22,** for the AM and PM peak periods respectively**.**

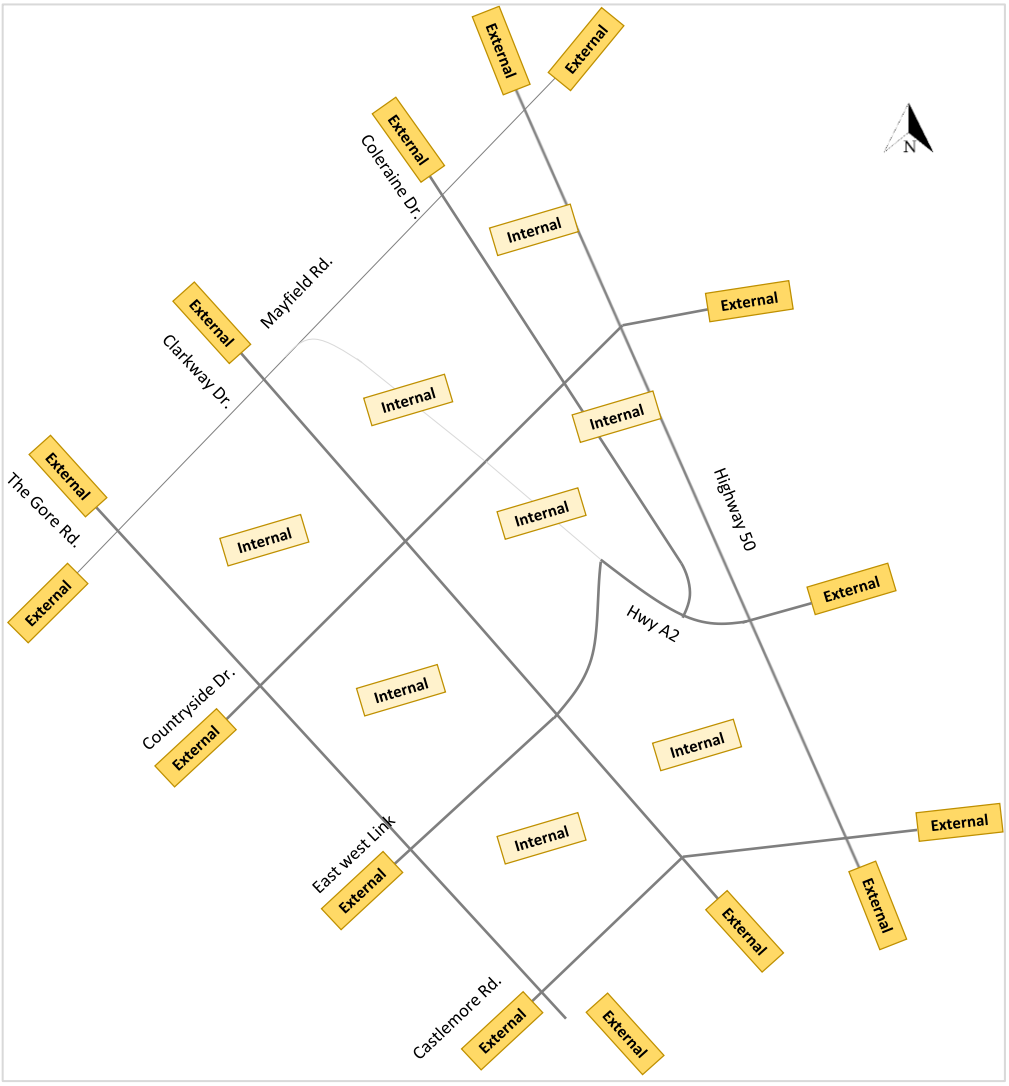


Figure 20: Internal and External Zones of the Sub-Area

The distribution analysis shows that majority of trips in both 2031 and 2041 are associated with external to external zones, while internal to internal zones account for the least number of trips. Thus, moving from 2031 to 2041 demands, major operational constraints are not expected within the local corridors and intersections of the study area as most of the trips are expected to travel on the main corridors such as Regional Road 50 or Castlemore Road from external to external zones.

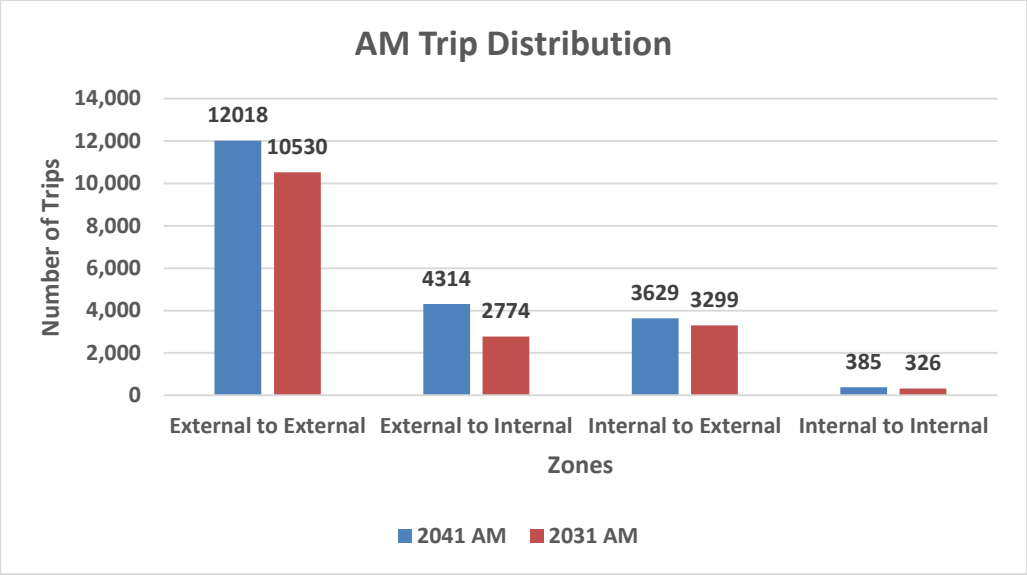


Figure 21: 2031 and 2041 Zonal Trip Distribution - AM

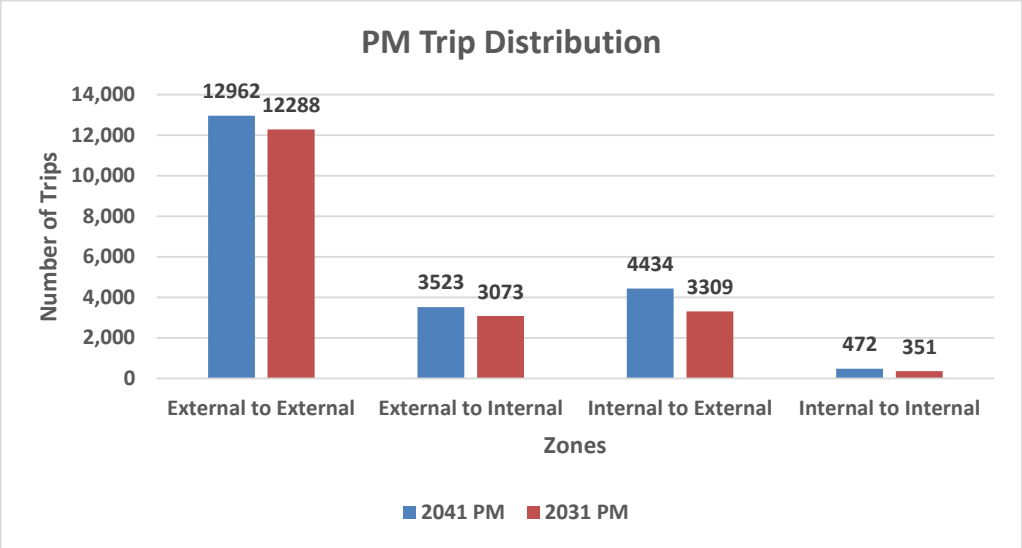


Figure 22: 2031 and 2041 Zonal Trip Distribution - PM

In the following section, the VISSIM microsimulation results provide further details on expected traffic operations in 2031 and 2041 at the intersection and corridor levels.

4.2. VISSIM Microsimulation Modeling

The VISSIM micro-simulation software (v7) was used to analyze traffic operations within the study area. VISSIM is a micro-simulation model which is capable of simulating individual vehicular movements through the network. VISSIM has been widely used to model urban and freeway networks in the GTA, and can produce various performance measures including LOS, delays, and speeds within the network.

The 2031 and 2041 VISSIM models were developed utilizing the calibrated existing condition model and applying the 2031 TMP recommended network and demand. Lane configurations were updated based on the SP47 TMP recommendation. As recommended for the 2031 horizon year in the SP47 TMP (**Figure 17**), an additional 28 signalized intersections, as well as three roundabouts were added to the existing model. All key network attributes were coded for these additional intersections, including storage lengths, speed profile, signal heads, stop signs, yield signs, turning restrictions, and detectors. The 2031 and 2041 VISSIM model network is illustrated in **Figure 23**.

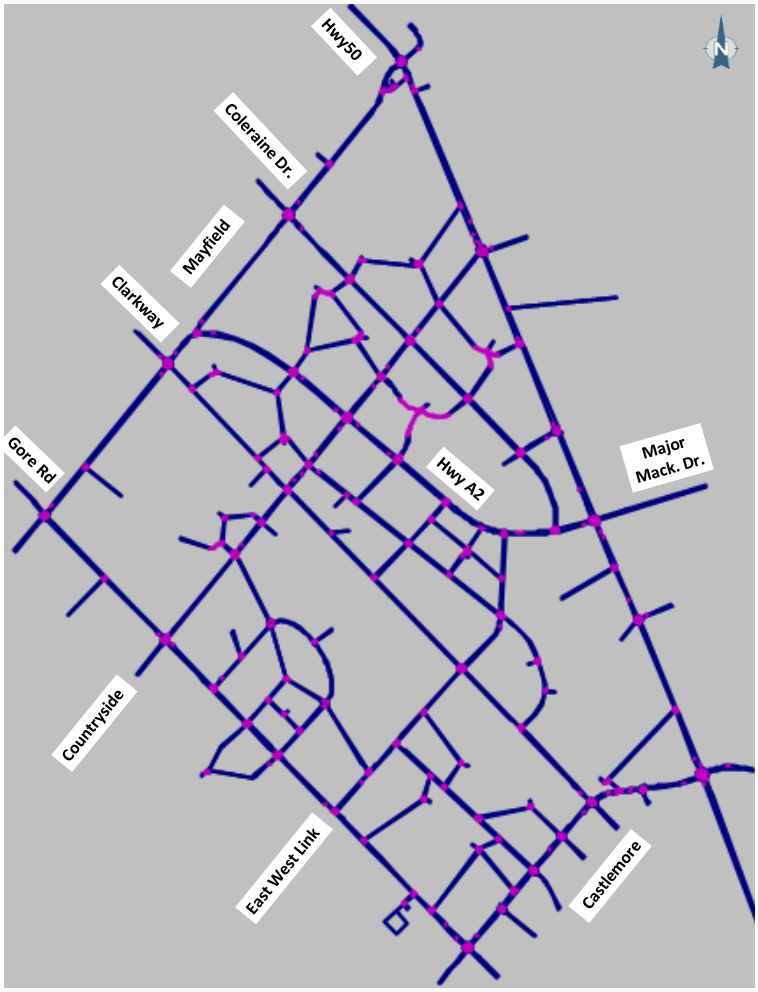


Figure 23: 2031 and 2041 developed VISSIM Model

The signal timing for all signalized intersections were developed in a Synchro model, which was used to optimize all timing plans based on the forecasted 2031 and 2041 demand for both AM and PM peak periods. Based on the 2031 and 2041 origin-destination (OD) demand, 20 additional zones were added to the existing network to reflect future traffic generators and attractions.

The 2031 and 2041 AM and PM traversal matrices obtained from City of Brampton sub-consultant, Peter Dalton, were utilized in the models. Multiple VISSIM runs (10 runs) were conducted for each 2031 and 2041 AM and PM models to capture the random variability of traffic. Based on the 10 runs, the average of the 10 runs were used to report on performance.

For each model, the VISSIM generated speed profiles were developed to identify the travel time delays and the long queues with the network. The speed profile used a generated speed color scheme (i.e. from pink with the lowest speed of 0 km/h, to green with the highest speed of 100 km/h) to highlight operation within the network.

In addition, the signalized intersections Level of Service (LOS) were developed for each time period. The LOS's were calculated based on the VISSIM generated delays and the HCM defined Level of Service criteria for signalized intersections.

4.3. 2031 VISSIM Analysis

2031 AM Peak

Approximately 16,928 trips are expected within the study area during the 2031 AM peak period. The VISSIM microsimulation analysis shows that all the vehicles are loaded onto the network during the AM peak, indicating the SP47 TMP roadway recommendations can accommodate the trips.

The VISSIM generated speed profile for the 2031 AM model is shown in **Figure 24** which was used to show the network-wide impacts under the 2031 AM traversal demand**.** According to the speed profile, no significant operational constraints are expected. The smaller scale speed profile at the critical intersections of Regional Road 50/ Major Mackenzie Drive and Arterial A2/ Coleraine Drive are illustrated in **Figure 25**. These two intersections are identified as critical intersections as they are 250m apart as per the SP47 TMP recommendation and high demand is anticipated through the intersections, which result in long queuing.

Based on the VISSIM results, the SBL movement at the intersection of Coleraine Drive/ Arterial A2 is expected to experience some congestion and delay. The reason for the congestion is that majority of the trips along Coleraine Drive SB (more than 900) are destined toward Major Mackenzie Drive EB and Regional Road 50 SB during AM peak period. An overall Level of Service of 'E' is expected for the SBL movement of the Coleraine Drive/Arterial

A2 intersection. The details of queue length and delay for the critical intersections in 2031 AM are summarized in **Appendix G**.

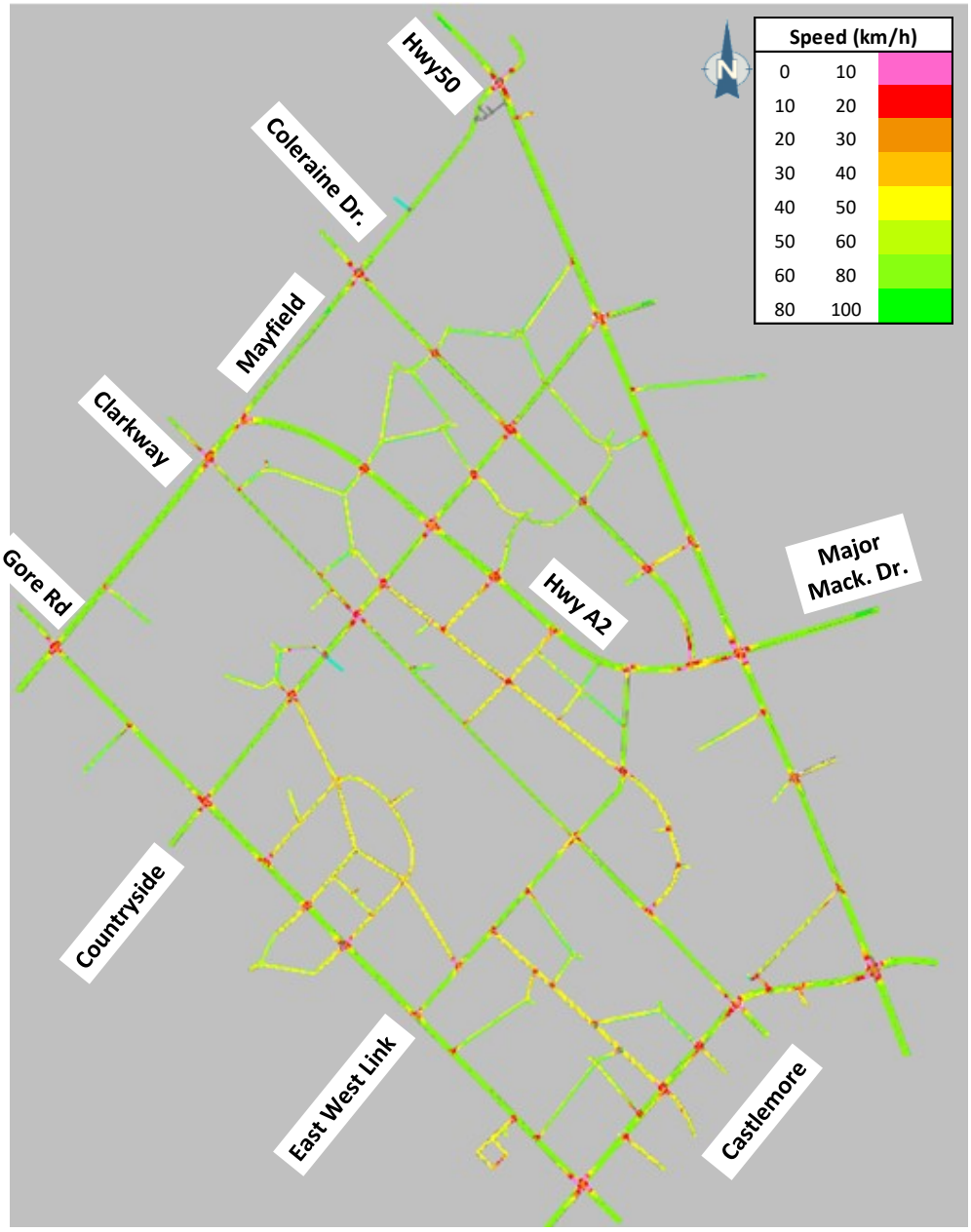


Figure 24: Speed Profiles - 2031 AM Peak

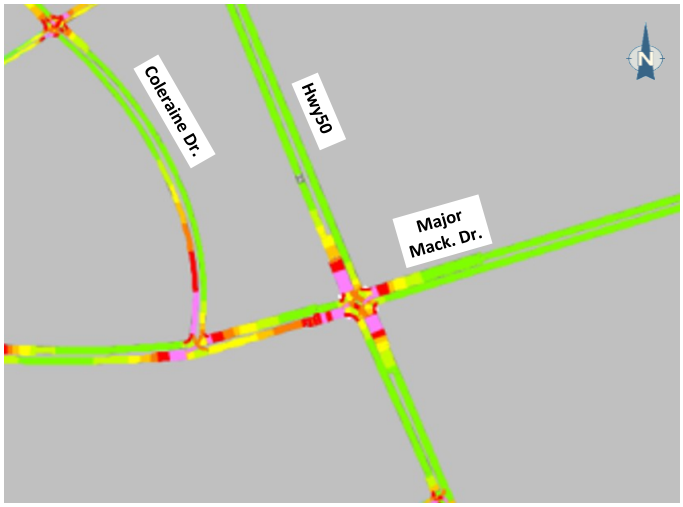


Figure 25: Speed Profile at Critical Intersections - 2031 AM Peak

The Highway Capacity Manual (HCM) Level of Service for signalized intersections for 2031 AM peak hour is illustrated in **Figure 26**. According to the LOS results, all the major signalized intersections are expected to operate at an overall LOS of C or better during 2031 AM peak. Moreover, no individual turning movement is expected to operate with LOS higher than E in 2031 AM peak.

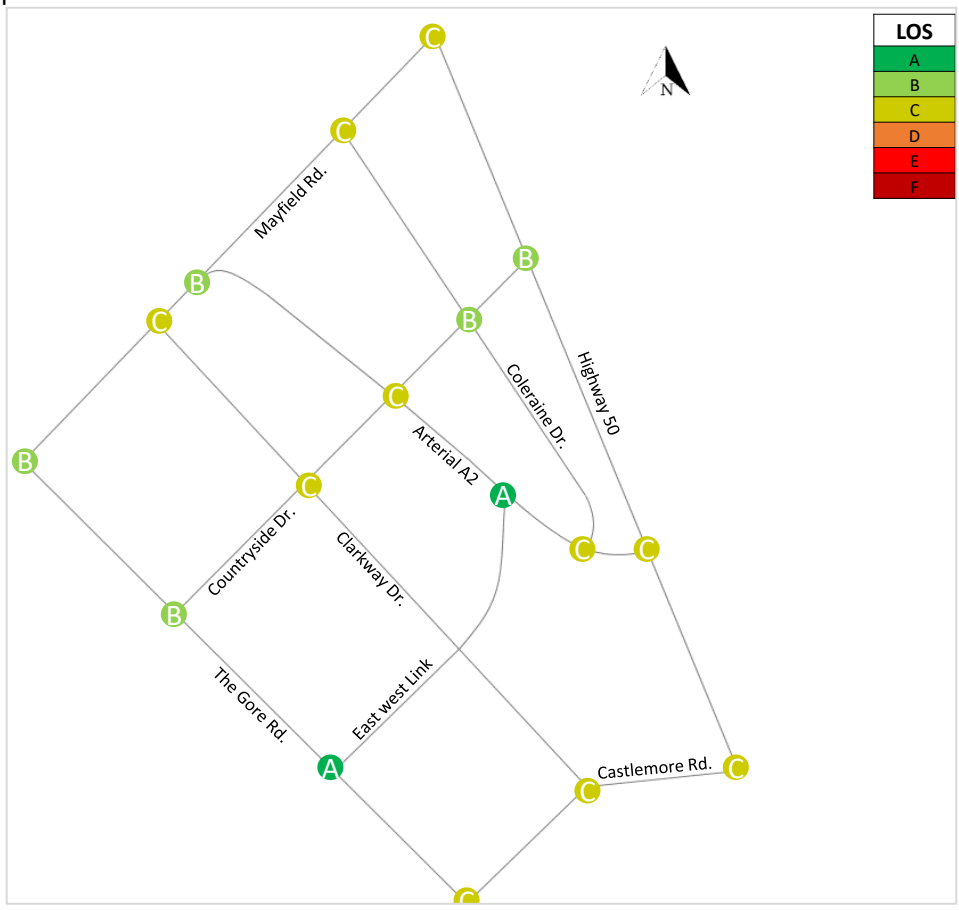


Figure 26: Signalized Intersections Level of Service - 2031 AM Peak

2031 PM Peak

Approximately, 19,021 trips are expected within the study area during 2031 PM peak period. Similar to the AM peak hour, the VISSIM microsimulation analysis shows that all the vehicles can be loaded onto the network during the PM peak hour.

The VISSIM generated speed profile for the 2031 PM model is illustrated in **Figure 27**. Similar to the AM model results, no significant operational constraints are expected at 2031 PM peak. The speed profiles at the critical intersections of Reginal Road 50/ Major Mackenzie Drive and Arterial A2/ Coleraine Drive are also presented in **Figure 28**.

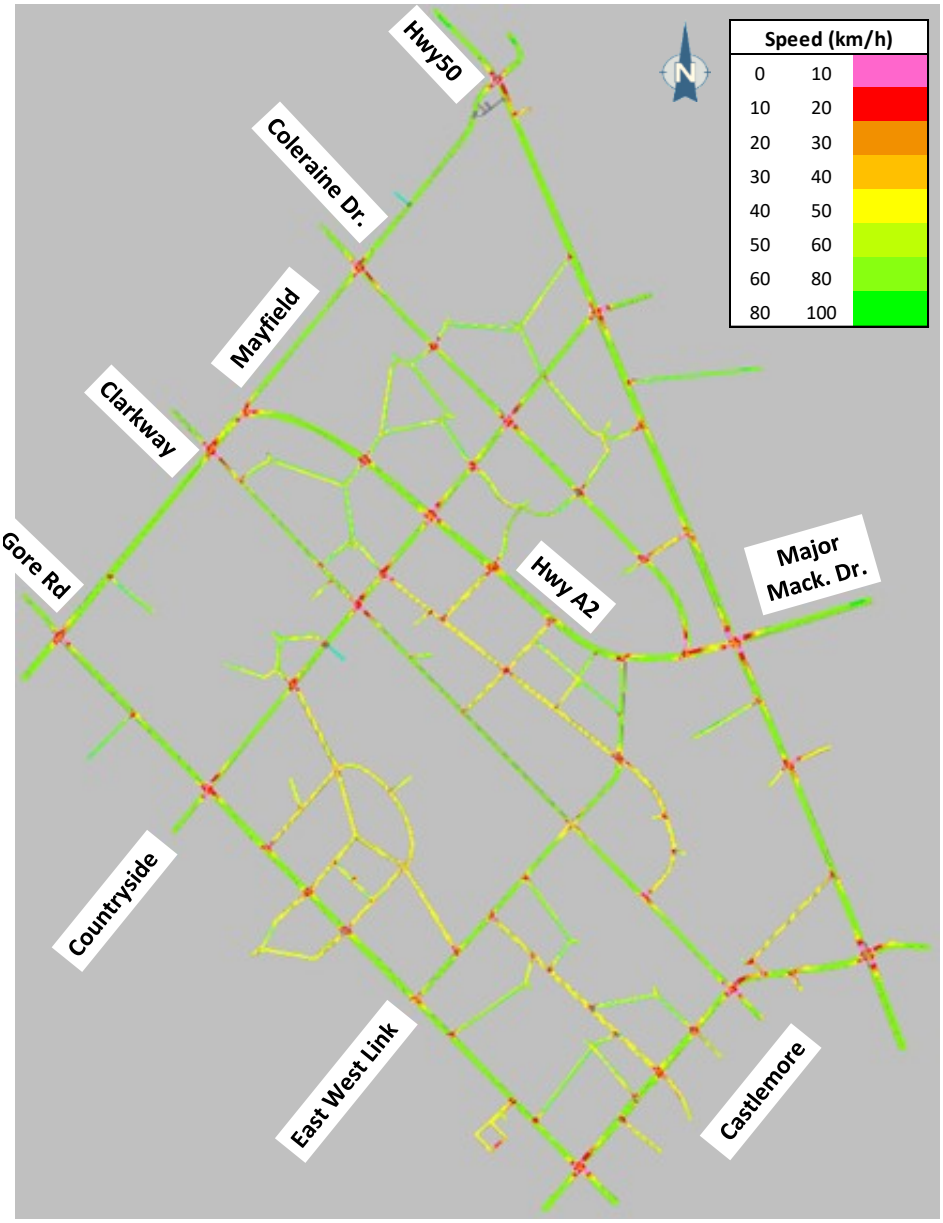


Figure 27: Speed Profile - 2031 PM Peak

Figure 28: Speed Profile at Critical Intersections - 2031 PM Peak

During the PM peak period, more than 1,000 trips are destined for the Arterial A2/ Coleraine Drive WBR movement. These are trips traveling along Major Mackenzie Drive WB or Regional Road 50 NB toward Coleraine Drive north.

The details of queue length and delay for the critical intersections in 2031 PM are presented in **Appendix G.**

The Level of Service analysis results for 2031 PM peak is presented in **Figure 29**. According to the LOS results, all the major signalized intersections are expected to operate at overall LOS C or better in 2031 PM peak, except for the Regional Road 50/ Major Mackenzie Drive intersection which is expected to operate at LOS D. It is also expected that no individual turning movement will operate with LOS higher than E in 2031 PM peak.

Geometry Improvements

Due to high demand at the WBR movement at Arterial A2/ Coleraine Drive and Castlemore Road/ Clarkway Drive during PM peak, these movements were coded as channelized right turns which significantly improves the operation during PM peak.

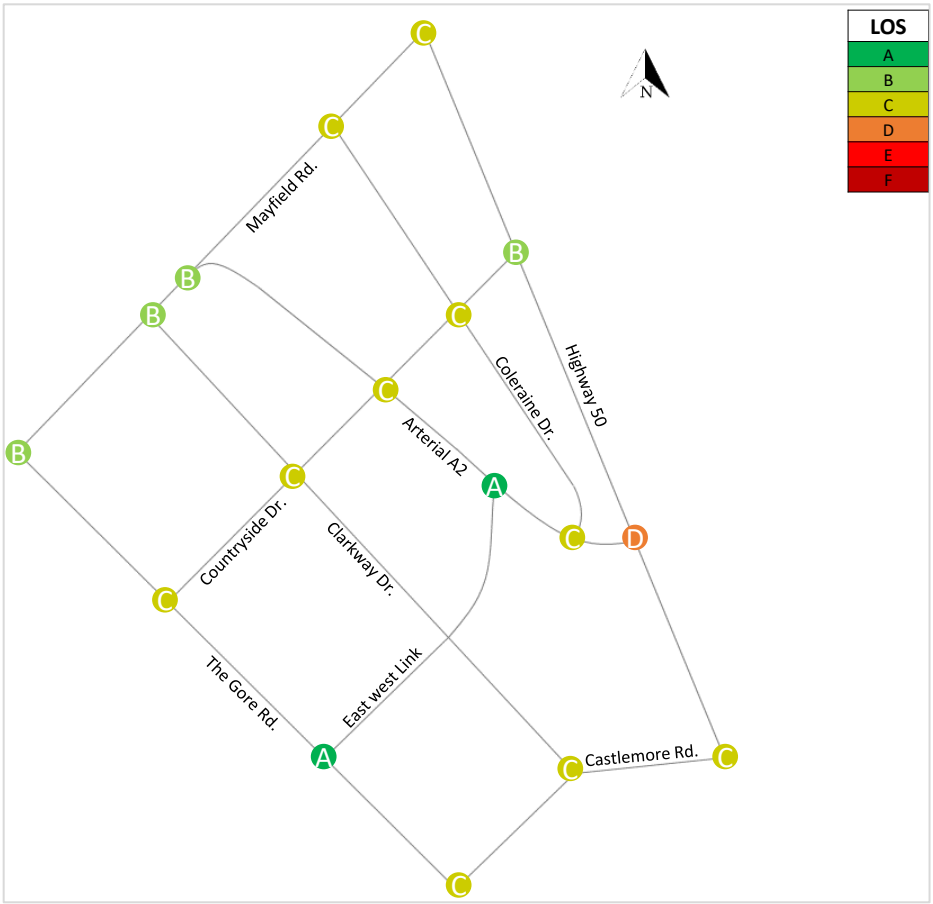


Figure 29: Signalized Intersections Level of Service - 2031 PM Peak

4.4. 2041 VISSIM Analysis

2041 AM Peak

In 2041, approximately 20,346 trips are expected within the study area during the AM peak period. The microsimulation analysis shows that all the vehicles can be loaded into the network during the AM peak period. During the AM peak period, EB and SB directions are the peak directions, with the majority of the vehicles traveling toward Major Mackenzie Drive EB and Regional Road 50 SB.

The VISSIM generated speed profile for 2041 AM peak is illustrated in **Figure 30**.

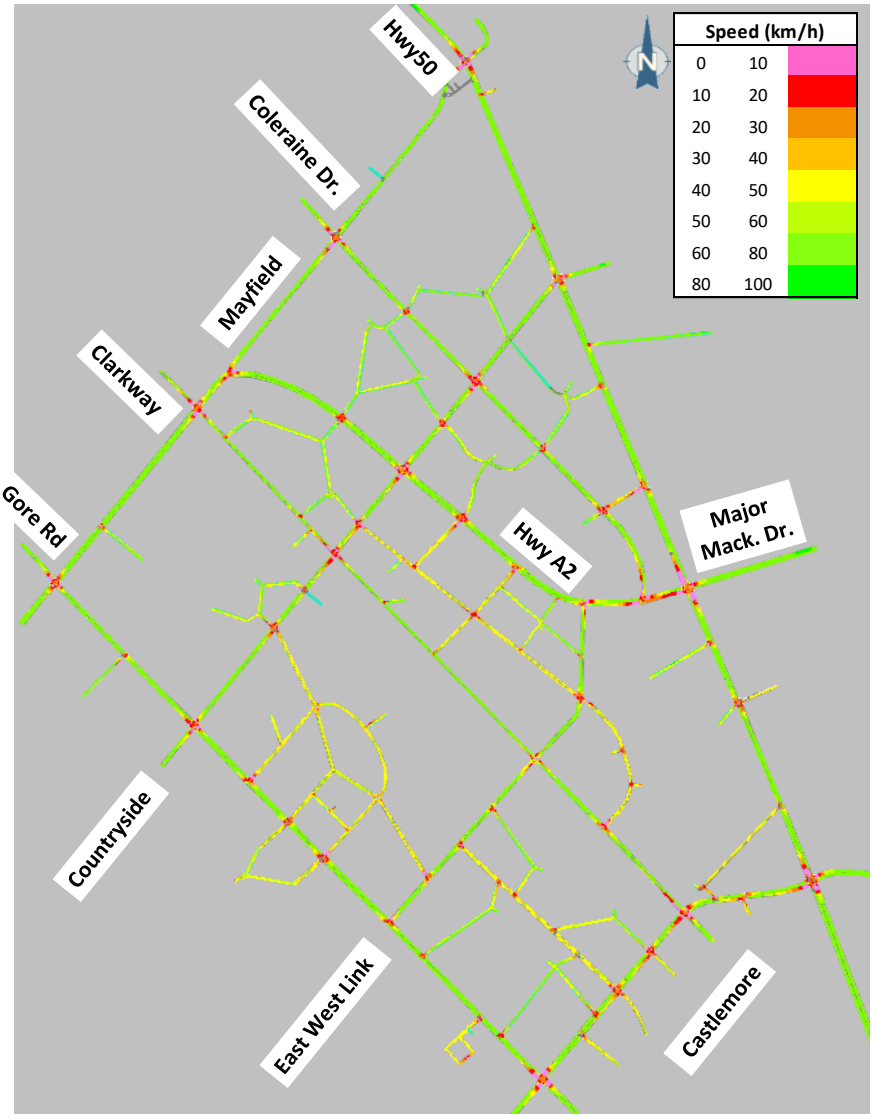


Figure 30: Speed Profile - 2041 AM Peak

According to the speed profile, no major operational constraints are anticipated for the majority of the network. However, the critical intersections of Regional Road 50/ Major Mackenzie Drive and Arterial A2/ Coleraine Drive are expected to experience some congestion and delay due to their close proximity (**Figure 32**).

The SBL and the EBT movements at the intersection Arterial A2/ Coleraine Drive are the major movements with high demand. Due to the high EBT demand at the Major Mackenzie Drive/ Regional Road 50 intersection, queue spillback is expected as far back as Coleraine Drive (as shown in **Figure 31**)

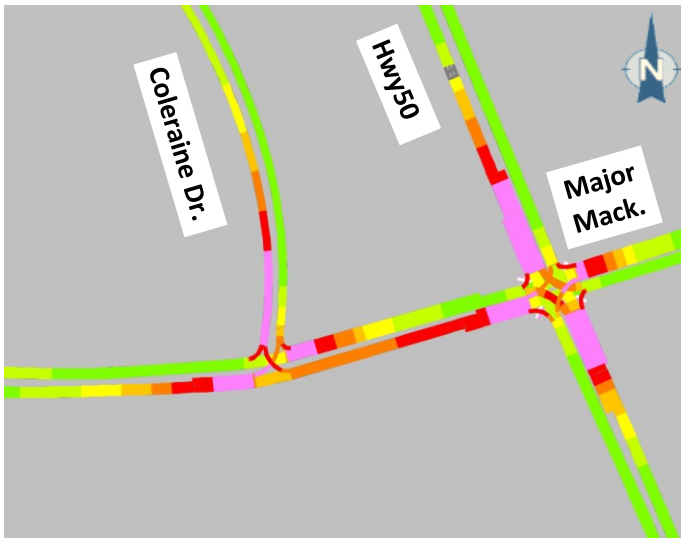


Figure 31: Speed Profile at Critical Intersections

Two other intersections that are expected to experience delays and queuing during 2041 AM peak hour are shown in **Figure 32**. The intersection of Castlemore Road/ Clarkway Drive and Castlemore Road/ Regional Road 50, at the EBR and SBL movements.

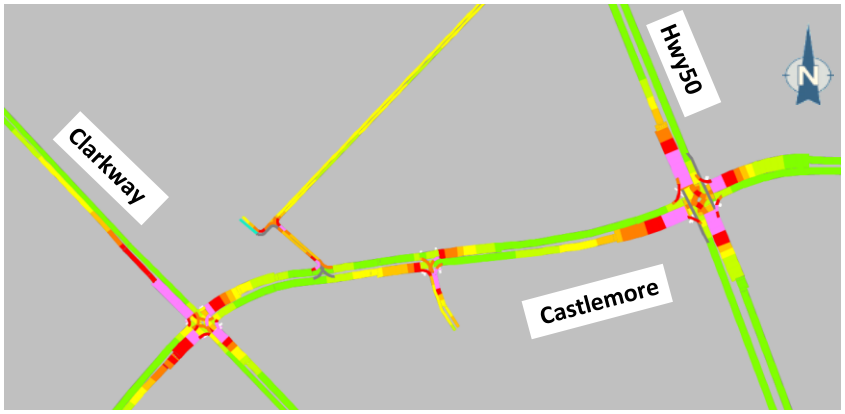


Figure 32: Speed Profile at Critical Intersections - 2041 AM Peak

The overall Level of Service analysis of the 2041 AM model (**Figure 33**) shows that all the major signalized intersections are expected to operate at overall LOS C or better, except for the following three intersections, which are expected to operate at LOS D:

- Regional Road 50/ Major Mackenzie Drive
- Arterial A2/ Coleraine Drive
- Regional Road 50/ Castlemore Road
- Clarkway Drive/Castlemore Road

In addition, the following critical turning movements are expected to operate at LOS F:

- NBL & SBT @ Regional Road 50/ Major Mackenzie Drive
- SBL @ Arterial A2/ Coleraine Drive
- SBL and SBT @ Castlemore Road/ Clarkway Drive

The signal optimization at intersections of Regional Road 50/ Major Mackenzie Drive and Arterial A2/ Coleraine Drive does not have a major impact in improving the Level of Service at these two intersections during AM peak period. The reason for this is the close proximity of the intersections in addition to the expected high demand through SB and EB approach of the intersections. However, the Level of Service at intersection of Castlemore Road/ Clarkway Drive is expected to improve when the signal timing optimization is applied.

The details of queue length and delay for the critical intersections in 2041 AM are presented in **Appendix G.**

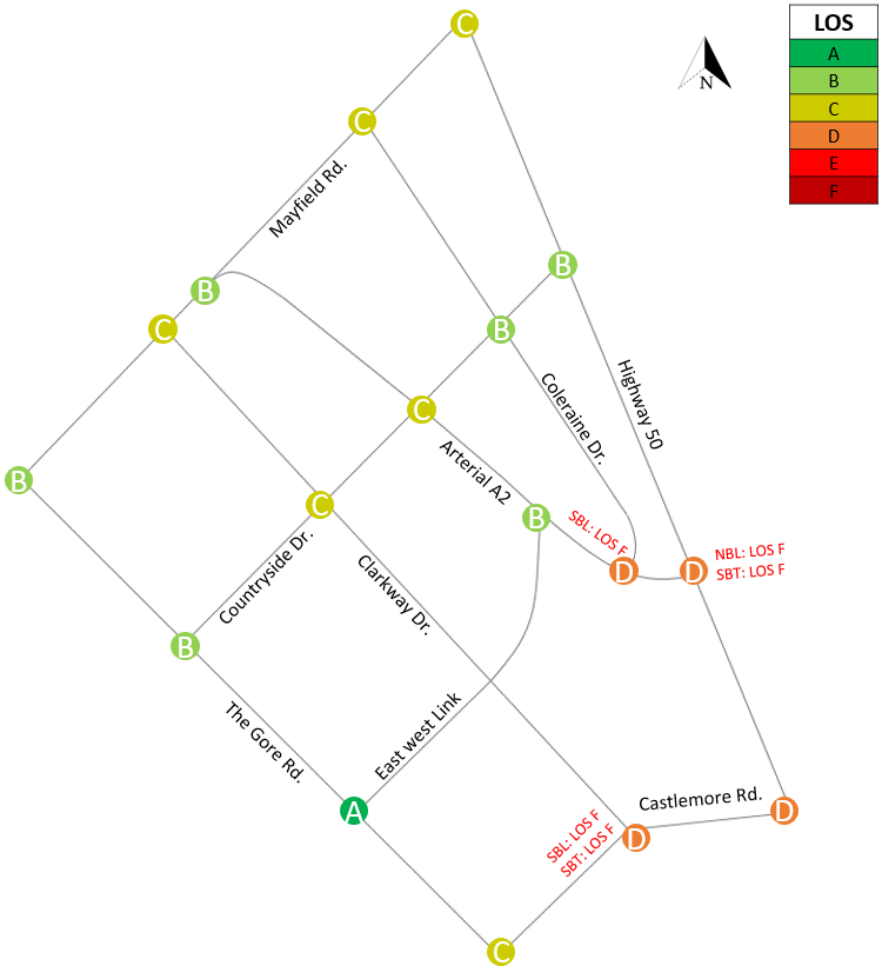


Figure 33: Signalized Intersections Level of Service - 2041 AM Peak

2041 PM Peak

In 2041 PM Peak, approximately 21,391 trips are expected within the study area network. The microsimulation analysis shows that all the vehicles can be loaded into the network during the PM peak period. During this peak period, WB and NB are the peak directions, with the majority of the vehicles traveling along Major Mackenzie Drive WB and Regional Road 50 NB to various zones (mostly external zones).

The VISSIM-generated overall speed profile for the 2041 PM peak is presented in **Figure 34**. The overall speed profile shows no major operational constraints in 2041 PM peak. Queuing and delays are expected for the SBL movement of the Arterial A2/ Coleraine Drive intersection (**Figure 35**).

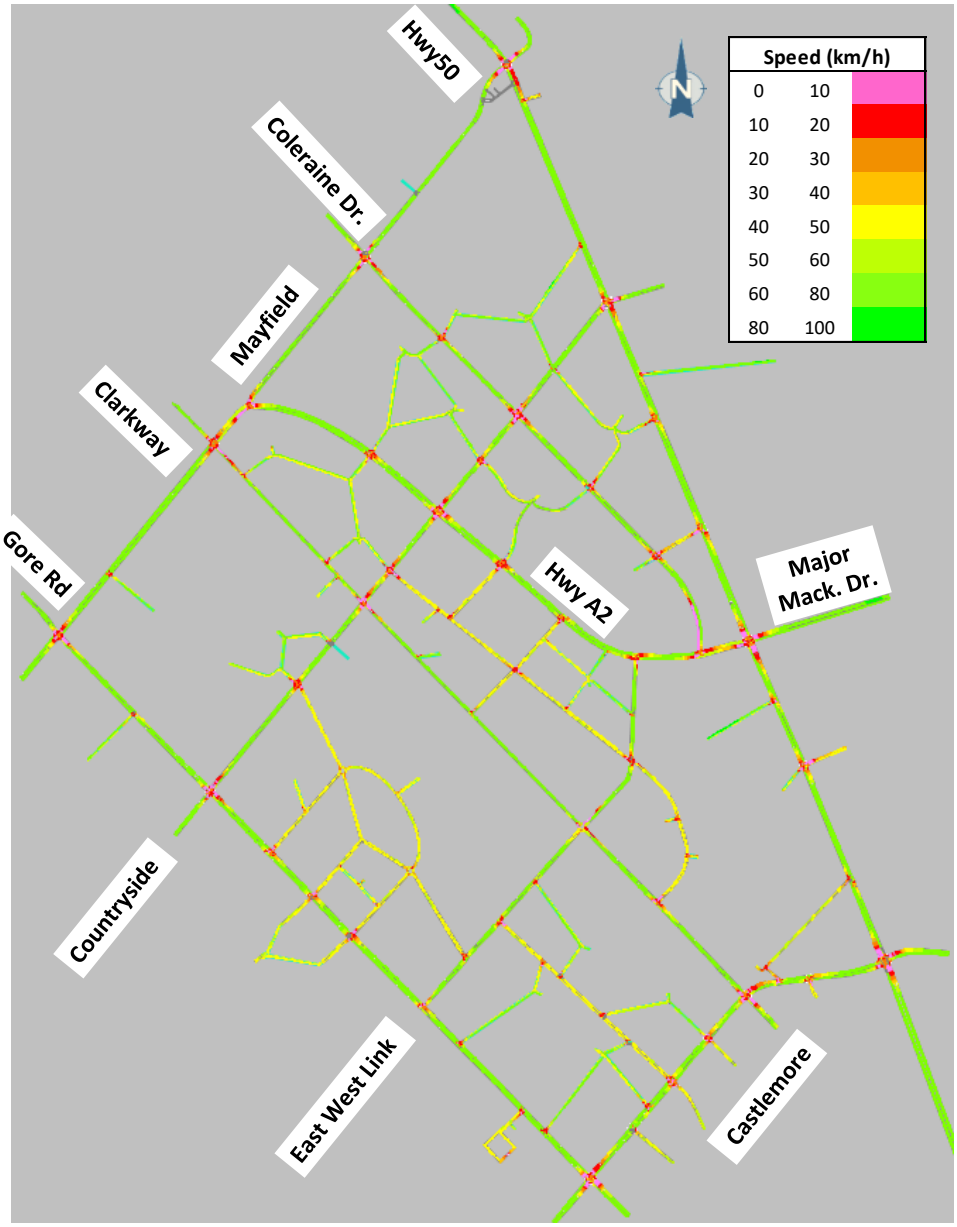


Figure 34: Speed Profile - 2041 PM Peak

Figure 35: Speed Profile at Critical Intersections - 2041 PM Peak

The Level of Service analysis of the 2041 PM model predicts that all the major signalized intersections to operate at overall LOS C or better, except for the following three intersections, which are expected to operate at LOS D (**Figure 36**):

- Regional Road 50/ Major Mackenzie Drive
- Regional Road/ Mayfield Road
- Regional Road/ Castlemore Road

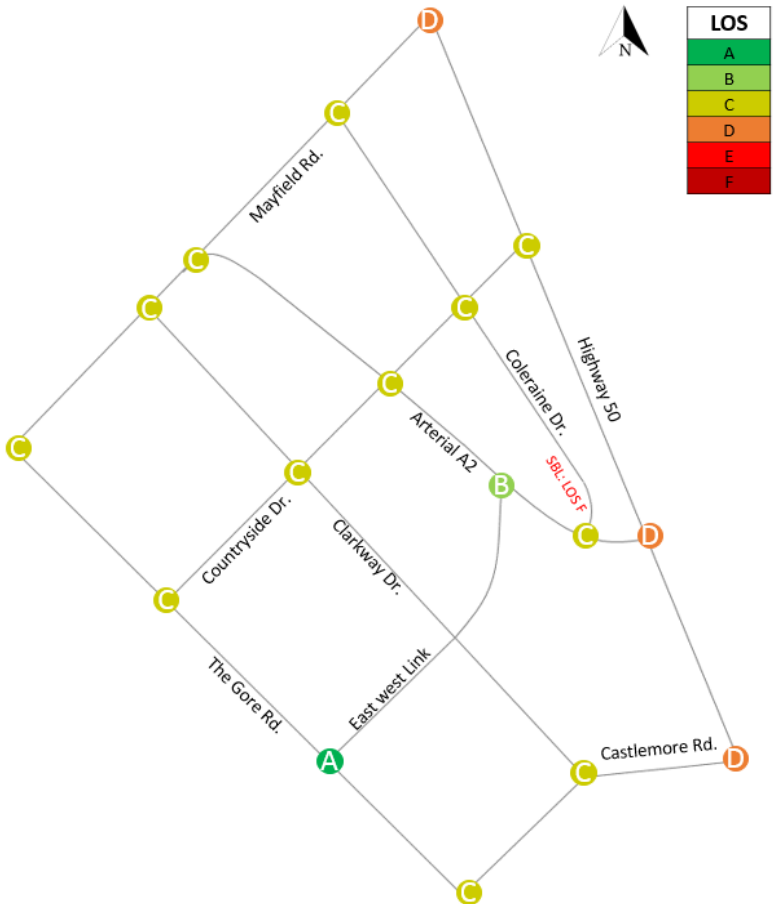


Figure 36: Signalized Intersections Level of Service - 2041 PM Peak

In addition, the following critical turning movement is expected to operate at LOS F:

- SBL @ Arterial A2/ Coleraine Drive

The details of queue length and delay for the critical intersections in 2041 PM are presented in **Appendix G.**

Due to high demand at the WBR movement at Arterial A2/ Coleraine Drive and Castlemore Road/ Clarkway Drive during PM peak, these movements are coded as channelized right turns which significantly improves the operation during PM peak. Moreover, to accommodate the NBR high demand (over 1,200 trips) at Regional Road 50/ Mayfield Road intersection during PM peak, this movement was also coded as channelized right turn.

4.5. Evaluation of Alternatives

Several alternatives which looked at roadway alignments/intersection configuration were developed as part of the Environmental Assessment Study of Arterials within the Highway 427 Industrial Secondary Plan Area (Area 47) to address both environmental constraints and operational impacts within the study area. The alternatives focus on different alignments at the intersections of Arterial A2/ Coleraine Drive, Arterial A2/ East-West Arterial, and Arterial A2/ Mayfield Road. The following sections summarize all the proposed alternatives for 2041, as well as a brief description on how they will impact traffic operation within the study area. The turning movements, queuing results from the operational analysis and associated functional design requirements of the preferred network is attached as **Appendix H**.

Additional evaluation of interchange alternatives, as well as the traffic operation analysis together with consideration of the nearby proposed bus Maintenance and Storage Facilities, are attached as **Appendix I** and **Appendix J**, respectively. Evaluation of the realignment at Regional Road 50/Arterial A2 is attached as **Appendix K**.

4.5.1. Special Area 2 Alternatives East-West Arterial and Coleraine Drive

There are 4 main alternatives with various combinations of the East-West Arterial and Coleraine Drive. A description of each alternative is provided below. Additional details of the proposed alignments are shown in **Appendix H**.

- **Alternative 1 – SP47 TMP Alignment**
    - This alternative is considered the base case which considers the SP47 TMP alignment for East-West Arterial and Coleraine Drive. In this alignment, Coleraine Drive is located approximately 250 m west of Regional Road 50/ Major Mackenzie Drive, and East-West Arterial is located approximately 350 m west of Coleraine Drive
- **Alternative 2 – East-West Arterial at Coleraine Drive**

- This alternative proposes a shift of the East-West Arterial further to the east and realignment to Coleraine Drive
- Considering that the poor traffic operation already shown in the VISSIM modelling in **Section 4.2**, realignment of the east west link to Coleraine drive was examined further and traffic distribution was considered not to significantly change and given the reduction of one intersection in the network this would improve overall operations (it also significantly reduces construction costs).

- **Alternative 3 – Intersection at Narrow Crossing**
  - This alternative proposes shifting of Coleraine Drive to the west and realignment to the East-West Arterial. The East-West Arterial would run parallel to, and immediately north of, the TransCanada pipeline (approximately 65 m north of SP47 TMP alignment)
  - This alternative will extend the gap between Coleraine Drive and Regional Road 50/ Major Mackenzie Drive and therefore is expected to help improve the traffic operational issues at Coleraine Drive
- **Alternative 4 – East-West Link Shift to North Creek**
  - This alternative proposes shifting of the East-West Arterial to approximately 670 m north of the SP47 TMP alignment, at the north limit of one of the Gore Road Tributary's main branches
  - This alternative is not expected to impact the traffic operation when compared to the SP47 TMP configuration, since it is only proposing shifting further to the north to where no traffic operation constraints were identified from the VISSIM modelling in **Section 4.2**.

4.5.2. Special Area 1 Alternatives at Arterial A2/ Mayfield Road

For the special policy area 1 (Arterial A2 and Mayfield Road), several alternatives were also investigated. A description of each alternative is provided below. Additional details of the proposed alignments are shown in **Appendix H**.

- **Alternative 1 – SP47 TMP Alignment**
  - This alternative is considered the base case which employs the SP47 TMP alignment for Arterial A2 and Mayfield Road.
  - This alternative is currently being used in the VISSIM micro simulation model. The VISSIM microsimulation analysis **(Section 4.2)** showed acceptable traffic operation for Arterial A2/ Mayfield Road with LOS B at AM and LOS C within PM.
- **Alternative 2 – T-Intersection at Mayfield Road**
  - This alternative proposes SP47 TMP A2 approach alignment, with a simple T-intersection.

    - Although the alternative is not expected to have a major impact on traffic operations it will be further evaluated using VISSIM microsimulation since it suggests a conventional geometry configuration.
- **Alternative 3 – Dead-End Mayfield Road at Arterial A2**
    - This alternative proposes the SP47 TMP Arterial A2 approach alignment, Arterial A2 continues to the west, while the east approach of Mayfield Road dead-ends at a T-intersection at Arterial A2.
    - The configuration proposed by this alternative is very similar to what was proposed by SP47, therefore no major traffic operation impact is expected here.
- **Alternative 4 – Arterial A2 Shifted East to Maintain Bridge**
    - In this alternative, Arterial A2 is relocated 310 m to the east, allowing the existing Clarkway Drive Creek Crossing to be maintained. Arterial A2 continues to the west, while the east approach of Mayfield Road dead-ends at a T-intersection at Arterial A2.
    - This alternative is not expected to have a major impact on traffic operation when compared with TMP recommendations, since it only proposes shifting of the corridor to where no operational constraints are expected.

As outlined in Sections **4.5.1** and **4.5.2,** the majority of the proposed alternatives are not expected to have a major impact on improvement of the traffic operational issues raised in the sections **4.4**, therefore, they are not further analyzed using VISSIM software. Among the proposed alternatives, *Alternative 3* from section **4.5.1** and *Alternative 2* from section **4.5.2** are further evaluated using VISSIM microsimulation. For the remainder of the discussion in this report, the *Alternative 3* from section **4.5.1** will be referred to as the *Alternative Coleraine Drive Realignment* and the *Alternative 2* from section **4.5.2** will be referred to as *Alternative T-Intersection at Arterial A2/ Mayfield Road***.** The following section presents the detail VISSIM analysis of these two alternatives.

4.5.3. Special Area 2 Alternative Coleraine Drive Realignment

The microsimulation results for 2031 and 2041 (**Section 4.3** and **4.4**) indicated that the intersection of Regional Road 50/ Major Mackenzie Drive and Arterial A2/ Coleraine Drive are expected to operate with poor levels of service and long queues during both the AM and PM peak hours. This is due to the close proximity of the two intersections (less than 250 m) and the high traffic demand expected through these intersections.

The *Alternative Coleraine Drive Realignment* proposes shifting Coleraine Drive further west, with realignment of the corridor to the East-West Arterial. The new alignment is expected to improve the operational constraints of the subject intersections as it provides additional distance between the two intersections where traffic can be discharged.

This alternative is evaluated for the AM peak period which is expected to be the worst period in 2041. Using the alignment plans provided by the design team, the 2041 AM peak VISSIM model was updated to reflect the new alignment. This included moving the intersection and all attributes (signals, detectors, geometry, etc.).

Similar to other VISSIM results presented earlier, a speed profile plot of the network was developed to highlight any operational constraints. The speed profile plot is shown in **Figure 37**. The results show that the proposed alternative improves the operational constraints at the subject intersections. The increase distance between the two intersections provided sufficient space for the traffic to discharge from the Arterial A2/ Coleraine Drive intersection and through Regional Road 50/Major Mackenzie Drive.
The details of queue length and delay for the critical intersections for current Alternative are presented in **Appendix H**.

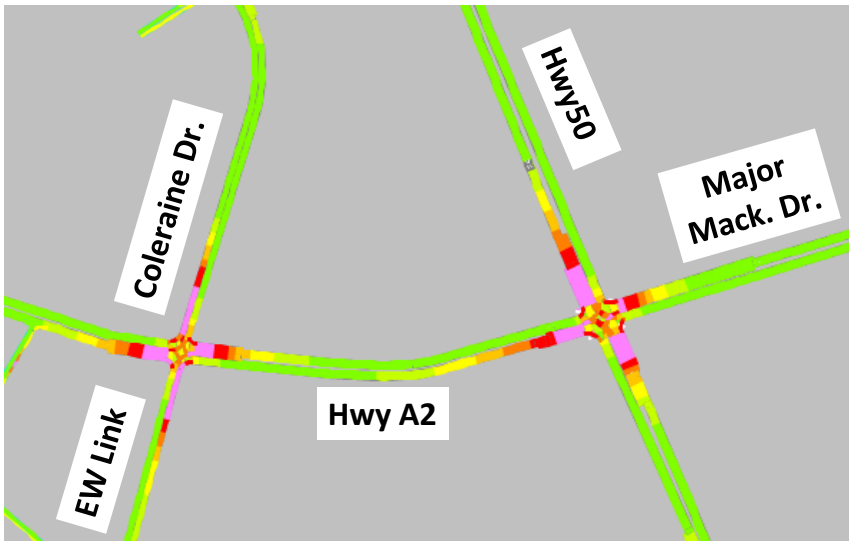


Figure 37: Speed Profile - 2041 Realignment Alternative - AM Peak

The Level of Service analysis (**Figure 38**) shows similar results to the results obtained from the SP47 TMP configuration for 2041 AM. All the major signalized intersections are expected to operate at overall Level of Service C or better during AM peak period, except for the following three intersections, which are expected to operate at LOS D:

- Regional Road 50/ Major Mackenzie Drive
- Regional Road 50/ Castlemore Road
- Arterial A2/ Coleraine Drive

In the current alternative scenario, the signal timing optimization also applied to individual movements with LOS F which were presented in **Section 4.4**. As a result, of the signal optimization, no individual turning movement is expected to operate with LOS higher than E in 2041 AM peak.

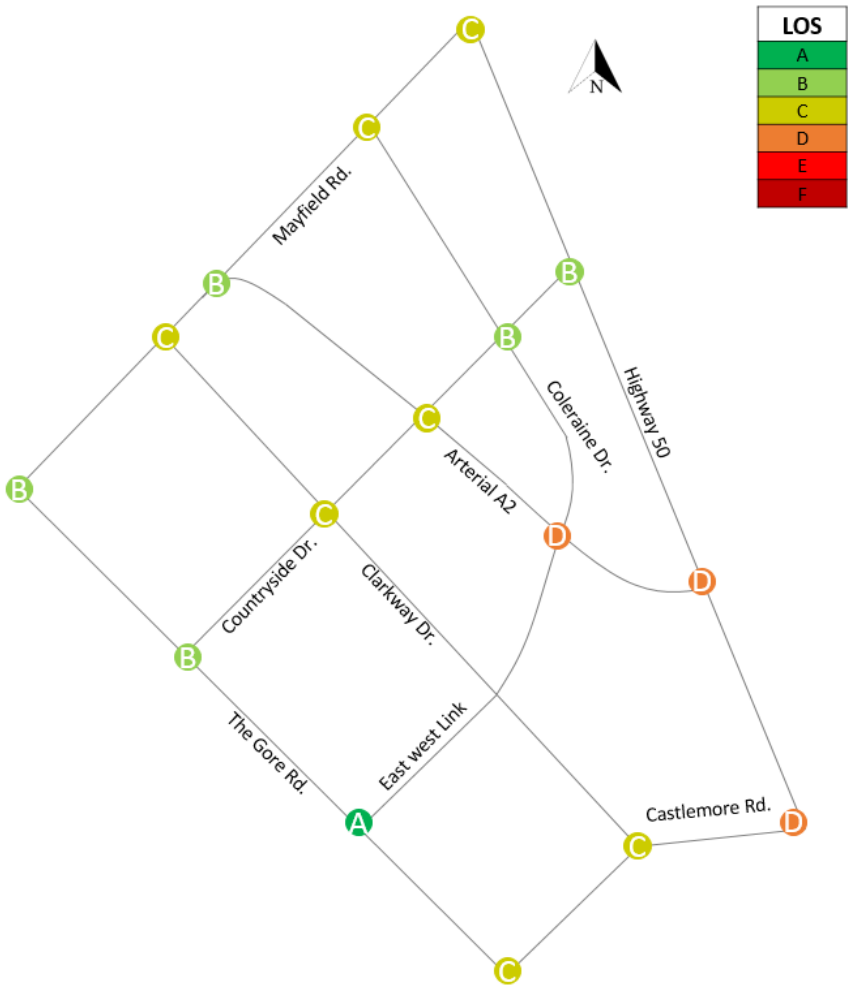


Figure 38: Signalized Intersections Level of Service - 2041 Realignment Alternative - AM Peak

4.5.4. Alternative T-intersection at Arterial A2/ Mayfield Road

As already shown in **Section 4.4**, under the SP47TMP recommended lane configuration at the intersection of Arterial A2/ Mayfield Road, there are no traffic operational constraints during both AM and PM peak hour. However, due to the special geometry configuration at this intersection (Special Area Policy # 1), the *Alternative T-intersection* was evaluated.

The PM peak hour VISSIM model was used to evaluate this alternative as it represented the worst case. With dual left turn lanes (NBL) and physically moving the Arterial A2 approach to Mayfield Road, the VISSIM model was updated to reflect the new alignment.

The speed profile generated from this alternative during PM peak period is illustrated in **Figure 39**. Similar to the TMP recommendation results, the speed profile for this alternative shows no operational constraints at this intersection and the adjacent intersections.

Figure 39: Zoom-in Speed Profile - 2041 T-Intersection Alternative - AM Peak

The results of Level of Service analysis for the current alternative are shown in **Figure 40.** Similar to the TMP recommendation results, the LOS C or better is expected at Arterial A2/ Mayfield Road and the adjacent intersections.

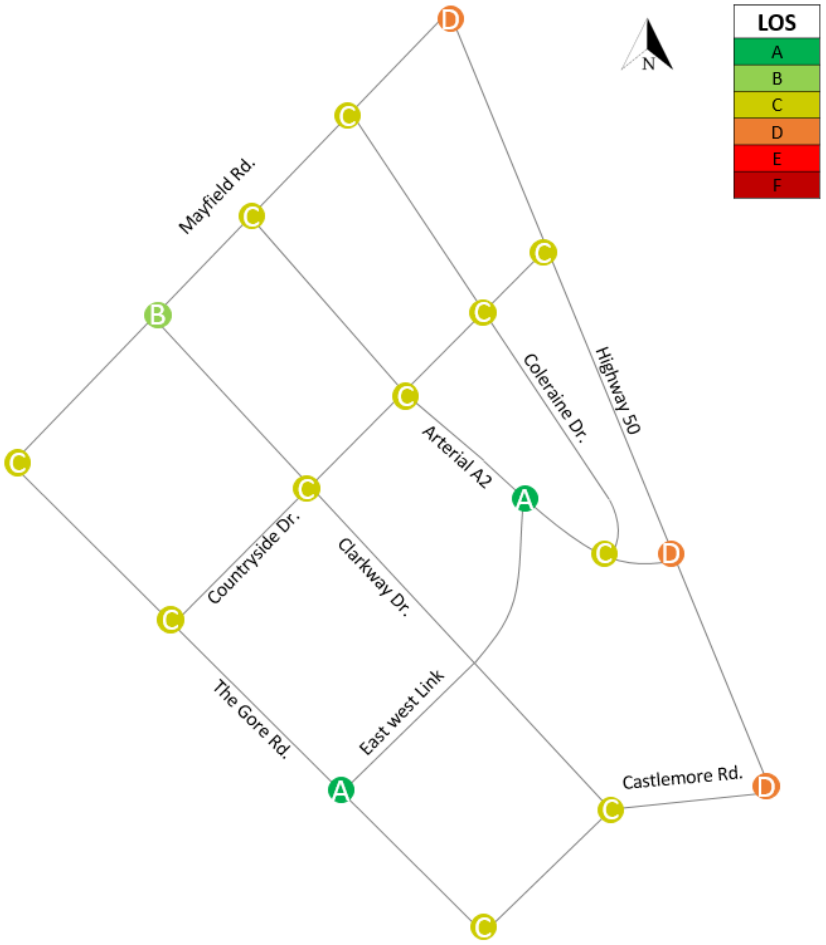


Figure 40: Signalized Intersections Level of Service - 2041 T-Intersection Alternative - AM Peak

5. Conclusion

This report covers the existing transportations and traffic operations analyses component and the future transportation modeling requirements for the Environmental Assessment study of arterial roads within highway 427 Industry Secondary Plan Area (SP47). This report outlines the data collection and analysis done, field investigation, capacity analysis and VISSIM simulation completed for existing conditions (2016) as well as the expected operational impacts at each study intersection and corridor.

5.1. Existing Conditions

A field investigation was conducted for the entire study area during AM and PM peak hours and existing traffic operations (long queues, operating speeds, high delays, etc.,) at each signalized intersection were observed. The results from the field investigation were used to validate findings from both the Synchro capacity analyses and the VISSIM Simulation analysis. In addition, there is a high truck percentage of heavy vehicles along Regional Road 50. The existing capacity analysis is showing reserved capacity at most of the intersections except a few that experienced high delays during the various peak hours (mainly those on Regional Road 50).

5.2. Forecasting and Microsimulation

In order to assess the vehicles' operations on the network a VISSIM microsimulation analysis was conducted for the existing conditions. This report outlined the calibration of the VISSIM models to existing conditions. Based on the results, the existing conditions VISSIM model was calibrated and validated to the recommended FHWA guidelines and moved to the next stage of evaluating 2031 and 2041 horizon demands and recommendations.

The base road network for future conditions evaluations was taken from the Highway 427 Industrial Secondary Plan (Area 47) completed in 2014. The 2031 and 2041 traversal matrices from the City's EMME modelling showed that most of the trips within the sub-area are primarily external to external trips. As such, most of the trips are using the major arterials to pass through the network. A 20% increase in trips is expected in 2041 during the AM peak while a 12 % increase is expected in the PM peak, relative to the anticipated 2031 traffic volume. The higher AM percentage is attributed to the increase in employment land use in 2041 when compared to 2031.

Utilizing the VISSIM microsimulation software, detailed traffic operational analyses were conducted for all intersections and corridors within the SP47 study area. The base case was first evaluated which looked at the operational results of the network under the SP 47 recommended road network with 2031 and 2041 forecasted demand. For most of the network, the VISSIM analysis showed acceptable levels of service for all intersections and corridors except for at two intersections.

Based on simulation results, the following geometric improvements were recommended in addition to the network recommendations for the Highway 427 Industrial Secondary Plan (Area 47) Road Network:

- Channelized westbound right turn lane at the intersection of Coleraine Drive / Castlemore Road/Clarkway Drive
- Channelized northbound right turn lane at the intersection of Regional Road 50 / Major Mackenzie Drive.

The two locations that showed poor performance are the intersection of Arterial A2/Coleraine Drive and Regional Road 50/Major Mackenzie Drive. There were individual movements with LOS of F and long queues. This was primarily due to the high demand destined through this area and the close proximity between the two intersections.

5.3. Evaluation of Alternatives

The Environmental Assessment Study for Arterials within the Highway 427 Industrial Secondary Plan Area (Area 47) considered two portions of the network: Special Area 1 including to Arterial A2 and Mayfield Road; and Special Area 2 including the East-West Arterial and Coleraine Drive. For each of these areas, 4 alternative alignments were generated for a total of 8 options.

In this study, the 8 alternatives were reviewed and two (one for each area) were selected for more detailed microsimulation analysis based on environmental and traffic operational constraints. The descriptions and results from this analysis follows:

- For Special Area 1, an Alternative T-intersection for Arterial A2/Mayfield Road was evaluated. This alternative was found to operate acceptably based on VISSIM analysis.
- For Special Area 2, an additional alternative (referred to as the *Coleraine Drive Realignment in* ***Section*** **4.5.2**) was evaluated in VISSIM primarily as it is the one alternative that would realign Coleraine Drive further west from Regional Road 50. Based on the results shown in **Section 4.5.3**. (**Figure 37**), the alternative provides overall operational improvements at both intersections (that is Coleraine Drive/Arterial A2 and Regional Road 50/Major Mackenzie Drive). As such, the re-alignment is recommended to alleviate the operational constraint identified under the SP47 recommended alignment.

Additional network options were analyzed separately from this study and these analyses are provided in Appendices I, J and K of this report. Descriptions of these additional options follow.

In Appendix I, microsimulation results for 3 different options for Regional Road 50/Major MacKenzie Drive are reported based on analysis done in 2018. The options evaluated were:

- Realign Coleraine Drive further west for sufficient queuing and weaving space between Coleraine Drive/Arterial A2 and Regional Road 50/Major MacKenzie Drive and operate these intersections at-grade;
- Construct a Single Point Urban Interchange (SPUI) for the intersection of Regional Road 50 / Major MacKenzie Drive; and
- Construct a Parclo A-type interchange for the intersection of Regional Road 50 / Major MacKenzie Drive.

Analysis results indicate that the SPUI would best serve the forecast traffic demand, followed by the at-grade Coleraine Drive realignment. The Parclo A-type interchange would operate poorly with the highest delay per vehicle and unserved vehicles.

Appendix J documents microsimulation analysis of a proposed Bus Maintenance and Storage Facility entrance on Regional Road 50 south of Cadetta Road, plus the intersection of Regional Road 50 / Cadetta Road and Regional Road 50 / Major MacKenzie Drive. The purpose of the analysis was to evaluate whether queuing problems would occur between these three intersections assuming forecast 2041 volumes. A single point urban interchange was assumed for Regional Road 50 / Major MacKenzie Drive. Traffic from the proposed Bus Maintenance and Storage Facility, plus a site on Arterial A2 referred to as the Triangle Lands site, and a proposed logistics/warehouse site are layered on top of the 2041 forecast volumes. The analysis indicated that neither queuing nor weaving problems between the intersections are expected.

Appendix K includes updated analysis for the intersection of Regional Road 50 / Major MacKenzie Drive conducted in 2021. The microsimulation analysis was supplemented with congestion costing analysis for a rigorous benefit-cost analysis. This analysis yielded a recommendation that the at-grade intersection alternative be constructed initially, with the ability to upgrade to a single point urban interchange at such time when congestion becomes a signification concern.

A

Appendix A - Turning Movement Counts & Adjusted Truck Percentages

Turning Movements Report - PM Period

Location..... CLARKWAY DR @ COUNTRYSIDE DR, Brampton

Municipality.

Traffic Cont. Stop sign

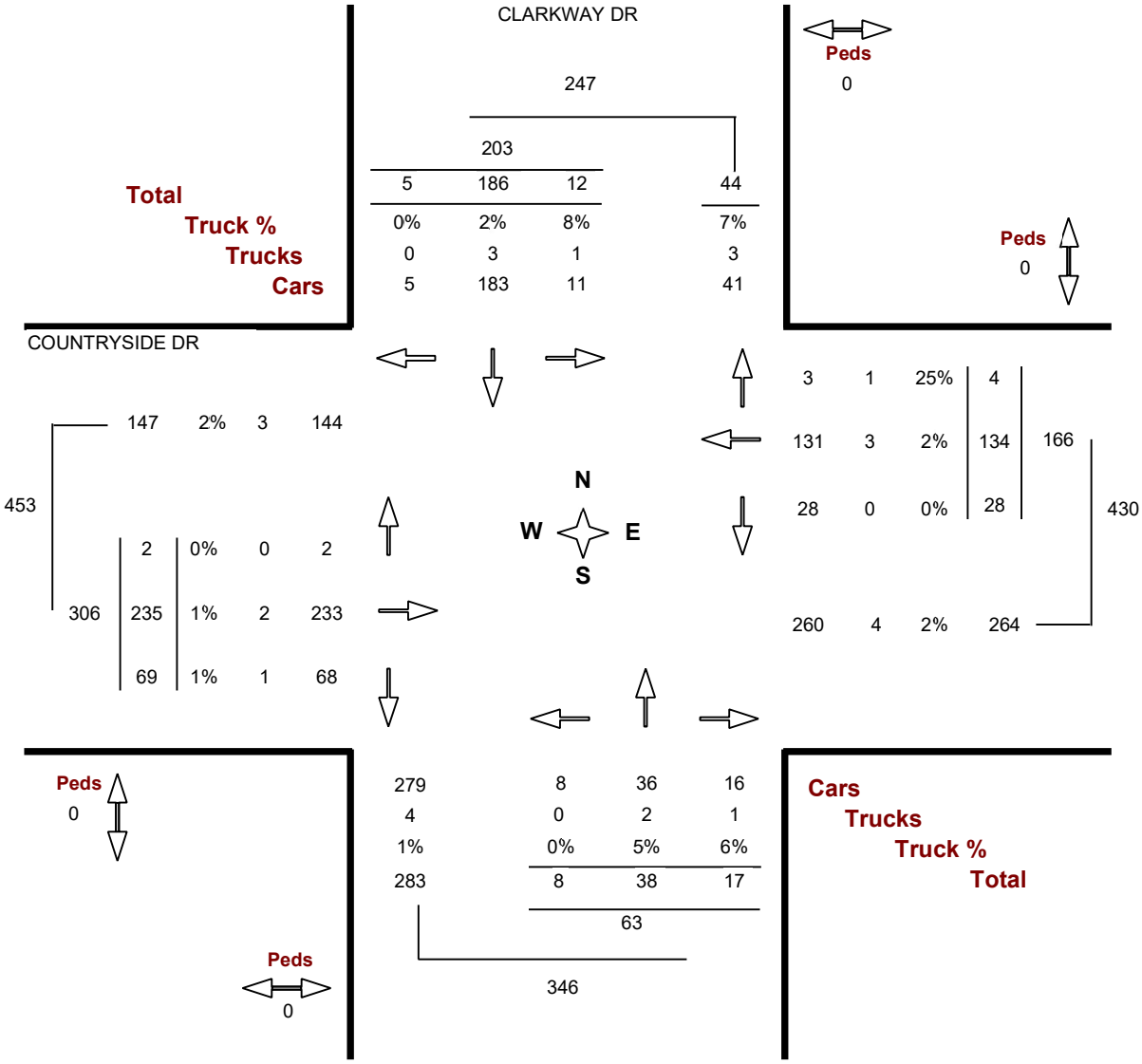
Major Dir..... None

GeoID.....

Count Date. Wednesday, 17 June, 2015

Count Time. 07:00 AM — 09:00 AM

Peak Hour.. 07:15 AM — 08:15 AM

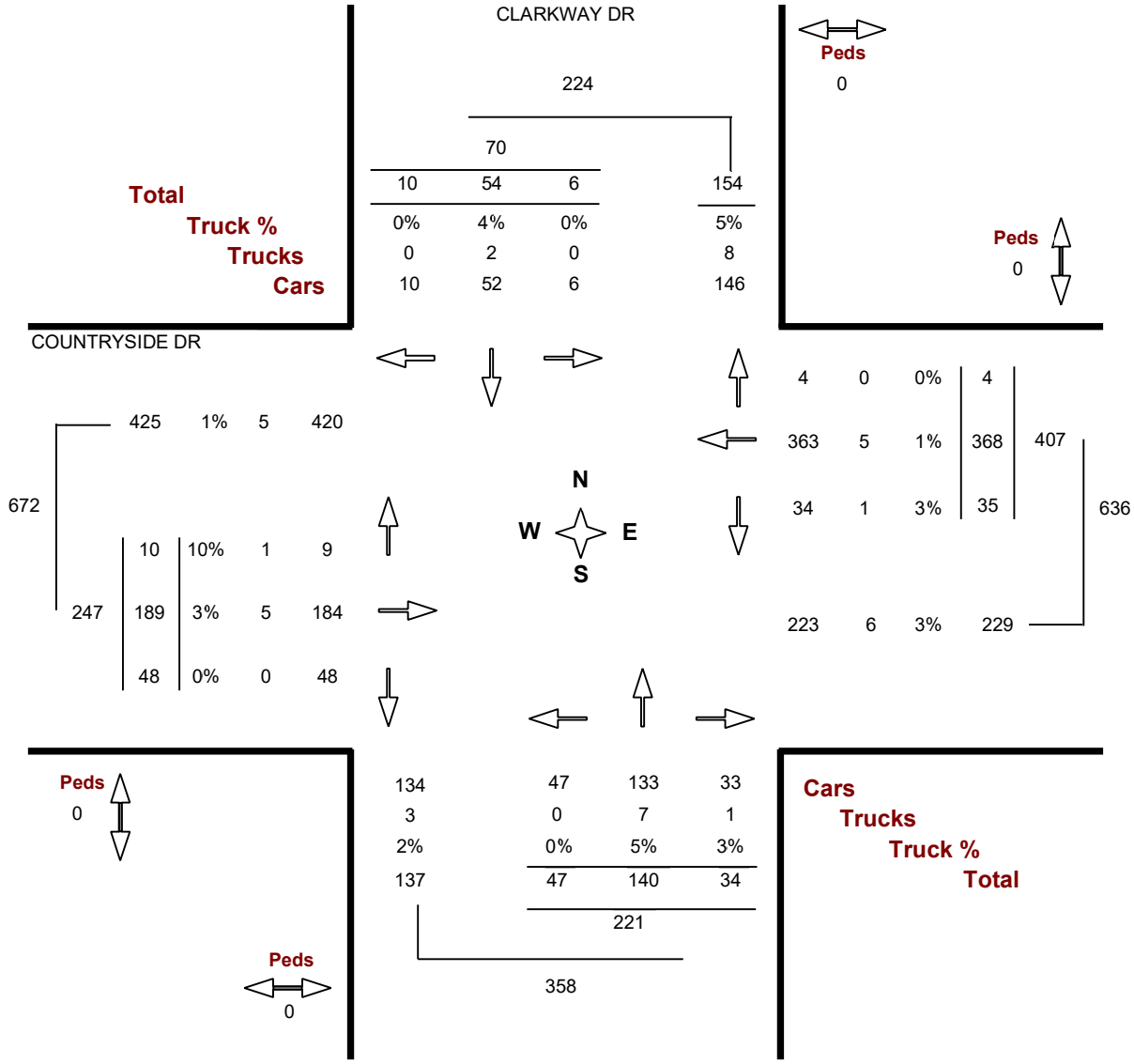


990 Tuesday, 24 June, 2014

Turning Movements Report - PM Period

Location..... CLARKWAY DR @ COUNTRYSIDE DR
Municipality. Brampton
Traffic Cont. Stop sign
Major Dir..... None

GeoID.....
Count Date. Wednesday, 17 June, 2015
Count Time. —
03:00 PM — 06:00 PM
Peak Hour.. 04:30 PM — 05:30 PM



990 Tuesday, 24 June, 2014

COLERAINE DR @ COUNTRYSIDE DR 1076

Turning Movements Report - PM Period

Location.....

Municipality. Brampton

Traffic Cont. Stop sign

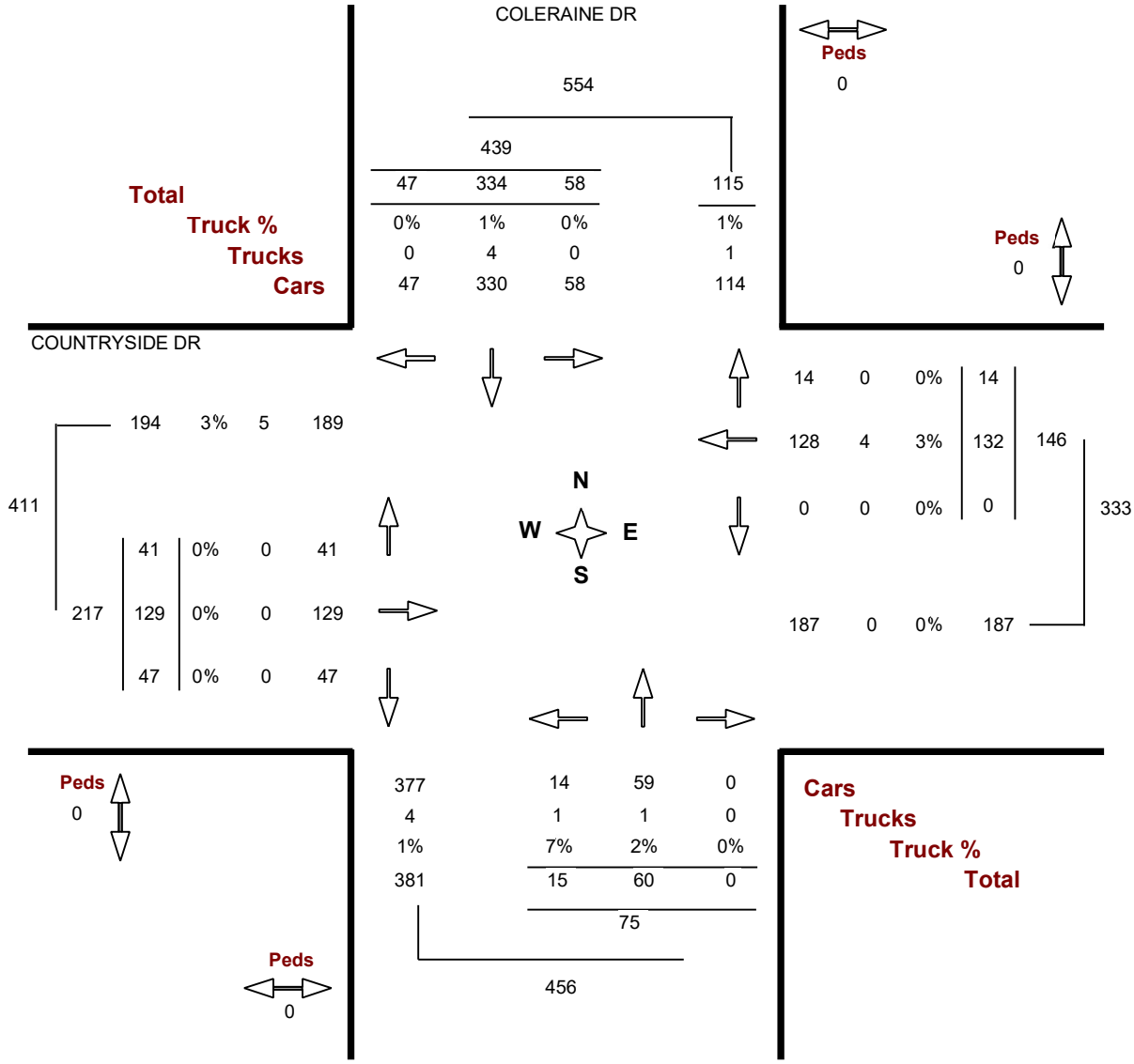
Major Dir..... None

GeoID.....

Count Date. Wednesday, 17 June, 2015

Count Time. 07:00 AM — 09:00 AM

Peak Hour.. 07:00 AM — 08:00 AM



COLERAINE DR @ COUNTRYSIDE DR 1076

Brampton

Turning Movements Report - PM Period

Location.....

Municipality.

Traffic Cont. Stop sign

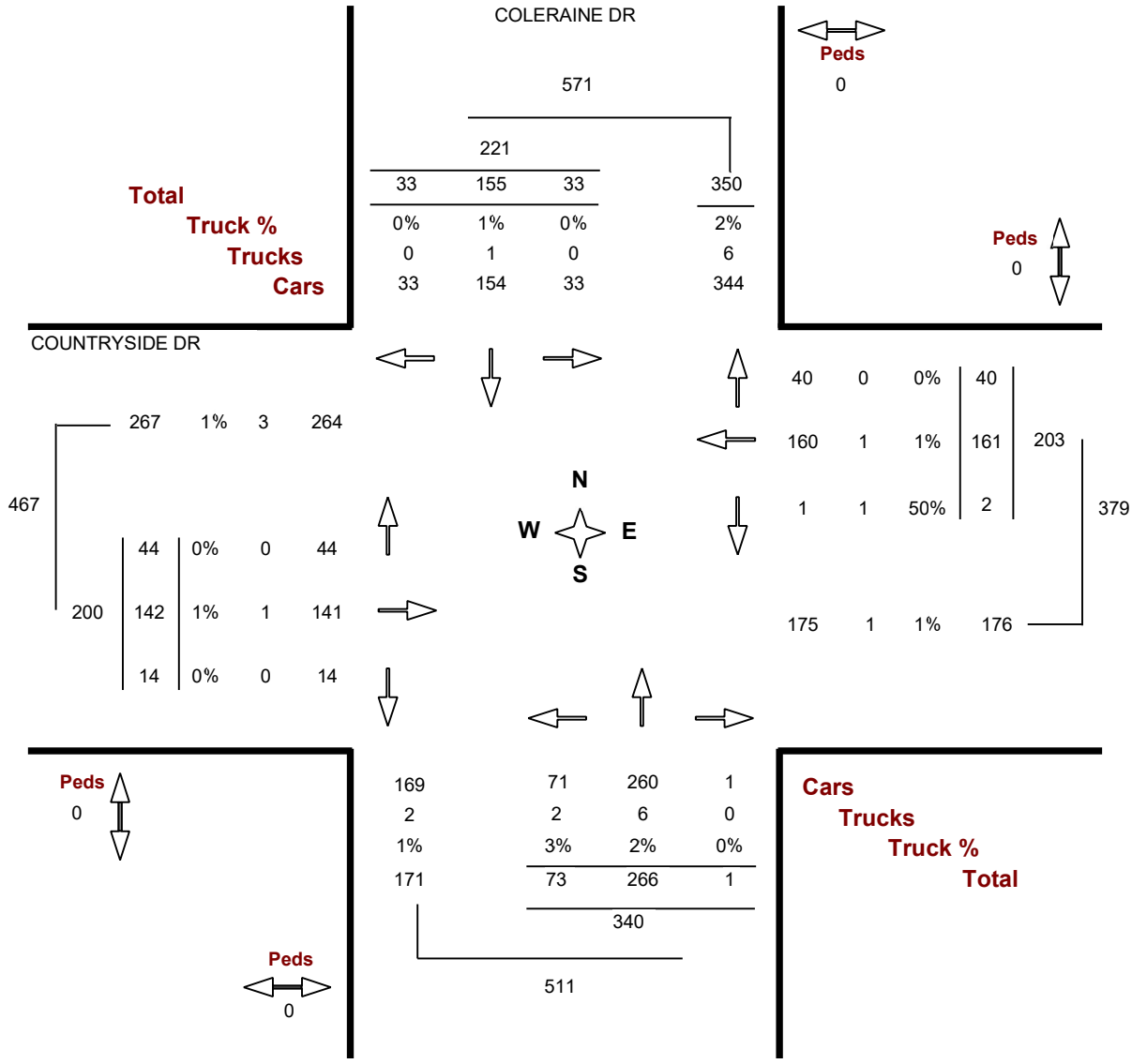
Major Dir..... None

GeoID.....

Count Date. Wednesday, 17 June, 2015

Count Time. 03:00 PM — 06:00 PM

Peak Hour.. 05:00 PM — 06:00 PM



CASTLEMORE RD @ CLARKWAY DR

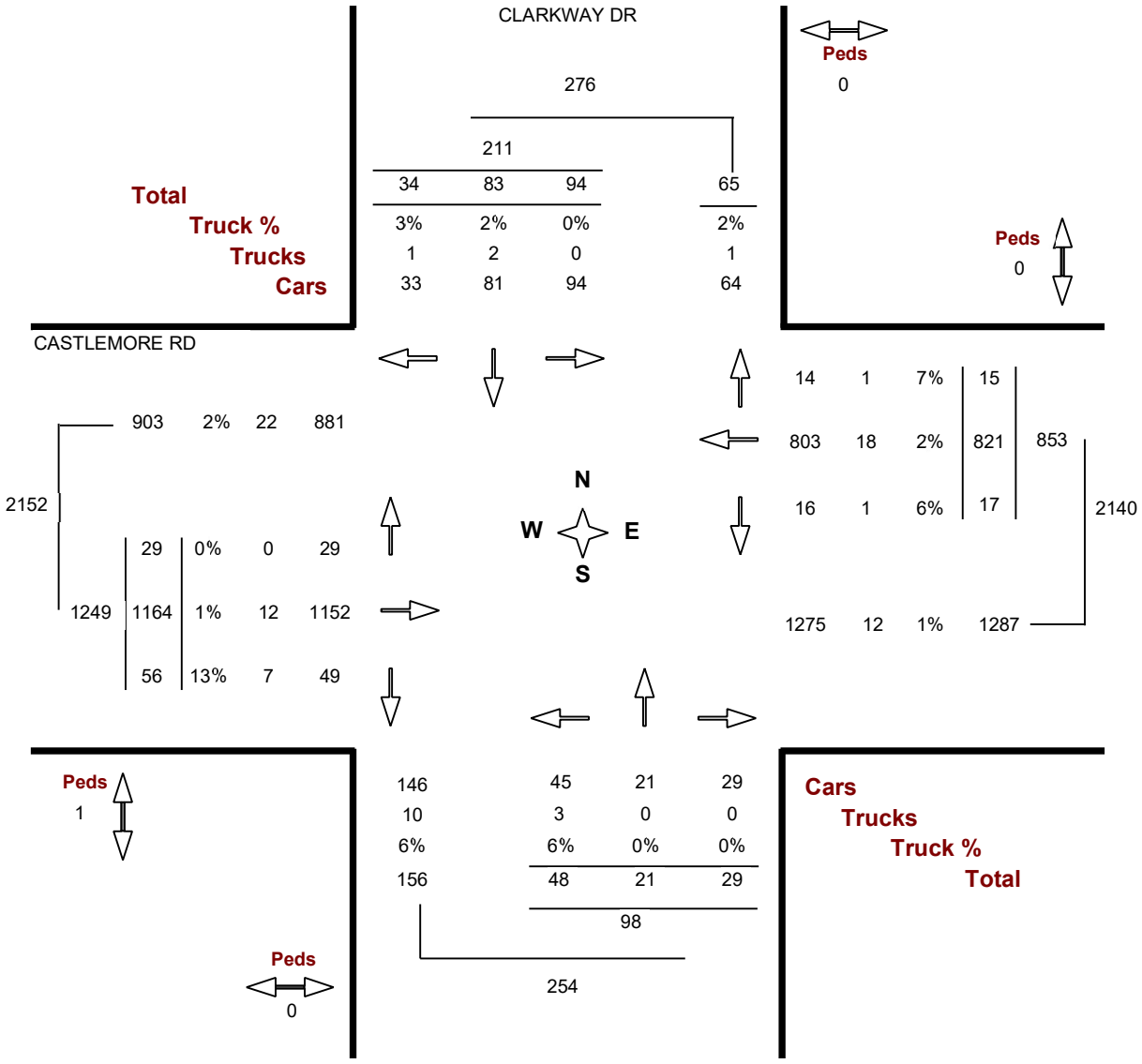
Brampton

991

Turning Movements Report - PM Period

Location.....
Municipality.
Traffic Cont. Traffic signal
Major Dir..... None

GeoID.....
Count Date. Wednesday, 17 June, 2015
Count Time. 07:00 AM — 09:00 AM
Peak Hour.. 07:15 AM — 08:15 AM



Turning Movements Report - PM Period

Location..... CASTLEMORE RD @ CLARKWAY DR

Municipality. Brampton

Traffic Cont. Traffic signal

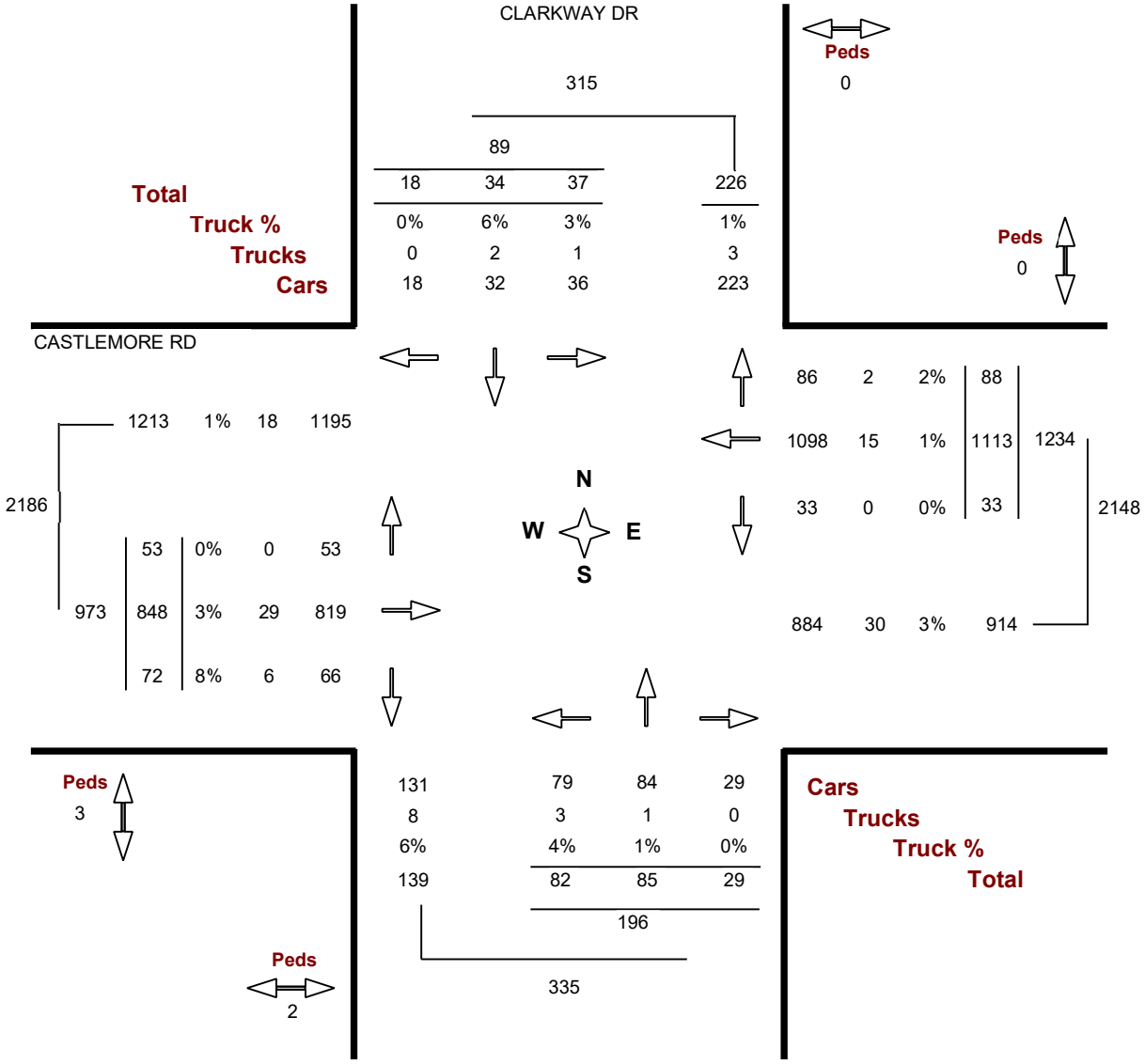
Major Dir..... None

GeoID..... 991

Count Date. Wednesday, 17 June, 2015

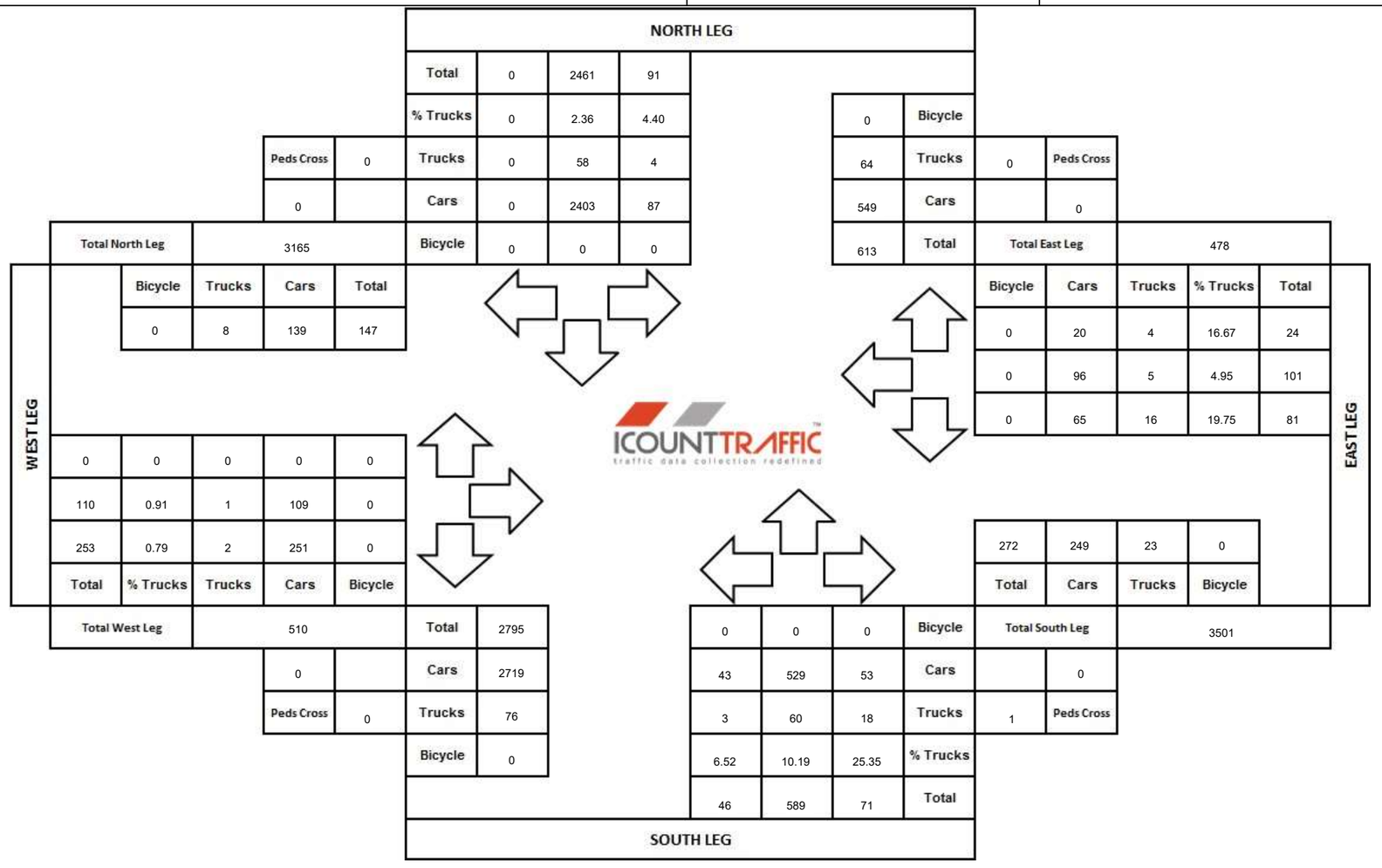
Count Time. 03:00 PM — 06:00 PM

Peak Hour.. 04:30 PM — 05:30 PM



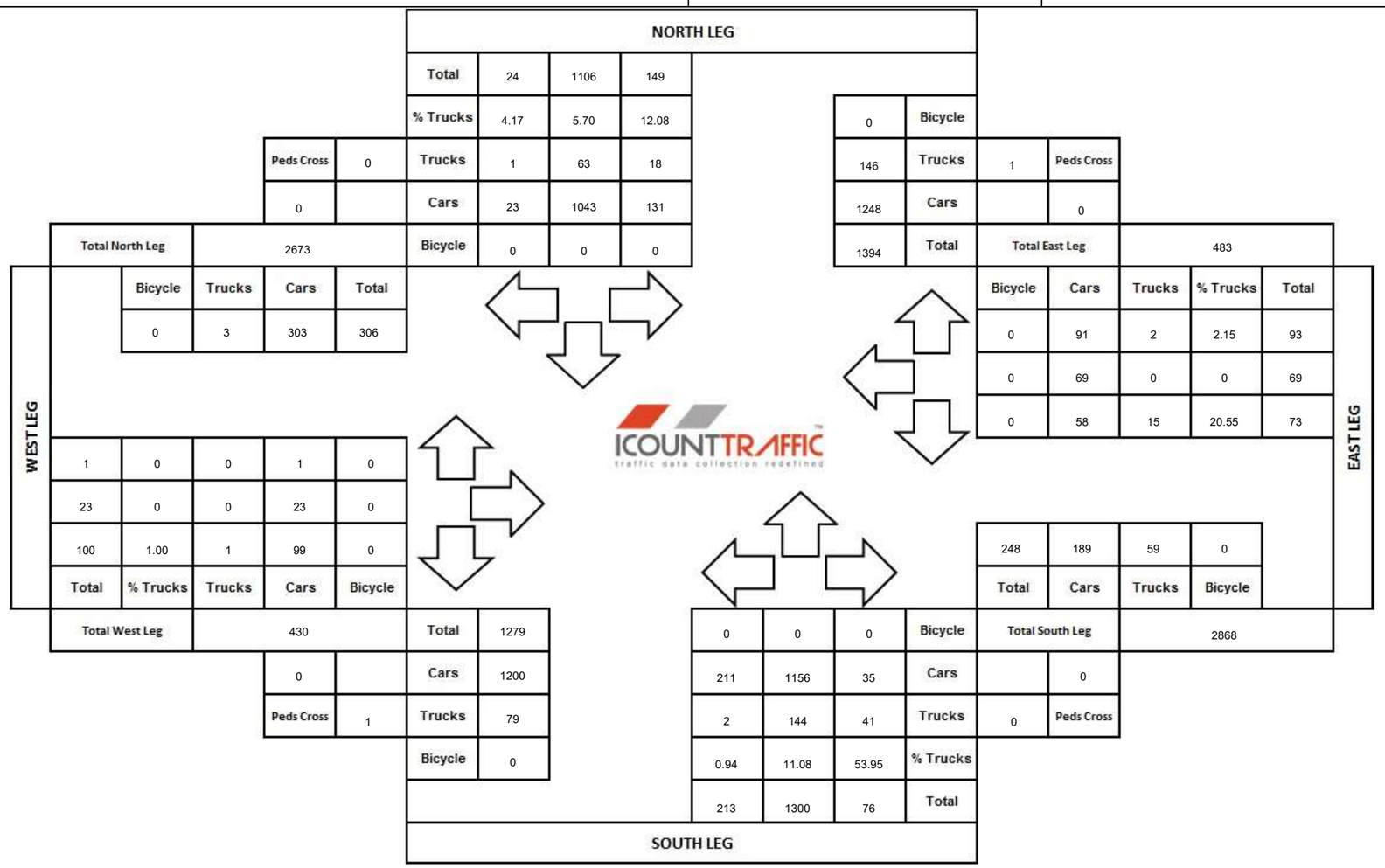
AM Peak Hour Count Diagram

City:	**Brampton**	**Weather:**	**Mostly Cloudy**
North/South Street:	**Highway 50**	**Count Date:**	**27/05/2014**
East/West Street:	**Coleraine Drive/Major Mackenzie Drive**	**Count Period:**	**AM**
GPS Coordinates:	**43.819111, -79.678642**	**Peak Period:**	**7:15 AM - 8:15 AM**
Site Number:	**05008281**	**Major Road:**	**Highway 50**
Control:	**Signalized**	**Surveyor:**	**Muhioddin Jahid, Amir Molla-Abbasi, Amir Molla-abbasi**



PM Peak Hour Count Diagram

City:	**Brampton**	**Weather:**	**Mostly Cloudy**
North/South Street:	**Highway 50**	**Count Date:**	**27/05/2014**
East/West Street:	**Coleraine Drive/Major Mackenzie Drive**	**Count Period:**	**PM**
GPS Coordinates:	**43.819111, -79.678642**	**Peak Period:**	**5:00 PM - 6:00 PM**
Site Number:	**05008281**	**Major Road:**	**Highway 50**
Control:	**Signalized**	**Surveyor:**	**Muhioddin Jahid, Amir Molla-Abbasi, Amir Molla-abbasi**



MG8 ENG

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:00:00
To: 8:00:00

Municipality: Region of Peel
Site #: 0001401354
Intersection: Mayfield Road & Coleraine Drive
TFR File #: 1
Count date: 7-May-2013

Weather conditions:

Person(s) who counted:
PREDO

**** Signalized Intersection ****

Major Road: Mayfield Road runs W/E

North Leg Total:	850								East Leg Total:	808	
North Entering:	488	Cyclists	0	1	0	1	Cyclists	1	East Entering:	467	
North Peds:	0	Trucks	26	8	7	41	Trucks	30	East Peds:	0	
Peds Cross:		Cars	108	330	8	446	Cars	331	Peds Cross:		
		Totals	134	339	15		Totals	362			

Coleraine Drive

Cyclists	Trucks	Cars	Totals
3	71	483	557

Cars	Trucks	Cyclists	Totals
12	8	0	20
357	43	3	403
44	0	0	44
413	51	3	

N

Mayfield Road

W E

Cyclists	Trucks	Cars	Totals
1	17	216	234
0	38	279	317
1	1	48	50
2	56	543	

S

Mayfield Road

Cars	Trucks	Cyclists	Totals
295	46	0	341

Coleraine Drive

Peds Cross:									Peds Cross:		
West Peds:	0	Cars	422	Cars	18	103	8	129	South Peds:	0	
West Entering:	601	Trucks	9	Trucks	2	5	1	8	South Entering:	137	
West Leg Total:	1158	Cyclists	2	Cyclists	0	0	0	0	South Leg Total:	570	
		Totals	433	Totals	20	108	9				

Comments

MG8 ENG

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 17:00:00
To: 18:00:00

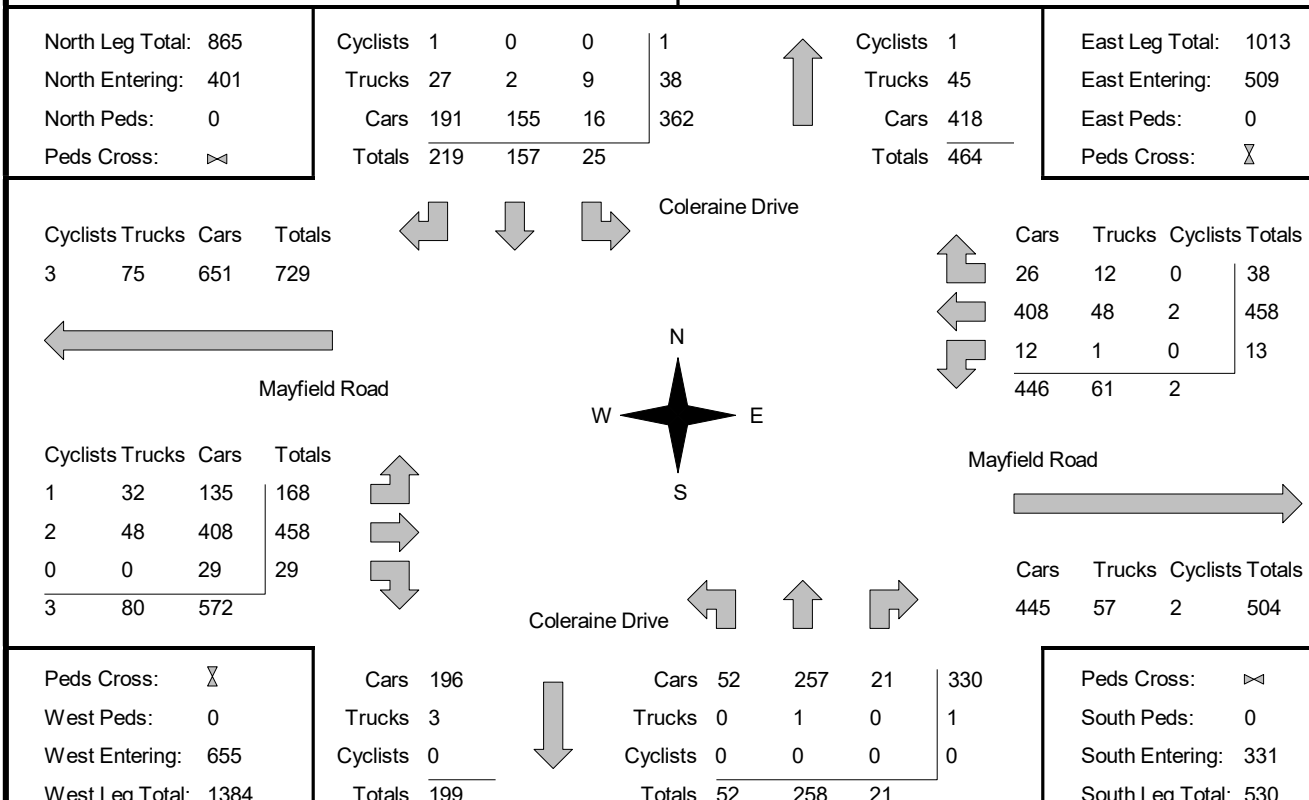
Municipality: Region of Peel
Site #: 0001401354
Intersection: Mayfield Road & Coleraine Drive
TFR File #: 1
Count date: 7-May-2013

Weather conditions:

Person(s) who counted:
PREDO

**** Signalized Intersection ****

Major Road: Mayfield Road runs W/E



Comments

MG8 ENG

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:00:00
To: 8:00:00

Municipality: Region of Peel
Site #: 0001400000
Intersection: Highway 50 & Mayfield Road
TFR File #: 1
Count date: 14-May-2013

Weather conditions:

Person(s) who counted:
PREDO
MILAN

**** Signalized Intersection ****

Major Road: Highway 50 runs N/S

North Leg Total:	2269			
North Entering:	1363			
North Peds:	0			
Peds Cross:	⋈			
Cyclists	0	0	0	0
Trucks	14	79	0	93
Cars	140	1124	6	1270
Totals	154	1203	6	
Cyclists	0			
Trucks	68			
Cars	838			
Totals	906			
East Leg Total:	1087			
East Entering:	849			
East Peds:	0			
Peds Cross:	⧖			

Highway 50

Cyclists	Trucks	Cars	Totals
0	67	480	547

	Cars	Trucks	Cyclists	Totals
	12	1	0	13
	307	16	0	323
	500	13	0	513
	819	30	0	

Mayfield Road

N
W E
S

Cyclists	Trucks	Cars	Totals
0	7	117	124
0	22	103	125
0	44	37	81
0	73	257	

Albion Vaughan Road

Cars	Trucks	Cyclists	Totals
196	42	0	238

Highway 50

Peds Cross:	⧖			
West Peds:	0			
West Entering:	330			
West Leg Total:	877			
Cars	1661			
Trucks	136			
Cyclists	0			
Totals	1797			
Cars	33	709	87	829
Trucks	37	60	20	117
Cyclists	0	0	0	0
Totals	70	769	107	
Peds Cross:	⋈			
South Peds:	0			
South Entering:	946			
South Leg Total:	2743			

Comments

MG8 ENG

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 17:00:00
To: 18:00:00

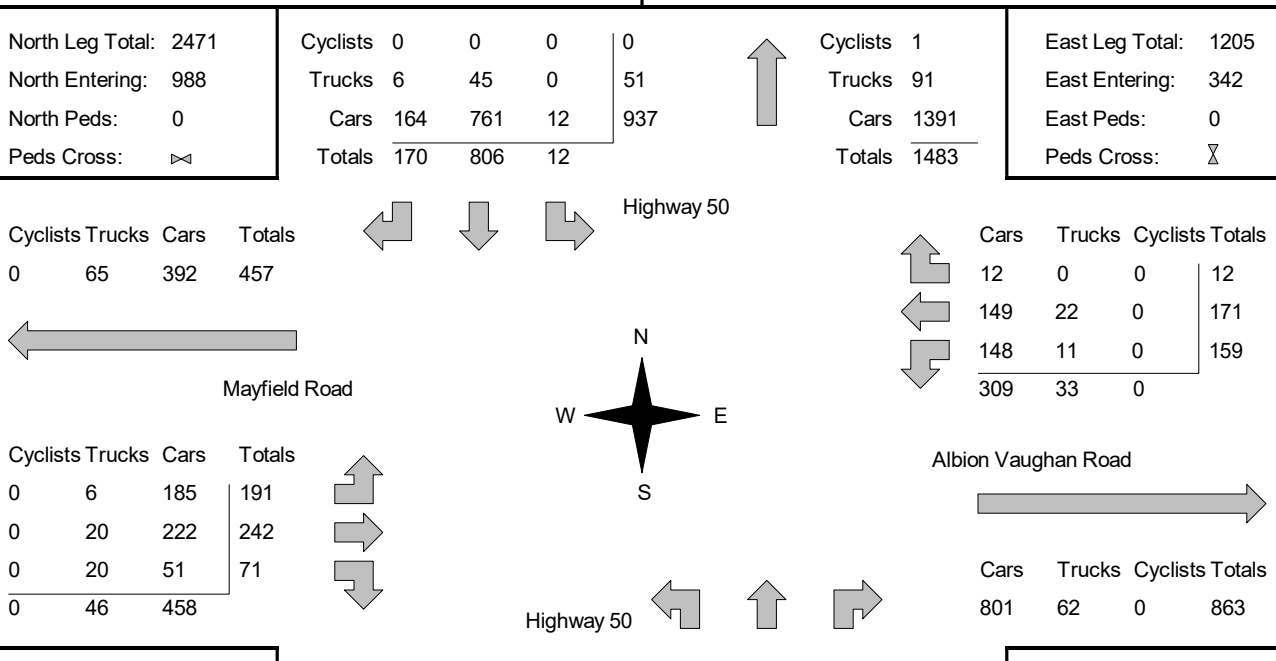
Municipality: Region of Peel
Site #: 0001400000
Intersection: Highway 50 & Mayfield Road
TFR File #: 1
Count date: 14-May-2013

Weather conditions:

Person(s) who counted:
PREDO
MILAN

**** Signalized Intersection ****

Major Road: Highway 50 runs N/S



Comments

MG8 ENG

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:00:00
To: 8:00:00

Municipality: Region of Peel
Site #: 0000809689
Intersection: The Gore Road & Mayfield Road
TFR File #: 1
Count date: 30-Apr-2013

Weather conditions:

Person(s) who counted:
BARRY

**** Signalized Intersection ****

Major Road: The Gore Road runs N/S

North Leg Total:	443
North Entering:	389
North Peds:	0
Peds Cross:	⋈

Cyclists	2	0	0	2
Trucks	4	6	3	13
Cars	41	320	13	374
Totals	47	326	16	

Cyclists	0
Trucks	5
Cars	49
Totals	54

East Leg Total:	1145
East Entering:	565
East Peds:	0
Peds Cross:	⧖

The Gore Road

Cyclists	Trucks	Cars	Totals
3	83	483	569

Cars	Trucks	Cyclists	Totals
5	0	0	5
433	77	1	511
46	3	0	49
484	80	1	

Mayfield Road

N
W E
S

Cyclists	Trucks	Cars	Totals
0	1	11	12
0	60	475	535
0	12	51	63
0	73	537	

Mayfield Road

Cars	Trucks	Cyclists	Totals
509	70	1	580

The Gore Road

Peds Cross:	⧖
West Peds:	0
West Entering:	610
West Leg Total:	1179

Cars	417
Trucks	21
Cyclists	0
Totals	438

Cars	9	33	21	63
Trucks	2	4	7	13
Cyclists	0	0	1	1
Totals	11	37	29	

Peds Cross:	⋈
South Peds:	4
South Entering:	77
South Leg Total:	515

Comments

MG8 ENG

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 16:45:00
To: 17:45:00

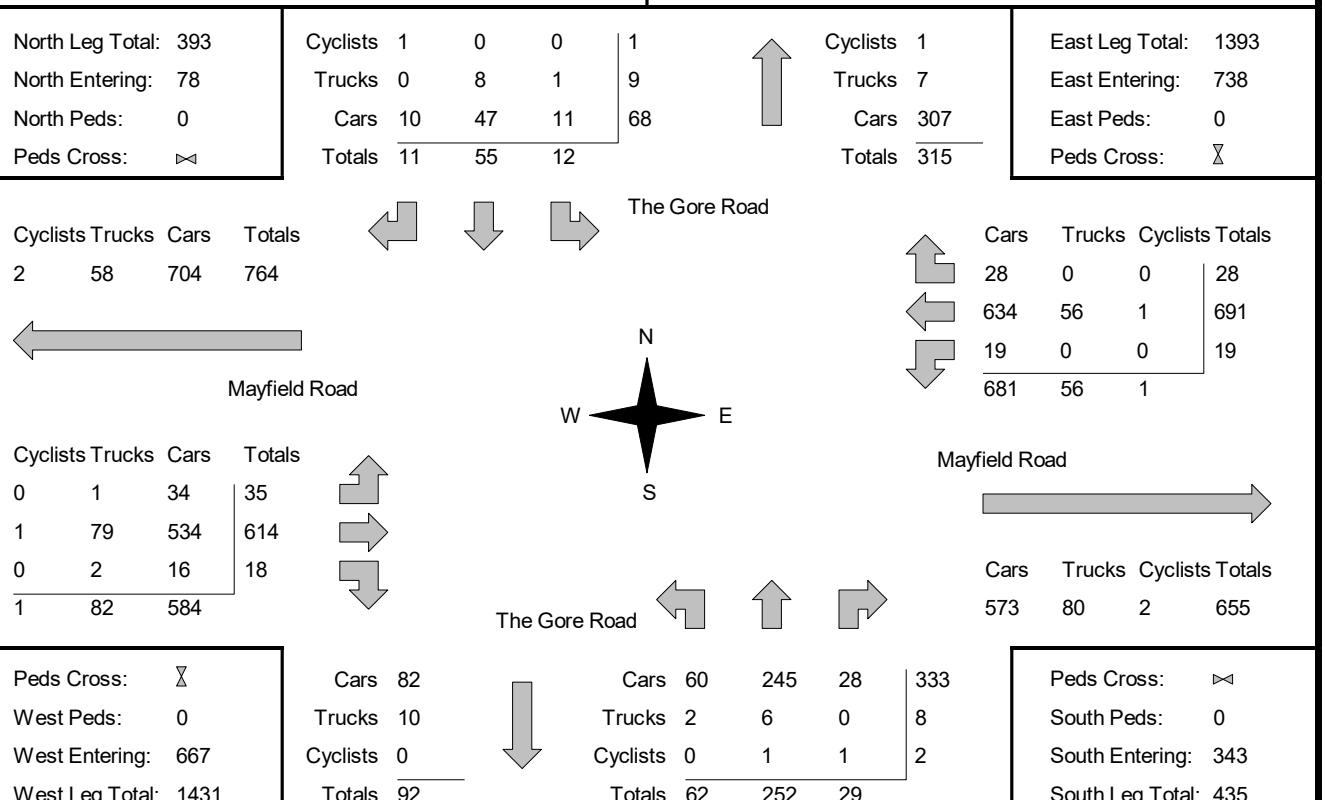
Municipality: Region of Peel
Site #: 0000809689
Intersection: The Gore Road & Mayfield Road
TFR File #: 1
Count date: 30-Apr-2013

Weather conditions:

Person(s) who counted:
BARRY

**** Signalized Intersection ****

Major Road: The Gore Road runs N/S



Comments

MG8 ENG

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:00:00
To: 8:00:00

Municipality: Region of Peel
Site #: 0001402728
Intersection: Mayfield Road & Clarkway Drive
TFR File #: 1
Count date: 7-May-2013

Weather conditions:

Person(s) who counted:
MILAN

**** Signalized Intersection ****

Major Road: Mayfield Road runs W/E

North Leg Total:	91
North Entering:	74
North Peds:	0
Peds Cross:	⋈

Cyclists	0	0	0	0
Trucks	1	2	0	3
Cars	9	56	6	71
Totals	10	58	6	

Cyclists	0
Trucks	1
Cars	16
Totals	17

East Leg Total:	1142
East Entering:	569
East Peds:	0
Peds Cross:	⧖

Humber Station Rd

Cyclists	Trucks	Cars	Totals
3	67	499	569

Cars	Trucks	Cyclists	Totals
5	1	0	6
484	65	3	552
11	0	0	11
500	66	3	

Mayfield Road

N
W E
S

Cyclists	Trucks	Cars	Totals
0	0	8	8
2	54	502	558
0	0	10	10
2	54	520	

Mayfield Road

Cars	Trucks	Cyclists	Totals
517	54	2	573

Clarkway Drive

Peds Cross:	⧖
West Peds:	0
West Entering:	576
West Leg Total:	1145

Cars	77			
Trucks	2			
Cyclists	0			
Totals	79			

Cars	6	3	9	18
Trucks	1	0	0	1
Cyclists	0	0	0	0
Totals	7	3	9	

Peds Cross:	⋈
South Peds:	1
South Entering:	19
South Leg Total:	98

Comments

MG8 ENG

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 16:45:00
To: 17:45:00

Municipality: Region of Peel
Site #: 0001402728
Intersection: Mayfield Road & Clarkway Drive
TFR File #: 1
Count date: 7-May-2013

Weather conditions:

Person(s) who counted:
MILAN

**** Signalized Intersection ****

Major Road: Mayfield Road runs W/E

North Leg Total:	105
North Entering:	30
North Peds:	1
Peds Cross:	⋈

Cyclists	0	0	0	0
Trucks	1	0	0	1
Cars	15	8	6	29
Totals	16	8	6	

Cyclists	1
Trucks	5
Cars	69
Totals	75

East Leg Total:	1416
East Entering:	751
East Peds:	0
Peds Cross:	⧖

Humber Station Rd

Cyclists	Trucks	Cars	Totals
2	72	673	747

Cars	Trucks	Cyclists	Totals
22	3	1	26
647	70	2	719
4	1	1	6
673	74	4	

Mayfield Road

N
W E
S

Cyclists	Trucks	Cars	Totals
0	0	14	14
2	95	550	647
0	2	9	11
2	97	573	

Mayfield Road

Cars	Trucks	Cyclists	Totals
568	95	2	665

Clarkway Drive

Peds Cross:	⧖
West Peds:	0
West Entering:	672
West Leg Total:	1419

Cars	21			
Trucks	3			
Cyclists	1			
Totals	25			

Cars	11	33	12	56
Trucks	1	2	0	3
Cyclists	0	0	0	0
Totals	12	35	12	

Peds Cross:	⋈
South Peds:	0
South Entering:	59
South Leg Total:	84

Comments

MG8 ENG

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:45:00
To: 8:45:00

Municipality: Region of Peel
Site #: 0000805384
Intersection: The Gore Rd & Castlemore Rd
TFR File #: 8
Count date: 25-Apr-2013

Weather conditions:

Person(s) who counted:
PREDO

**** Signalized Intersection ****

Major Road: The Gore Rd runs N/S

North Leg Total:	619			
North Entering:	484			
North Peds:	1			
Peds Cross:	⋈			
Cyclists	0	0	0	0
Trucks	2	19	6	27
Cars	43	370	44	457
Totals	45	389	50	
Cyclists	0			
Trucks	18			
Cars	117			
Totals	135			
East Leg Total:	1628			
East Entering:	780			
East Peds:	0			
Peds Cross:	⧖			

The Gore Road

Cyclists	Trucks	Cars	Totals
0	39	926	965

Cars	Trucks	Cyclists	Totals
18	7	0	25
683	25	0	708
46	1	0	47
747	33	0	

Castlemore Road

N
W E
S

Cyclists	Trucks	Cars	Totals
0	2	16	18
0	17	737	754
0	19	384	403
0	38	1137	

Castlemore Road

Cars	Trucks	Cyclists	Totals
821	27	0	848

The Gore Road

Peds Cross:	⧖			
West Peds:	2			
West Entering:	1175			
West Leg Total:	2140			
Cars	800			
Trucks	39			
Cyclists	0			
Totals	839			
Cars	200	83	40	323
Trucks	12	9	4	25
Cyclists	0	0	0	0
Totals	212	92	44	
Peds Cross:	⋈			
South Peds:	8			
South Entering:	348			
South Leg Total:	1187			

Comments

MG8 ENG

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 16:45:00
To: 17:45:00

Municipality: Region of Peel
Site #: 0000805384
Intersection: The Gore Rd & Castlemore Rd
TFR File #: 8
Count date: 25-Apr-2013

Weather conditions:

Person(s) who counted:
PREDO

**** Signalized Intersection ****

Major Road: The Gore Rd runs N/S

North Leg Total: 750
North Entering: 191
North Peds: 1
Peds Cross: ⋈

Cyclists	0	0	0	0
Trucks	1	4	3	8
Cars	37	123	23	183
Totals	38	127	26	

Cyclists	0
Trucks	16
Cars	543
Totals	559

East Leg Total: 1791
East Entering: 1030
East Peds: 0
Peds Cross: ⧖

The Gore Road

Cyclists	Trucks	Cars	Totals
0	14	1218	1232

Castlemore Road

	Cars	Trucks	Cyclists	Totals
	80	2	0	82
	895	11	0	906
	42	0	0	42
	1017	13	0	

N
W E
S

Cyclists	Trucks	Cars	Totals
0	1	63	64
0	11	662	673
0	6	200	206
0	18	925	

Castlemore Road

Cars	Trucks	Cyclists	Totals
745	16	0	761

The Gore Road

Peds Cross: ⧖
West Peds: 0
West Entering: 943
West Leg Total: 2175

Cars	365			
Trucks	10			
Cyclists	0			
Totals	375			

Cars	286	400	60	746
Trucks	2	13	2	17
Cyclists	0	0	0	0
Totals	288	413	62	

Peds Cross: ⋈
South Peds: 1
South Entering: 763
South Leg Total: 1138

Comments

MG8 ENG

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:30:00
To: 8:30:00

Municipality: Region of Peel
Site #: 0000808457
Intersection: The Gore Road & Countryside Driv
TFR File #: 9
Count date: 25-Apr-2013

Weather conditions:

Person(s) who counted:
NIKOLA

**** Signalized Intersection ****

Major Road: The Gore Road runs N/S

North Leg Total: 525
North Entering: 418
North Peds: 0
Peds Cross: ⋈

Cyclists	0	0	0	0
Trucks	0	12	2	14
Cars	21	357	26	404
Totals	21	369	28	

Cyclists	0
Trucks	15
Cars	92
Totals	107

East Leg Total: 485
East Entering: 197
East Peds: 0
Peds Cross: ⋈

The Gore Road

Cyclists	Trucks	Cars	Totals
0	4	195	199

Cars	Trucks	Cyclists	Totals
13	0	0	13
157	3	0	160
24	0	0	24
194	3	0	

Countryside Drive

N
W E
S

Cyclists	Trucks	Cars	Totals
0	4	17	21
0	6	245	251
0	5	87	92
0	15	349	

Countryside Drive

Cars	Trucks	Cyclists	Totals
280	8	0	288

The Gore Road

Peds Cross: ⋈
West Peds: 0
West Entering: 364
West Leg Total: 563

Cars	468
Trucks	17
Cyclists	0
Totals	485

Cars	17	62	9	88
Trucks	1	11	0	12
Cyclists	0	0	0	0
Totals	18	73	9	

Peds Cross: ⋈
South Peds: 0
South Entering: 100
South Leg Total: 585

Comments

MG8 ENG

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 16:45:00
To: 17:45:00

Municipality: Region of Peel
Site #: 0000808457
Intersection: The Gore Road & Countryside Driv
TFR File #: 9
Count date: 25-Apr-2013

Weather conditions:

Person(s) who counted:
NIKOLA

**** Signalized Intersection ****

Major Road: The Gore Road runs N/S

North Leg Total:	469
North Entering:	104
North Peds:	0
Peds Cross:	⋈

Cyclists	0	0	0	0
Trucks	0	3	0	3
Cars	14	78	9	101
Totals	14	81	9	

Cyclists	0
Trucks	17
Cars	348
Totals	365

East Leg Total:	549
East Entering:	332
East Peds:	0
Peds Cross:	⧖

The Gore Road

Cyclists	Trucks	Cars	Totals
0	2	418	420

Countryside Drive

Cyclists	Trucks	Cars	Totals
0	1	16	17
0	4	182	186
0	0	40	40
0	5	238	

Cars	Trucks	Cyclists	Totals
16	2	0	18
305	2	0	307
7	0	0	7
328	4	0	

N
W E
S

Countryside Drive

Cars	Trucks	Cyclists	Totals
212	5	0	217

The Gore Road

Peds Cross:	⧖
West Peds:	0
West Entering:	243
West Leg Total:	663

Cars	125			
Trucks	3			
Cyclists	0			
Totals	128			

Cars	99	316	21	436
Trucks	0	14	1	15
Cyclists	0	0	0	0
Totals	99	330	22	

Peds Cross:	⋈
South Peds:	0
South Entering:	451
South Leg Total:	579

Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:15:00
To: 8:15:00

Municipality: Brampton
Site #: 1602800004
Intersection: Castlemore Rd & Bloom Dr
TFR File #: 1
Count date: 26-Jan-16

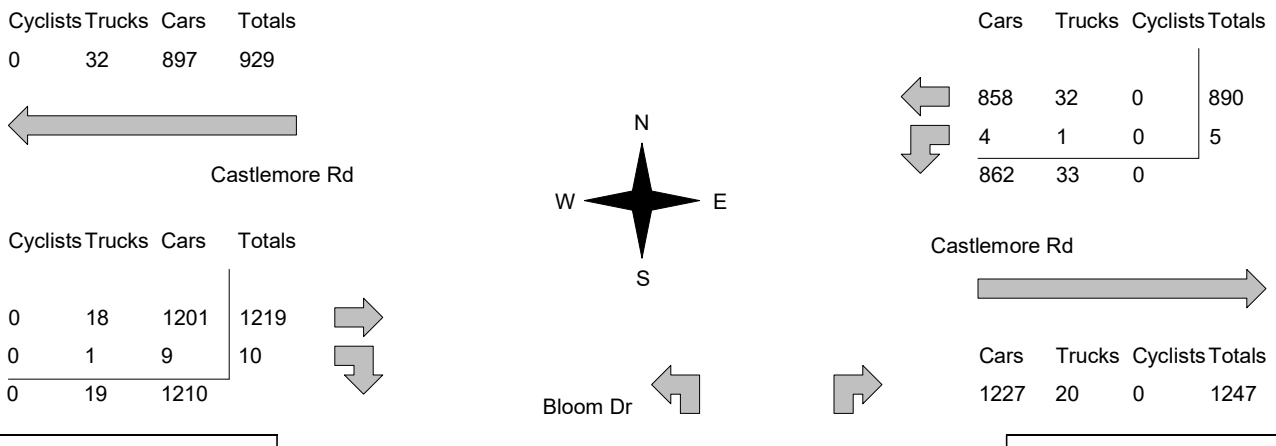
Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E

East Leg Total: 2142
East Entering: 895
East Peds: 1
Peds Cross: ⧖



Peds Cross: ⧖
West Peds: 0
West Entering: 1229
West Leg Total: 2158

Cars 13
Trucks 2
Cyclists 0
Totals 15

Cars 39 26 65
Trucks 0 2 2
Cyclists 0 0 0
Totals 39 28

Peds Cross: ⋈
South Peds: 3
South Entering: 67
South Leg Total: 82

Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:15:00
To: 17:15:00

Municipality: Brampton
Site #: 1602800004
Intersection: Castlemore Rd & Bloom Dr
TFR File #: 1
Count date: 26-Jan-16

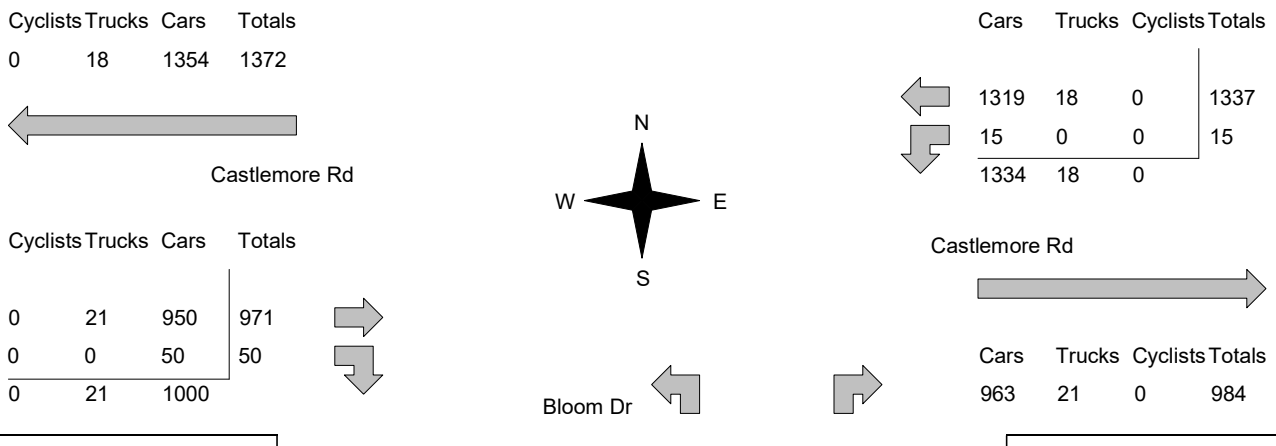
Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E

East Leg Total: 2336
East Entering: 1352
East Peds: 1
Peds Cross: ⧖



Peds Cross: ⧖
West Peds: 0
West Entering: 1021
West Leg Total: 2393

Cars 65
Trucks 0
Cyclists 0
Totals 65

Cars 35 13 48
Trucks 0 0 0
Cyclists 0 0 0
Totals 35 13

Peds Cross: ⋈
South Peds: 3
South Entering: 48
South Leg Total: 113

Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:15:00
To: 8:15:00

Municipality: Brampton
Site #: 1602800005
Intersection: Castlemore Rd & Gardenbrooke Tra
TFR File #: 1
Count date: 26-Jan-16

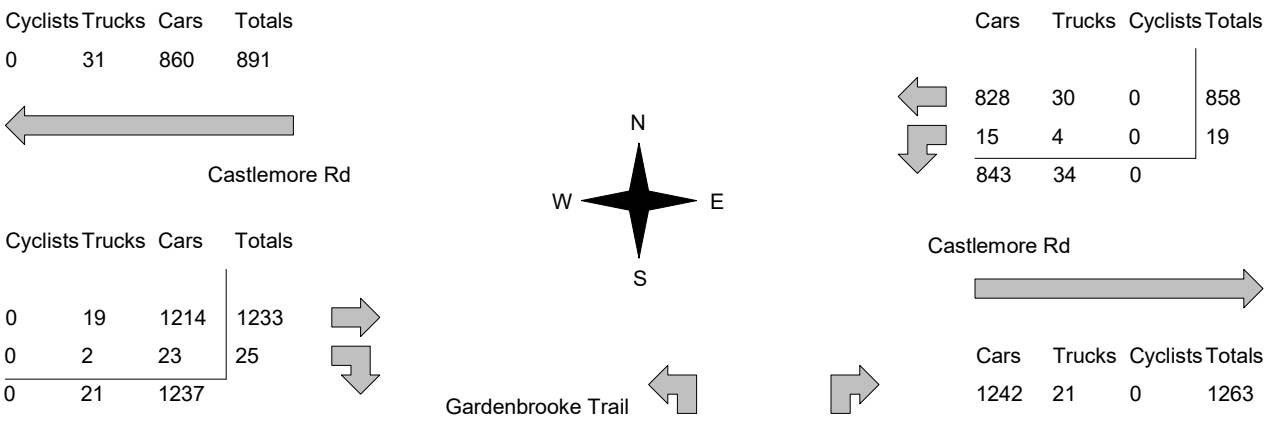
Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E

East Leg Total: 2140
East Entering: 877
East Peds: 0
Peds Cross: ⧖



Peds Cross: ⧖
West Peds: 0
West Entering: 1258
West Leg Total: 2149

Cars 38
Trucks 6
Cyclists 0
Totals 44

Cars 32 28 60
Trucks 1 2 3
Cyclists 0 0 0
Totals 33 30

Peds Cross: ⋈
South Peds: 0
South Entering: 63
South Leg Total: 107

Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:15:00
To: 17:15:00

Municipality: Brampton
Site #: 1602800005
Intersection: Castlemore Rd & Gardenbrooke Tra
TFR File #: 1
Count date: 26-Jan-16

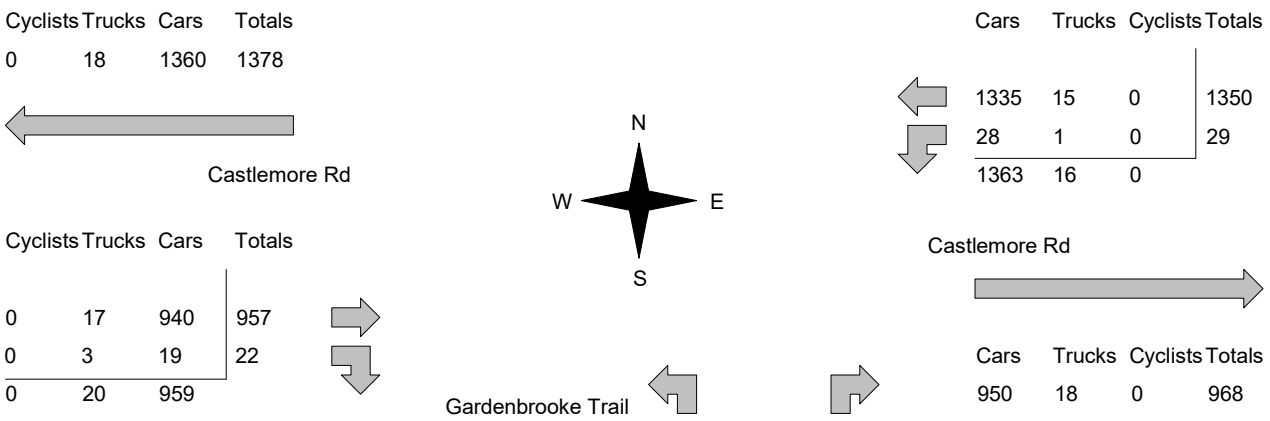
Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E

East Leg Total: 2347
East Entering: 1379
East Peds: 0
Peds Cross: ⧖



Peds Cross: ⧖
West Peds: 1
West Entering: 979
West Leg Total: 2357

Cars 47
Trucks 4
Cyclists 0
Totals 51

Cars 25 10 35
Trucks 3 1 4
Cyclists 0 0 0
Totals 28 11

Peds Cross: ⋈
South Peds: 1
South Entering: 39
South Leg Total: 90

Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:15:00
To: 8:15:00

Municipality: Brampton
Site #: 1602800007
Intersection: Castlemore Rd & Apple Valley Way
TFR File #: 1
Count date: 26-Jan-16

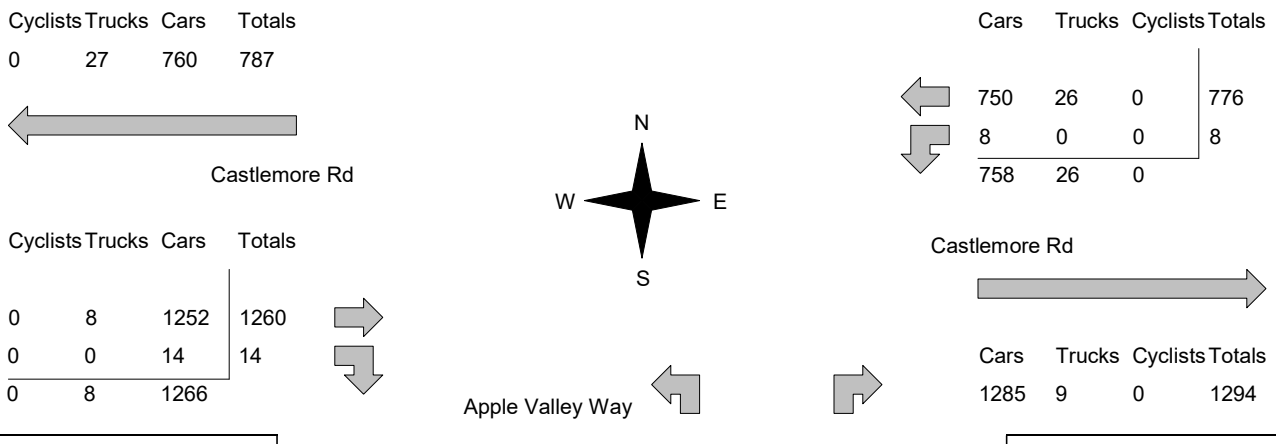
Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E

East Leg Total: 2078
East Entering: 784
East Peds: 0
Peds Cross: ⧖



Peds Cross: ⧖
West Peds: 0
West Entering: 1274
West Leg Total: 2061

Cars 22
Trucks 0
Cyclists 0
Totals 22

Cars 10 33 43
Trucks 1 1 2
Cyclists 0 0 0
Totals 11 34

Peds Cross: ⋈
South Peds: 0
South Entering: 45
South Leg Total: 67

Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:15:00
To: 17:15:00

Municipality: Brampton
Site #: 1602800007
Intersection: Castlemore Rd & Apple Valley Way
TFR File #: 1
Count date: 26-Jan-16

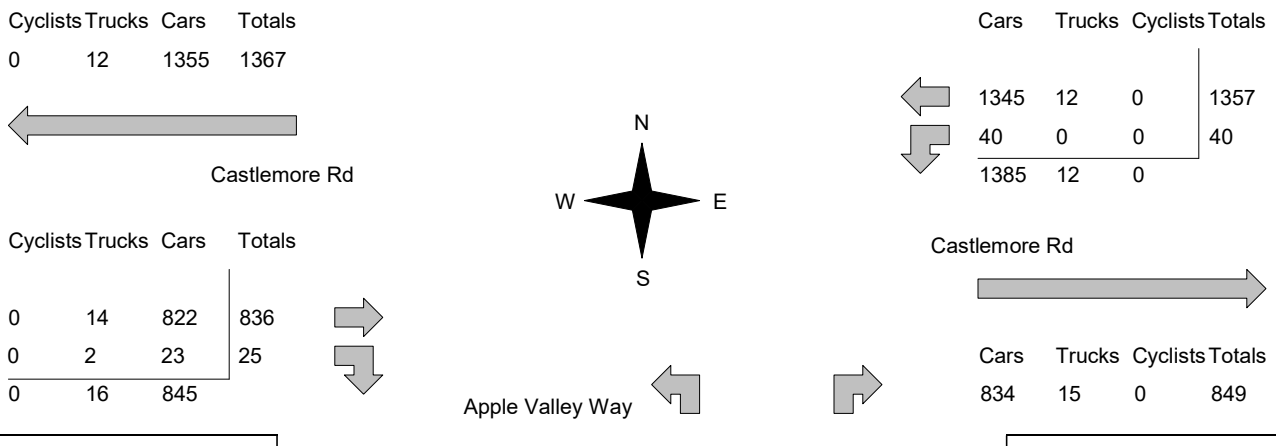
Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E

East Leg Total: 2246
East Entering: 1397
East Peds: 0
Peds Cross: ⧖



Peds Cross: ⧖
West Peds: 0
West Entering: 861
West Leg Total: 2228

Cars	63		
Trucks	2		
Cyclists	0		
Totals	65		
Cars	10	12	22
Trucks	0	1	1
Cyclists	0	0	0
Totals	10	13	

Peds Cross: ⋈
South Peds: 0
South Entering: 23
South Leg Total: 88

Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:15:00
To: 8:15:00

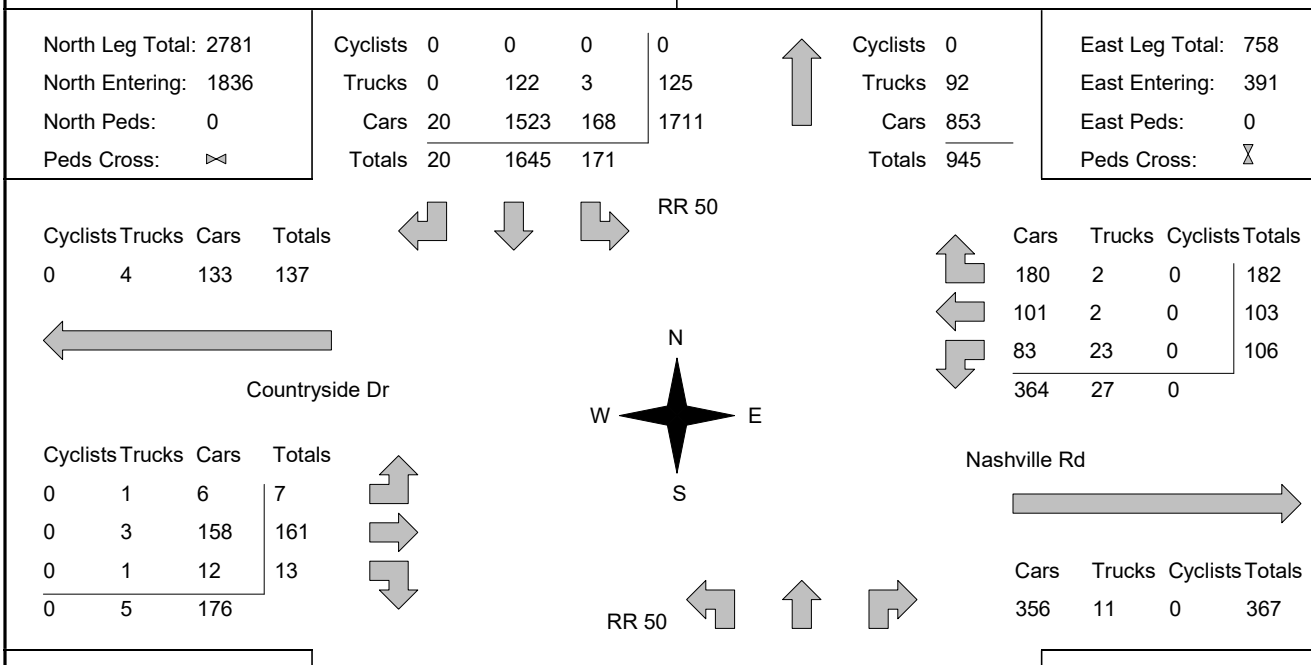
Municipality: Brampton
Site #: 1602800001
Intersection: RR 50 & Countryside Dr
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: RR 50 runs N/S



Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:45:00
To: 17:45:00

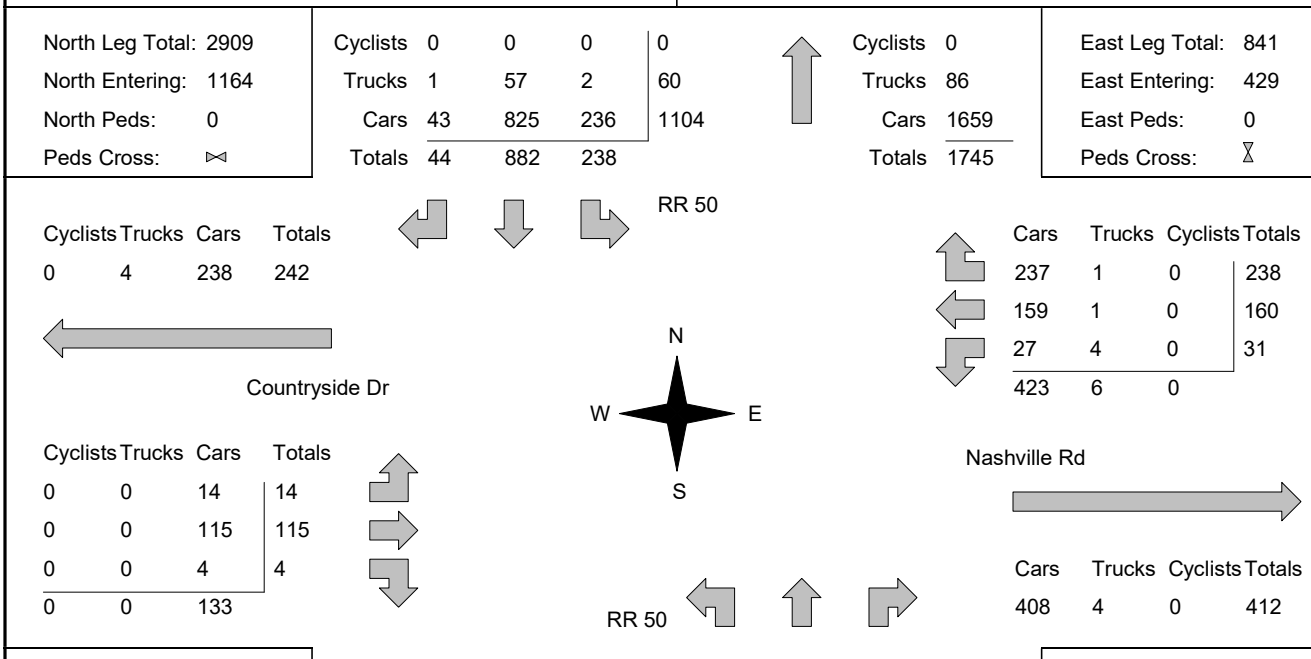
Municipality: Brampton
Site #: 1602800001
Intersection: RR 50 & Countryside Dr
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: RR 50 runs N/S



Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:15:00
To: 8:15:00

Municipality: Brampton
Site #: 1602800003
Intersection: RR 50 & Castlemore Rd-Rutherford
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: RR 50 runs N/S

North Leg Total:	3095	Cyclists	0	0	0	0	Cyclists	0	East Leg Total:	2224
North Entering:	2072	Trucks	8	183	41	232	Trucks	124	East Entering:	896
North Peds:	0	Cars	78	1572	190	1840	Cars	899	East Peds:	0
Peds Cross:		Totals	86	1755	231		Totals	1023	Peds Cross:	

RR 50

Cyclists	Trucks	Cars	Totals
0	26	757	783

Cars	Trucks	Cyclists	Totals
125	24	0	149
628	14	0	642
38	67	0	105
791	105	0	

N

Castlemore Rd

W E

Cyclists	Trucks	Cars	Totals
0	4	115	119
0	3	1006	1009
0	2	200	202
0	9	1321	

Rutherford Rd

S

Cars	Trucks	Cyclists	Totals
1253	75	0	1328

RR 50

Peds Cross:		Cars	1810	Cars	51	659	57	767	Peds Cross:	
West Peds:	0	Trucks	252	Trucks	4	96	31	131	South Peds:	0
West Entering:	1330	Cyclists	0	Cyclists	0	0	0	0	South Entering:	898
West Leg Total:	2113	Totals	2062	Totals	55	755	88		South Leg Total:	2960

Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:30:00
To: 17:30:00

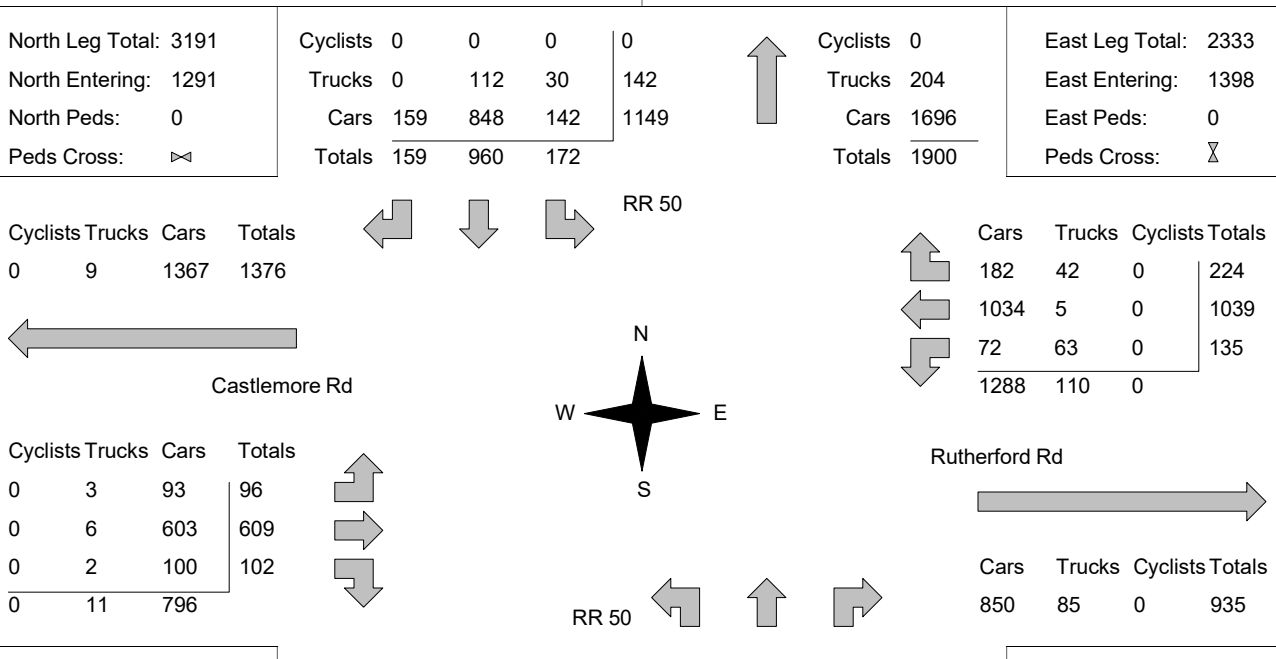
Municipality: Brampton
Site #: 1602800003
Intersection: RR 50 & Castlemore Rd-Rutherford
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: RR 50 runs N/S



Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:00:00
To: 8:00:00

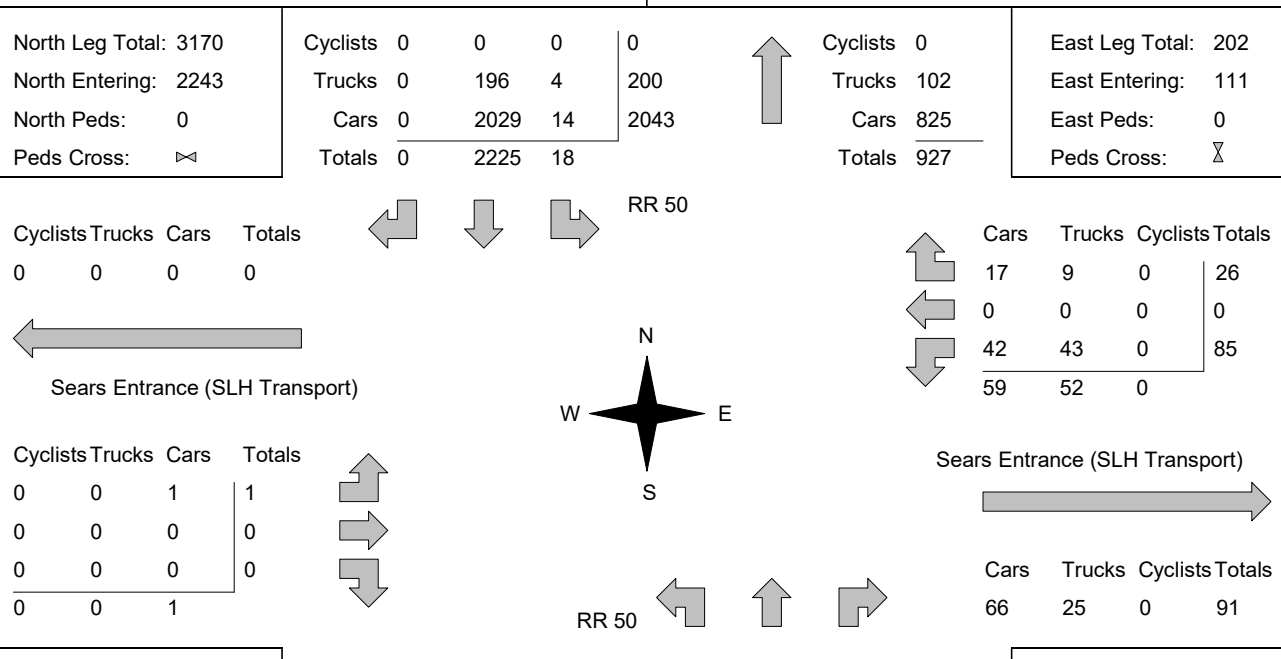
Municipality: Brampton
Site #: 1602800002
Intersection: RR 50 & Sears Entrance (SLH Tran
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: RR 50 runs N/S



Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:30:00
To: 17:30:00

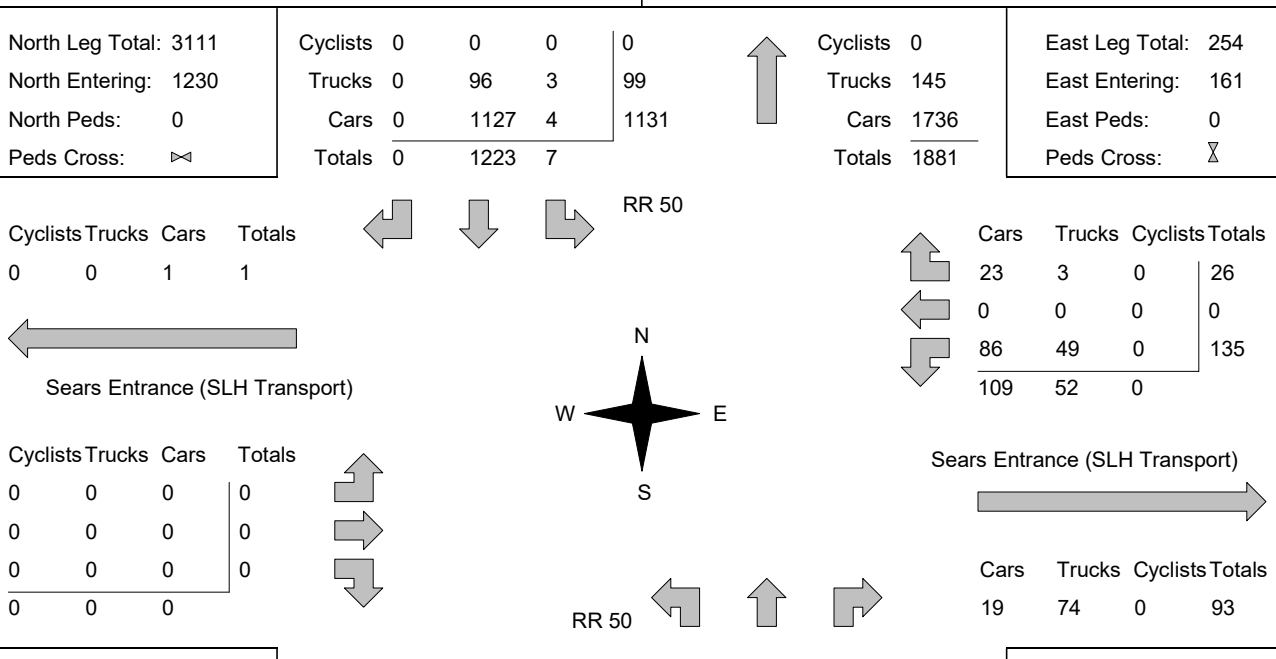
Municipality: Brampton
Site #: 1602800002
Intersection: RR 50 & Sears Entrance (SLH Tran
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: RR 50 runs N/S



Comments

Ontario Traffic Inc.

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 7:15:00
To: 8:15:00

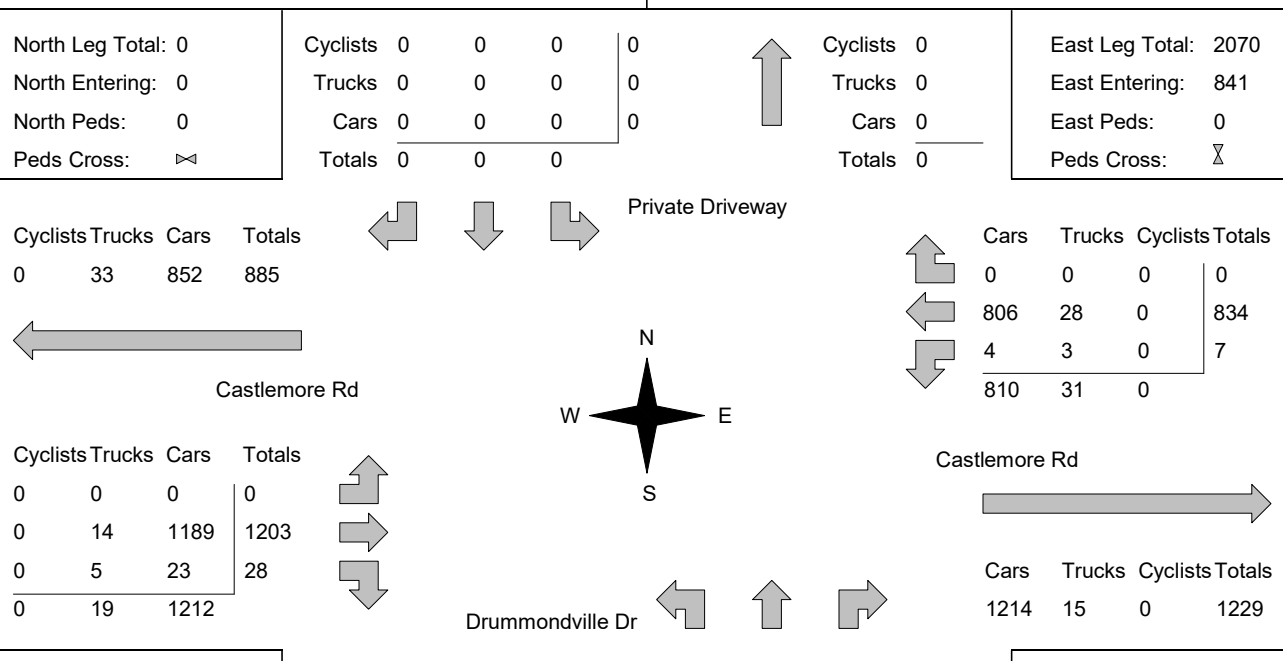
Municipality: Brampton
Site #: 1602800006
Intersection: Castlemore Rd & Drummondville Dr
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E



Comments

Ontario Traffic Inc.

Afternoon Peak Diagram

Specified Period
From: 16:00:00
To: 18:00:00

One Hour Peak
From: 16:15:00
To: 17:15:00

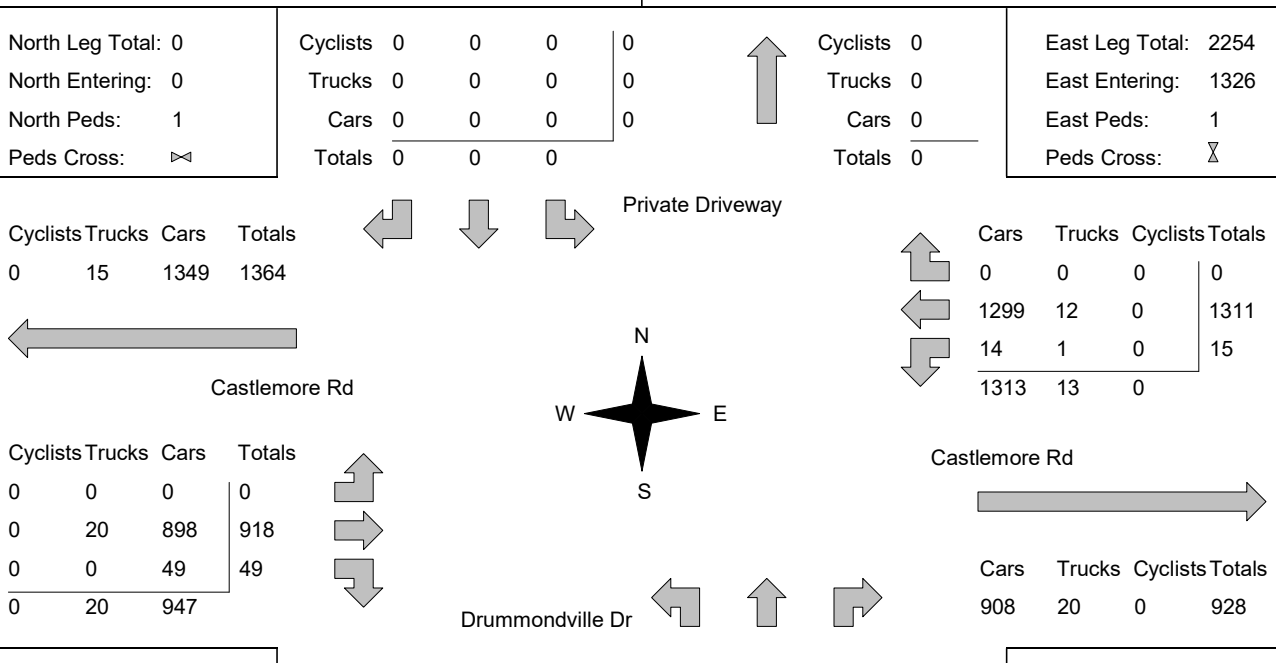
Municipality: Brampton
Site #: 1602800006
Intersection: Castlemore Rd & Drummondville Dr
TFR File #: 1
Count date: 26-Jan-16

Weather conditions:

Person(s) who counted:

**** Signalized Intersection ****

Major Road: Castlemore Rd runs W/E



Comments

AM

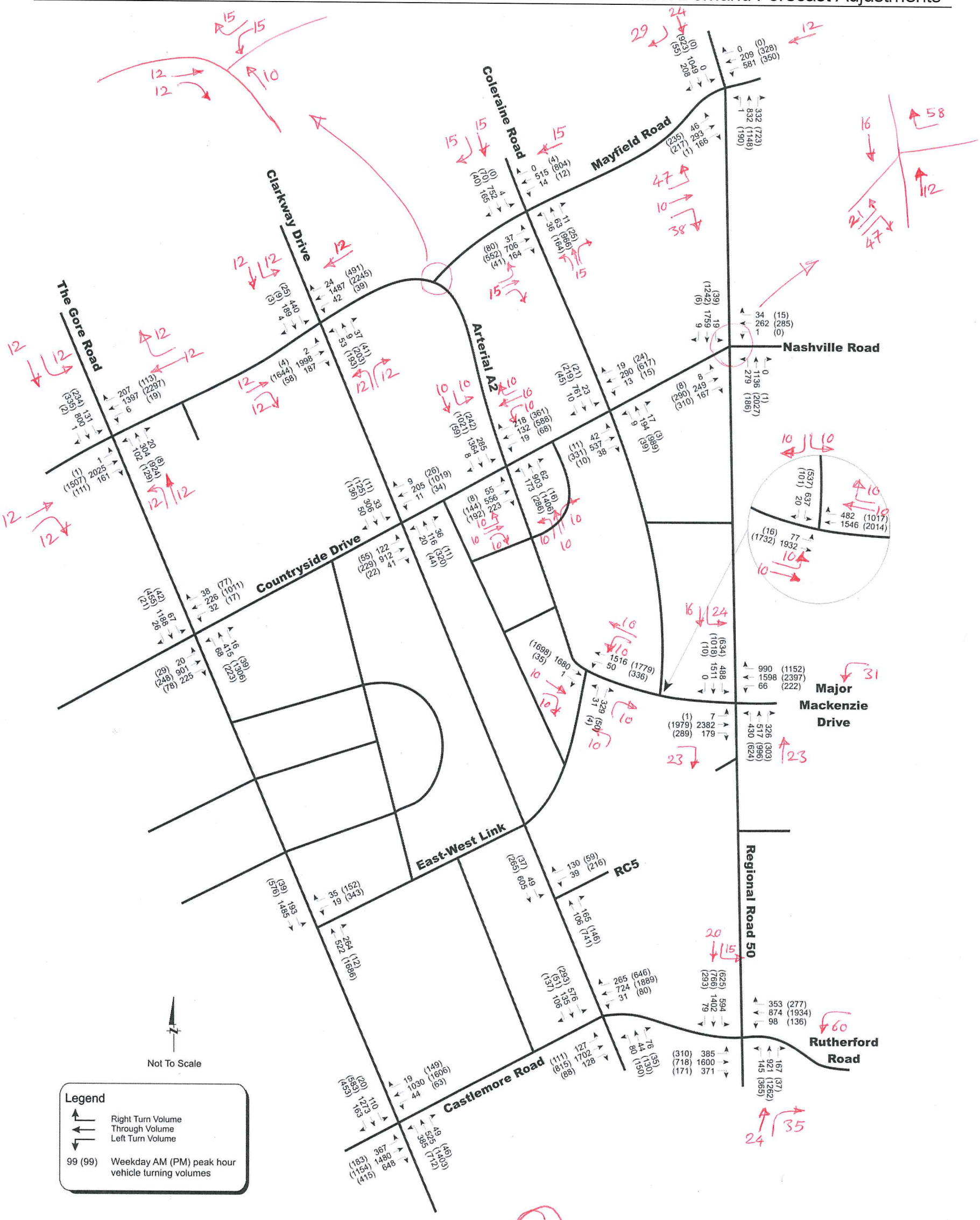


Exhibit 4-2: 2031 Turning Movement Volumes (AM and PM Peak Hour)

Adjusted Truck Percentages

PM

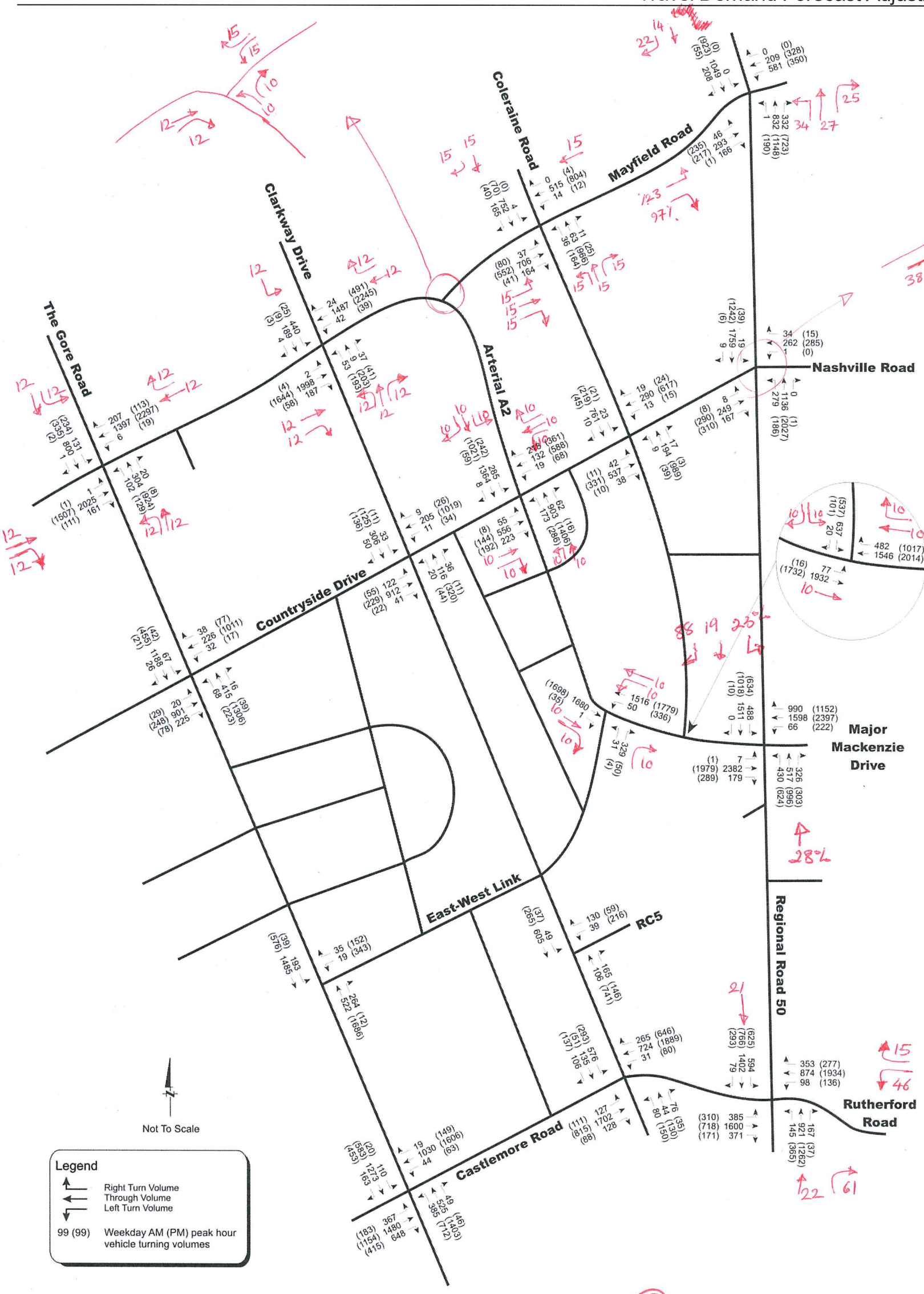


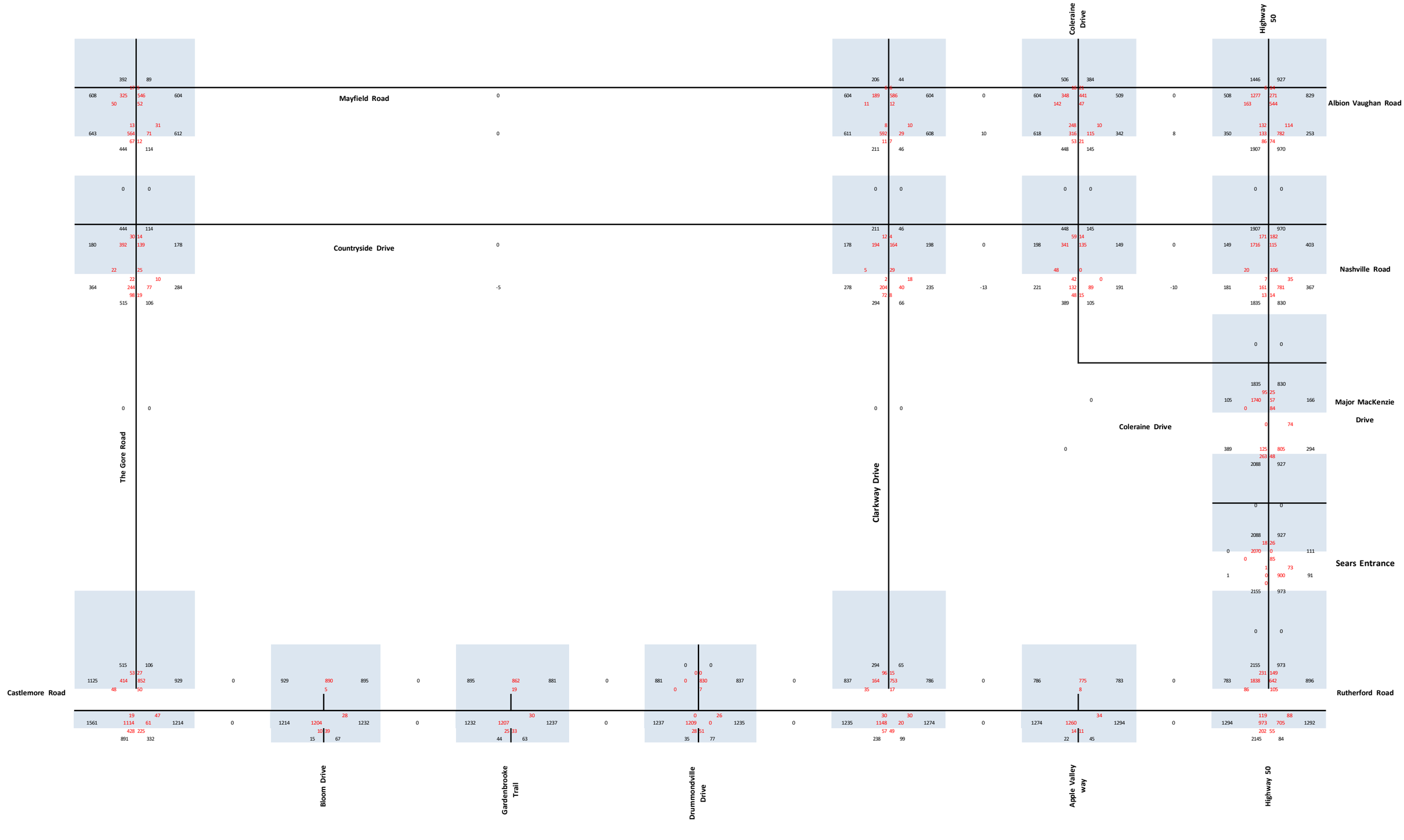
Exhibit 4-2: 2031 Turning Movement Volumes (AM and PM Peak Hour)

Adjusted Truck Percentages

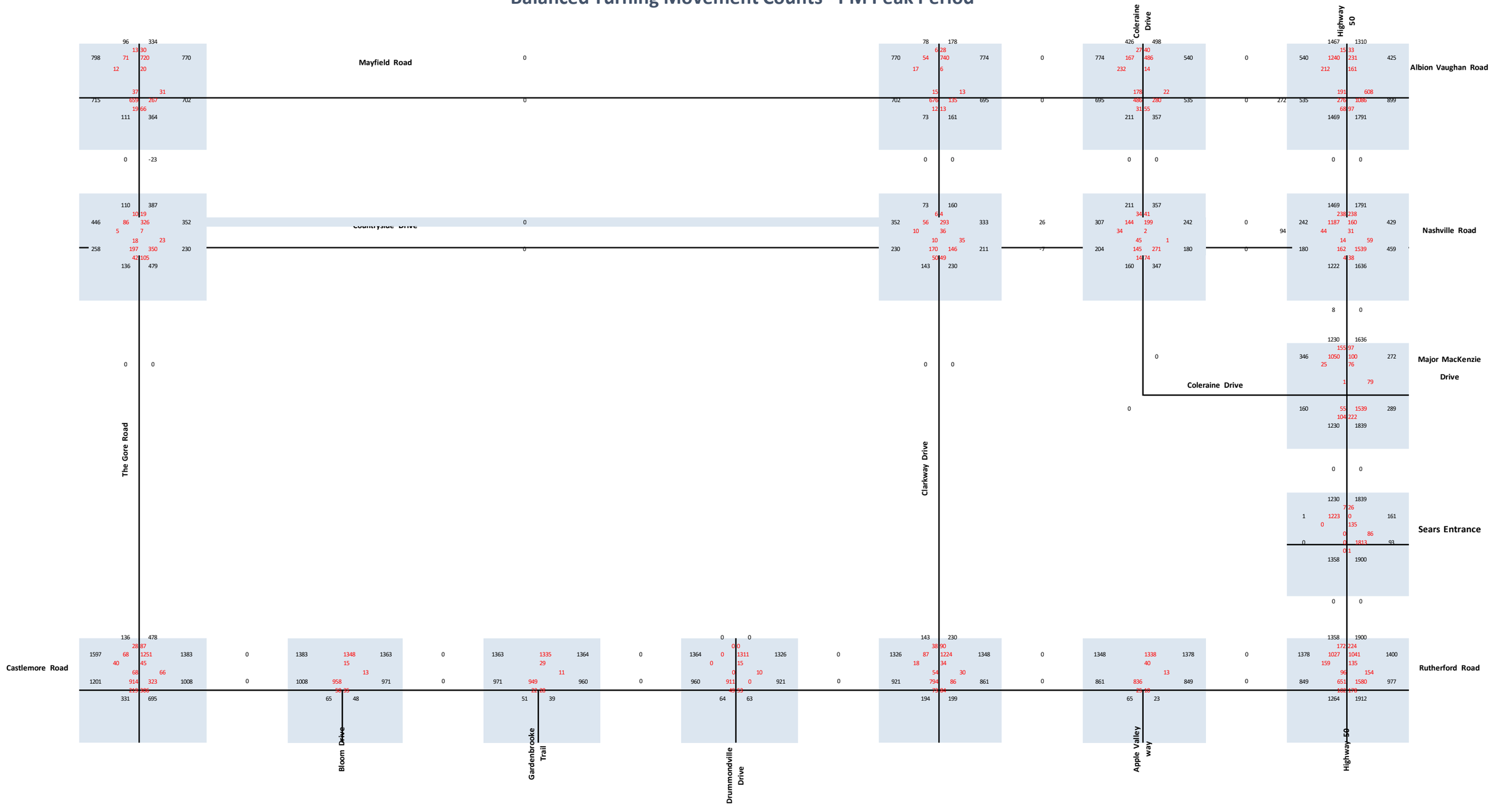
B

Appendix B - Balanced Network – AM/PM Peak Period

Balanced Turning Movement Counts - AM Peak Period



Balanced Turning Movement Counts - PM Peak Period



C

Appendix C - Signal Timing Plans

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	June 27, 2014		Prepared Date:	November 6, 2015
Database Rev	4		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location: Gore Rd @ Countryside Dr

Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.) WALK	Pedestrian Minimum (sec.) FDWALK	Amber (sec.)	All Red (sec.)	TIME PERIOD (sec.) (Green+Amber+All Red) AM MAX	OFF MAX	PM MAX
1	Not In Use								
2	Gore Rd - SB	12.0	8.0	9.0	4.0	2.0	80.0	54.0	70.0
3	Not In Use								
4	Countryside Dr - WB	12.0	8.0	17.0	4.0	2.6	40.0	36.0	50.0
5	Not In Use								
6	Gore Rd - NB	12.0	8.0	9.0	4.0	2.0	80.0	54.0	70.0
7	Not In Use								
8	Countryside Dr - EB	12.0	8.0	17.0	4.0	2.6	40.0	36.0	50.0

System Control	YES
Local Control	NO
Semi-Actuated Mode	YES

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:00-09:00	AM	120	-
9:00 - 15:00	OFF	90	-
15:00 - 19:00	PM	120	-

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	September 3, 2014		Prepared Date:	November 6, 2015
Database Rev	6		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location: Gore Rd @ Mayfield Rd

Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.) WALK	Pedestrian Minimum (sec.) FDWALK	Amber (sec.)	All Red (sec.)	TIME PERIOD (sec.) (Green+Amber+All Red) AM MAX	OFF MAX	PM MAX
1	E/W - Mayfield Rd	12.0	8.0	15.0	4.0	2.0	72.0	60.0	80.0
2	N/S - Gore Rd	12.0	8.0	11.0	4.0	2.0	48.0	40.0	40.0
3									
4									
5									
6									
7									
8									

System Control	YES
Local Control	NO
Semi-Actuated Mode	NO (Fully actuated)

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:30-09:00	AM	120	90
9:00 - 15:00 19:30-00:00	OFF	100	96
15:00 - 19:30	PM	120	94

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	October 24, 2014		Prepared Date:	November 10, 2015
Database Rev	36		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location:	Hwy 50 @ Castlemore_Rutherford						TIME PERIOD (sec.) (Green+Amber+All Red)		
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.) WALK	Pedestrian Minimum (sec.) FDWALK	Amber (sec.)	All Red (sec.)	AM MAX	OFF MIN/MAX	PM MAX
1	NB P.P. LT - Hwy 50	5.0			3.0		10.0	15.0	10.0
2	SB - Hwy 50	22.0	8.0	18.0	4.6	2.0	61.0	77.6	73.0
3	EB P.P. LT - Castlemore	5.0			3.0		14.0	10.0	12.0
4	WB - Rutherford	12.0	8.0	29.0	4.2	2.8	55.0	44.0 / 66.0	45.0
5	SB P.P. LT - Hwy 50	5.0			3.0		24.0	15.0	14.0
6	NB P.P. LT - Hwy 50	22.0	8.0	18.0	4.6	2.0	47.0	77.6	69.0
7	WB P.P. LT - Rutherford	5.0			3.0		16.0	18.0	24.0
8	EB - Castlemore	12.0	8.0	29.0	4.2	2.8	53.0	44.0 / 66.0	33.0

System Control	YES
Local Control	NO
Semi-Actuated Mode	NO (Fully Actuated)

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:00-09:00	AM	140	0
9:00 - 15:00	OFF	FREE	0
15:00 - 19:00	PM	140	0

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	May 2, 2014		Prepared Date:	November 6, 2015
Database Rev	3		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location:	Hwy 50 @ Coleraine_Major Mackenzie						TIME PERIOD (sec.) (Green+Amber+All Red)	
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.) WALK	Pedestrian Minimum (sec.) FDWALK	Amber (sec.)	All Red (sec.)	AM / PM MAX	OP MIN/MAX
1								
2	SB - Hwy 50	12.0	8.0	8.0	4.6	2.0	74.6	44.6
3								
4	WB - Major Mackenzie	12.0	8.0	13.0	4.6	4.6	57.2	MIN 30.2 / MAX 42.2
5								
6	NB - Hwy 50	12.0	8.0	8.0	4.6	2.0	74.6	44.6
7								
8	EB - Coleraine	12.0	8.0	13.0	4.6	4.6	57.2	MIN 30.2 / MAX 42.2

System Control	YES
Local Control	NO
Semi-Actuated Mode	YES

TIME (M-F)	PEAK
6:00 - 9:00 15:00 - 19:00	AM/PM
9:00 - 15:00	OFF PEAK

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	February 3, 2011		Prepared Date:	November 9, 2015
Database Rev	2		Completed By:	DB
Timing Card / Field rev			Checked By:	RC

Location:	Hwy 50 @ Sears Entrance_Private Drive						TIME PERIOD (sec.) (Green+Amber+All Red)
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.) WALK	Pedestrian Minimum (sec.) FDWALK	Amber (sec.)	All Red (sec.)	AM/OFF/PM MAX
1	SB P.P. LT - Hwy 50	5.0	-		3.0		18.0
2	N/S - Hwy 50	12.0	8.0	25.0	4.6	2.2	91.8
3	EB - Private Drive	8.0			4.0	3.7	22.7
4	WB - Sears Entrance	8.0	8.0	16.0	4.0	3.7	53.7

System Control	YES		
Local Control	NO	TIME (M-F)	CYCLE LENGTH (sec.)
Semi-Actuated Mode	NO (Fully Actuated)	AM/OFF/PM	FREE

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	February 3, 2011		Prepared Date:	November 6, 2015
Database Rev	5		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location:	Hwy 50 @ Countryside_Nashville						TIME PERIOD (sec.) (Green+Amber+All Red)
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.) WALK	Pedestrian Minimum (sec.) FDWALK	Amber (sec.)	All Red (sec.)	AM/OFF/PM MAX
1	SB P.P. LT - Hwy 50	5.0			3.0		13.0
2	NB / SB - Hwy 50	20.0	8.0	12.0	4.6	2.0	73.6
3	Not in Use						
4	EB / WB - Countryside_Nashville	12.0	8.0	18.0	4.6	2.0	MIN 32.6 / MAX 49.6
5							
6							
7							
8							

System Control	YES
Local Control	NO
Semi-Actuated Mode	NO (Fully Actuated)

TIME (M-F)	CYCLE LENGTH (sec.)
AM/OFF/PM	FREE

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	Septmeber 30, 2014		Prepared Date:	November 9, 2015
Database Rev	5		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location:	Mayfield Rd @ Clarkway Dr_Humber Station Rd						TIME PERIOD (sec.) (Green+Amber+All Red)		
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.)		Amber (sec.)	All Red (sec.)	AM MAX	OFF MAX	PM MAX
			WALK	FDWALK					
1	Not in Use								
2	EB - Mayfield Rd	12.0	8.0	8.0	4.6	2.7	80.0	60.0	80.0
3	SB - Humber Station Rd	8.0	8.0	7.0	4.2	2.8	20.0	20.0	20.0
4	NB - Clarkway Dr	8.0	8.0	7.0	4.2	2.8	20.0	20.0	20.0
5	Not in Use								
6	WB - Mayfield Rd	12.0	8.0	8.0	4.6	2.7	80.0	60.0	80.0
7	Not in Use								
8	Computer Phase	8.0	8.0	7.0	4.2	2.8	40.0	40.0	40.0

System Control	YES
Local Control	NO
Semi-Actuated Mode	NO (Fully Actuated)

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:30-09:00	AM	120	31
9:00 - 15:00	OFF	100	45
15:00 - 19:30	PM	120	43

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	March 27, 2013		Prepared Date:	November 6, 2015
Database Rev	6		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location:	Gore Rd @ Castlemore Rd						TIME PERIOD (sec.) (Green+Amber+All Red)		
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.)		Amber (sec.)	All Red (sec.)	AM MAX	OFF MAX	PM MAX
			WALK	FDWALK					
1	Not in Use								
2	SB - The Gore Rd	12.0	8.0	27.0	4.2	2.6	51.0	46.0	55.0
3	Not in Use								
4	WB - Castlemore Rd	12.0	8.0	24.0	4.2	2.4	49.0	44.0	45.0
5	Not in Use								
6	NB - The Gore Rd	12.0	8.0	27.0	4.2	2.6	51.0	46.0	55.0
7	Not in Use								
8	EB - Castlemore Rd	12.0	8.0	24.0	4.2	2.4	49.0	44.0	45.0

System Control	YES
Local Control	NO
Semi-Actuated Mode	NO (Fully actuated)

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:00-09:00	AM	100	0
9:00 - 15:30	OFF	90	0
15:30 - 19:00	PM	100	33

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	October 10, 2014		Prepared Date:	November 10, 2015
Database Rev	11		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location:	Mayfield @ Hwy 50								
							TIME PERIOD (sec.) (Green+Amber+All Red)		
Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.)		Amber (sec.)	All Red (sec.)	AM MAX	OFF MAX	PM MAX
			WALK	FDWALK					
1	Hwy 50 - N/B P.P. LT	5.0			3.0		10.0	9.0	9.0
2	Hwy 50 - S/B	20.0	8.0	18.0	4.6	2.0	60.0	48.0	66.0
3	Mayfield - W/B P.P. LT	5.0			3.0		20.0	9.0	10.0
4	Mayfield - E/B	12.0	8.0	19.0	4.6	2.0	30.0	34.0	35.0
5	Not in use								
6	Hwy 50 - N/B	20.0	8.0	18.0	4.6	2.0	70.0	57.0	75.0
7	Mayfield - E/B P.P. LT	5.0			3.0		10.0	0.0	10.0
8	Mayfield - W/B	12.0	8.0	19.0	4.6	2.0	40.0	43.0	35.0

System Control	YES
Local Control	NO
Semi-Actuated Mode	NO (Fully)

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:00-09:00	AM	120	37
09:00-15:00 19:30-00:00	OFF	100	7
15:00-19:30	PM	120	72

REGIONAL MUNICIPALITY OF PEEL

Traffic Signal Timing Parameters

Database Date	Novmeber 4, 2015		Prepared Date:	November 10, 2015
Database Rev	6		Completed By:	DB
Timing Card / Field rev	-		Checked By:	RC

Location: Mayfield Rd @ Coleraine Dr

Phase #	Direction	Vehicle Minimum (sec.)	Pedestrian Minimum (sec.)		Amber (sec.)	All Red (sec.)	TIME PERIOD (sec.) (Green+Amber+All Red)		
			WALK	FDWALK			AM MAX	OFF MAX	PM MAX
1	Not in Use								
2	EB - Mayfield Rd	12.0	8.0	18.0	4.6	2.4	85.0	66.0	85.0
3	SB P.P. LT - Coleraine Dr	5.0			3.0		10.0	10.0	10.0
4	NB - Coleraine Dr	12.0	8.0	18.0	4.2	2.8	35.0	34.0	35.0
5	EB P.P. LT - Mayfield Rd	5.0			3.0		15.0	9.0	12.0
6	WB - Mayfield Rd	12.0	8.0	18.0	4.6	2.4	70.0	57.0	73.0
7	Not in Use								
8	SB - Coleraine Dr	12.0	8.0	18.0	4.2	2.8	45.0	44.0	45.0

System Control	YES
Local Control	NO
Semi-Actuated Mode	YES

TIME (M-F)	PEAK	CYCLE LENGTH (sec.)	OFFSET (sec.)
06:30-09:00	AM	130	93
9:00 - 15:00 19:30-00:00	OFF	110	48
15:00 - 19:30	PM	130	116

Signal Timing Plans - Castlemore Road & Apple Valley Way

PHASE DESCRIPTION

Ph1	N/A
Ph2	Castlemore Road - Eastbound
Ph3	N/A
Ph4	Apple Valley Way - Northbound
Ph5	N/A
PH6	Castlemore Road - Westbound
Ph7	N/A
Ph8	N/A

PHASE DATA - VEHICLE TIMINGS

Basic Timings	Phase:	1	2	3	4	5	6	7	8
Minimum Green.....	:	0	8	0	8	0	8	0	8
Passage Time /10....	:	0	50	0	**30**	0	50	0	**30**
Maximum No 1.....	:	0	29	0	18	0	29	0	18
Maximum No 2.....	:	0	29	0	18	0	29	0	18
Yellow Change /10....	:	40	40	40	40	40	40	40	40
Red Clearance /10.....	:	20	20	20	20	20	20	20	20

PHASE DATA - PEDESTRIAN TIMINGS & CONTROL *** - 3 - 3**

Pedestrian Times	Phase:	1	2	3	4	5	6	7	8
Walk.....	:	0	8	0	8	0	8	0	8
Pedestrian Clearance.	:	0	14	0	34	0	14	0	34
Act Rest In Walk.....	:	0	0	0	0	0	0	0	0

Pedestrian Control Entry "1" = Yes & "0" = No

PHASE DATA - VEHICLE AND PEDESTRIAN RECALLS

	Phase:	1	2	3	4	5	6	7	8
Vehicle Recall.....	:	0	3	0	0	0	3	0	0
Pedestrian Recall.....	:	0	0	0	0	0	0	0	0
Recall Delay (SEC)....	:	0	0	0	0	0	0	0	0

Codes.....	:	0	1	2	3	4
Vehicle Recall.....	:	NONE	1 CALL	MINIMUM	MAXIMUM	SOFT
Pedestrian Recall.....	:	NONE	1 CALL	PED	NA	NA+

COORD DATA - TIMING PLAN

Control Timing Plan	:	D1/S1	D1/S2	D1/S3	D1/S4	D2/S1	D2/S2	D2/S3	D2/S4
Cycle Length.....	:	110	105	140					
Phase 01 Time/Mode	:	0/6	0/6	0/6					
Phase 02 Time/Mode	:	60/1	56/1	91/1					
Phase 03 Time/Mode	:	0/6	0/6	0/6					
Phase 04 Time/Mode	:	50/0	49/0	49/0					
Phase 05 Time/Mode	:	0/6	0/6	0/6					
Phase 06 Time/Mode	:	60/1	56/1	91/1					
Phase 07 Time/Mode	:	0/6	0/6	0/6					
Phase 08 Time/Mode	:	50/0	49/0	49/0					
Offset 1.....	:	77	59	112					
Offset 1 Pattern Mode	:								
Offset 2.....	:								
Offset 2 Pattern Mode	:								
Offset 3.....	:								
Offset 3 Pattern Mode	:								

Codes	:	
Phase Mode.....	:	0-Actuated 1-Coord Phase 2-Min Rec 3-Max Rec 4-Ped Rec 5-Max+Ped Recall 6-Phase Omitted 7-Dual Coord Phase
Pattern Mode.....	:	0-Normal/ 1-Perm/ 2-Yield/ 3-Perm Yield/ 4-Perm Omit/ 5-Seq Omit /6-Full Act
Alternate Sequence		Values To Be Set To Zero "0"
R# LAG		N/A

TIME BASE DATA - TRAFFIC EVEI

PDAY	HH:MM	PATTERN
01	09:00	1/2/1
01	19:00	FREE
02	00:00	FREE
02	06:00	1/1/1
02	09:00	1/2/1
02	15:00	1/3/1
02	19:00	1/2/1
02	22:00	FREE
07	00:00	FREE
07	08:00	1/2/1
07	20:00	FREE

Signal Timing Plans - Castlemore Road & Clarkway Drive

PHASE DESCRIPTION

Ph1	N/A
Ph2	Castlemore Road -
Ph3	N/A
Ph4	Clarkway Drive -
Ph5	N/A
PH6	Castlemore Road - Westbound
Ph7	N/A
Ph8	Clarkway Drive - Southbound

PHASE DATA - VEHICLE TIMINGS

Basic Timings	Phase:	1	2	3	4	5	6	7	8
Minimum Green……..	:	0	8	0	8	0	8	0	8
Passage Time /10….	:	0	50	0	50	0	50	0	50
Maximum No 1……..	:	0	29	0	18	0	29	0	18
Maximum No 2……..	:	0	29	0	18	0	29	0	18
Yellow Change /10….	:	40	50	40	50	40	50	40	50
Red Clearance /10…..	:	20	20	20	20	20	20	20	20

PHASE DATA - PEDESTRIAN TIMINGS & CONTROL

Pedestrian Times	Phase:	1	2	3	4	5	6	7	8
Walk……..	:	0	8	0	8	0	8	0	8
Pedestrian Clearance.	:	0	34	0	35	0	34	0	35
Act Rest In Walk…….	:	0	0	0	0	0	0	0	0

Pedestrian Control Entry "1" = Yes & "0" = No

PHASE DATA - VEHICLE AND PEDESTRIAN RECALLS

	Phase:	1	2	3	4	5	6	7	8
Vehicle Recall……..	:	0	3	0	0	0	3	0	0
Pedestrian Recall……	:	0	0	0	0	0	0	0	0
Recall Delay (SEC)….	:	0	0	0	0	0	0	0	0

Codes……	:	0	1	2	3	4
Vehicle Recall……..	:	NONE	1 CALL	MINIMU	MAXIMU	SOFT
Pedestrian Recall……	:	NONE	1 CALL	PED	NA	NA+

COORD DATA - TIMING PLAN

Control Timing Plan	:	D1/S1	D1/S2	D1/S3	D1/S4	D2/S1	D2/S2	D2/S3	D2/S4
Cycle Length……	:	110	105	140					
Phase 01 Time/Mode	:	0/6	0/6	0/6					
Phase 02 Time/Mode	:	59/1	54/1	89/1					
Phase 03 Time/Mode	:	0/6	0/6	0/6					
Phase 04 Time/Mode	:	51/0	51/0	51/0					
Phase 05 Time/Mode	:	0/6	0/6	0/6					
Phase 06 Time/Mode	:	59/1	54/1	89/1					
Phase 07 Time/Mode	:	0/6	0/6	0/6					
Phase 08 Time/Mode	:	51/0	51/0	51/0					
Offset 1……..	:	56	103	127					
Offset 1 Pattern Mode	:								
Offset 2……..	:								
Offset 2 Pattern Mode	:								
Offset 3……..	:								
Offset 3 Pattern Mode	:								

Codes …… :

Phase Mode…… : 0-Actuated 1-Coord Phase 2-Min Rec 3-Max Rec
4-Ped Rec 5-Max+Ped Recall 6-Phase Omitted 7-Dual Coord Phase

Pattern Mode…… : 0-Normal/ 1-Perm/ 2-Yield/ 3-Perm Yield/ 4-Perm Omit/ 5-Seq Omit /6-Full Act

Alternate Sequence Values To Be Set To Zero "0"

R# LAG N/A

TIME BASE DATA - TRAFFIC EVENTS

DAY PDAY	TIME HH:MM	PATTERN
01	09:00	1/2/1
01	19:00	FREE
02	00:00	FREE
02	06:00	1/1/1
02	09:00	1/2/1
02	15:00	1/3/1
02	19:00	1/2/1
02	22:00	FREE
07	00:00	FREE
07	08:00	1/2/1
07	20:00	FREE

Signal Timing Plans - Castlemore Road & Drummondville Drive

PHASE DESCRIPTION

Ph1	N/A
Ph2	Castlemore Road - Eastbound
Ph3	N/A
Ph4	Drummondville Drive - Northbound
Ph5	N/A
PH6	Castlemore Road - Westbound
Ph7	N/A
Ph8	Private Drive - Southbound

PHASE DATA - VEHICLE TIMINGS

Basic Timings	Phase:	1	2	3	4	5	6	7	8
Minimum Green.....	:	0	8	0	8	0	8	0	8
Passage Time /10....	:	0	50	0	30	0	50	0	30
Maximum No 1.....	:	0	29	0	18	0	29	0	18
Maximum No 2.....	:	0	29	0	18	0	29	0	18
Yellow Change /10....	:	40	40	40	40	40	40	40	40
Red Clearance /10.....	:	20	20	20	20	20	20	20	20

PHASE DATA - PEDESTRIAN TIMINGS & CONTROL

Pedestrian Times	Phase:	1	2	3	4	5	6	7	8
Walk.....	:	0	8	0	8	0	8	0	8
Pedestrian Clearance.	:	0	18	0	30	0	18	0	30
Act Rest In Walk.....	:	0	0	0	0	0	0	0	0

Pedestrian Control Entry "1" = Yes & "0" = No

PHASE DATA - VEHICLE AND PEDESTRIAN RECALLS

	Phase:	1	2	3	4	5	6	7	8
Vehicle Recall.....	:	0	3	0	0	0	3	0	0
Pedestrian Recall.....	:	0	0	0	0	0	0	0	0
Recall Delay (SEC)....	:	0	0	0	0	0	0	0	0

Codes.....	:	0	1	2	3	4
Vehicle Recall.....	:	NONE	1 CALL	MINIMUM	MAXIMUM	SOFT
Pedestrian Recall.....	:	NONE	1 CALL	PED	NA	NA+

COORD DATA - TIMING PLAN

Control Timing Plan	:	D1/S1	D1/S2	D1/S3	D1/S4	D2/S1	D2/S2	D2/S3	D2/S4
Cycle Length.....	:	110	105	140					
Phase 01 Time/Mode	:	0/6	0/6	0/6					
Phase 02 Time/Mode	:	65/1	60/1	95/1					
Phase 03 Time/Mode	:	0/6	0/6	0/6					
Phase 04 Time/Mode	:	45/0	45/0	45/0					
Phase 05 Time/Mode	:	0/6	0/6	0/6					
Phase 06 Time/Mode	:	65/1	60/1	95/1					
Phase 07 Time/Mode	:	0/6	0/6	0/6					
Phase 08 Time/Mode	:	45/0	45/0	45/0					
Offset 1.....	:	32	101	137					
Offset 1 Pattern Mode	:								
Offset 2.....	:								
Offset 2 Pattern Mode	:								
Offset 3.....	:								
Offset 3 Pattern Mode	:								

Codes ..... :

Phase Mode..... : 0-Actuated 1-Coord Phase 2-Min Rec 3-Max Rec
4-Ped Rec 5-Max+Ped Recall 6-Phase Omitted 7-Dual Coord Phase

Pattern Mode..... : 0-Normal/ 1-Perm/ 2-Yield/ 3-Perm Yield/ 4-Perm Omit/ 5-Seq Omit /6-Full Act

Alternate Sequence Values To Be Set To Zero "0"

R# LAG N/A

TIME BASE DATA - TRAFFIC EVENTS

DAY PDAY	TIME HH:MM	PATTERN
01	00:00	FREE
01	09:00	1/2/1
01	19:00	FREE
02	00:00	FREE
02	06:00	1/1/1
02	09:00	1/2/1
02	15:00	1/3/1
02	19:00	1/2/1
02	22:00	FREE
07	00:00	FREE
07	08:00	1/2/1
07	20:00	FREE

Signal Timing Plans - Castlemore Road & Gardenbrooke Trail

PHASE DESCRIPTION

Ph1	N/A
Ph2	Castlemore Road - Eastbound
Ph3	N/A
Ph4	Gardenbrook Trail - Northbound
Ph5	N/A
PH6	Castlemore Road - Westbound
Ph7	N/A
Ph8	N/A

PHASE DATA - VEHICLE TIMINGS

Basic Timings	Phase:	1	2	3	4	5	6	7	8
Minimum Green.....	:	0	8	0	8	0	8	0	8
Passage Time /10....	:	0	50	0	50	0	50	0	50
Maximum No 1.....	:	0	29	0	18	0	29	0	18
Maximum No 2.....	:	0	29	0	18	0	29	0	18
Yellow Change /10....	:	40	40	40	40	40	40	40	40
Red Clearance /10.....	:	20	20	20	20	20	20	20	20

PHASE DATA - PEDESTRIAN TIMINGS & CONTROL

Pedestrian Times	Phase:	1	2	3	4	5	6	7	8
Walk.....	:	0	8	0	8	0	8	0	8
Pedestrian Clearance.	:	0	16	0	31	0	16	0	31
Act Rest In Walk.....	:	0	0	0	0	0	0	0	0

Pedestrian Control Entry "1" = Yes & "0" = No

PHASE DATA - VEHICLE AND PEDESTRIAN RECALLS

Phase:		1	2	3	4	5	6	7	8
Vehicle Recall.....	:	0	3	0	0	0	3	0	0
Pedestrian Recall.....	:	0	0	0	0	0	0	0	0
Recall Delay (SEC)....	:	0	0	0	0	0	0	0	0

Codes.....	:	0	1	2	3	4
Vehicle Recall.....	:	NONE	1 CALL	MINIMUM	MAXIMUM	SOFT
Pedestrian Recall.....	:	NONE	1 CALL	PED	NA	NA+

COORD DATA - TIMING PLAN

Control Timing Plan	:	D1/S1	D1/S2	D1/S3	D1/S4	D2/S1	D2/S2	D2/S3	D2/S4
Cycle Length.....	:	110	105	140					
Phase 01 Time/Mode	:	0/6	0/6	0/6					
Phase 02 Time/Mode	:	64/1	59/1	94/1					
Phase 03 Time/Mode	:	0/6	0/6	0/6					
Phase 04 Time/Mode	:	46/0	46/0	46/0					
Phase 05 Time/Mode	:	0/6	0/6	0/6					
Phase 06 Time/Mode	:	64/1	59/1	94/1					
Phase 07 Time/Mode	:	0/6	0/6	0/6					
Phase 08 Time/Mode	:	0/6	0/6	0/6					
Offset 1.....	:	16	100	8					
Offset 1 Pattern Mode	:								
Offset 2.....	:								
Offset 2 Pattern Mode	:								
Offset 3.....	:								
Offset 3 Pattern Mode	:								

Codes ..... :

Phase Mode..... : 0-Actuated 1-Coord Phase 2-Min Rec 3-Max Rec 4-Ped Rec 5-Max+Ped Recall 6-Phase Omitted 7-Dual Coord Phase

Pattern Mode..... : 0-Normal/ 1-Perm/ 2-Yield/ 3-Perm Yield/ 4-Perm Omit/ 5-Seq Omit /6-Full Act

Alternate Sequence: Values To Be Set To Zero "0"

R# LAG: N/A

TIME BASE DATA - TRAFFIC EVENTS *** - 6 - 2**

DAY PDAY	TIME HH:MM	PATTERN
01	00:00	FREE
01	09:00	1/2/1
01	19:00	FREE
02	00:00	FREE
02	06:00	1/1/1
02	09:00	1/2/1
02	15:00	1/3/1
02	19:00	1/2/1
02	22:00	FREE
07	00:00	FREE
07	08:00	1/2/1
07	20:00	FREE

Signal Timing plans - Castlemore Road & Bloom Drive

PHASE DESCRIPTION

Ph1	N/A
Ph2	Castlemore Road - Eastbound
Ph3	N/A
Ph4	Bloom Drive - Northbound
Ph5	N/A
PH6	Castlemore Road - Westbound
Ph7	N/A
Ph8	N/A

PHASE DATA - VEHICLE TIMINGS

Basic Timings	Phase:	1	2	3	4	5	6	7	8
Minimum Green……..	:	0	8	0	8	0	8	0	8
Passage Time /10….	:	0	50	0	30	0	50	0	30
Maximum No 1……..	:	0	29	0	18	0	29	0	18
Maximum No 2……..	:	0	29	0	18	0	29	0	18
Yellow Change /10….	:	40	40	40	40	40	40	40	40
Red Clearance /10…..	:	20	20	20	20	20	20	20	20

PHASE DATA - PEDESTRIAN TIMINGS & CONTROL * - 3 - 3

Pedestrian Times	Phase:	1	2	3	4	5	6	7	8
Walk……	:	0	8	0	8	0	8	0	8
Pedestrian Clearance.	:	0	16	0	32	0	16	0	32
Act Rest In Walk…….	:	0	0	0	0	0	0	0	0

Pedestrian Control Entry "1" = Yes & "0" = No

PHASE DATA - VEHICLE AND PEDESTRIAN RECALLS * - 3 - 5

Phase:		1	2	3	4	5	6	7	8
Vehicle Recall…….	:	0	3	0	0	0	3	0	0
Pedestrian Recall……	:	0	0	0	0	0	0	0	0
Recall Delay (SEC)….	:	0	0	0	0	0	0	0	0

Codes……	:	0	1	2	3	4
Vehicle Recall…….	:	NONE	1 CALL	MINIMU	MAXIMU	SOFT
Pedestrian Recall……	:	NONE	1 CALL	PED	NA	NA+

COORD DATA - TIMING PLAN * - 5 - 3

Control Timing Plan	:	D1/S1	D1/S2	D1/S3	D1/S4	D2/S1	D2/S2	D2/S3	D2/S4
Cycle Length……	:	110	105	140					
Phase 01 Time/Mode	:	0/6	0/6	0/6					
Phase 02 Time/Mode	:	63/1	58/1	93/1					
Phase 03 Time/Mode	:	0/6	0/6	0/6					
Phase 04 Time/Mode	:	47/0	47/0	47/0					
Phase 05 Time/Mode	:	0/6	0/6	0/6					
Phase 06 Time/Mode	:	63/1	58/1	93/1					
Phase 07 Time/Mode	:	0/6	0/6	0/6					
Phase 08 Time/Mode	:	0/6	0/6	0/6					
Offset 1……..	:	2	50	130					
Offset 1 Pattern Mode	:								
Offset 2……..	:								
Offset 2 Pattern Mode	:								
Offset 3……..	:								
Offset 3 Pattern Mode	:								
Codes ……..	:								
Phase Mode……	:	0-Actuated		1-Coord Phase		2-Min Rec		3-Max Rec	
		4-Ped Rec		5-Max+Ped Recall		6-Phase Omitted		7-Dual Coord Phase	
Pattern Mode……	:	0-Normal/ 1-Perm/ 2-Yield/ 3-Perm Yield/ 4-Perm Omit/ 5-Seq Omit /6-Full Act							
Alternate Sequence		Values To Be Set To Zero "0"							
R# LAG		N/A							

TIME BASE DATA - TRAFFIC EVENTS * - 6 - 2

DAY PDAY	TIME HH:MM	PATTERN
01	00:00	FREE
01	09:00	1/2/1
01	19:00	FREE
02	00:00	FREE
02	06:00	1/1/1
02	09:00	1/2/1
02	15:00	1/3/1
02	19:00	1/2/1
02	22:00	FREE
07	00:00	FREE
07	08:00	1/2/1
07	20:00	FREE

D

Appendix D - Synchro Model Reports

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	119	973	202	105	642	149	55	705	88	231	1838	86
Future Volume (vph)	119	973	202	105	642	149	55	705	88	231	1838	86
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.6	6.6	3.0	6.6	6.6
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1772	3579	1601	1113	3579	1408	1706	4641	1210	1547	4768	1498
Flt Permitted	0.29	1.00	1.00	0.09	1.00	1.00	0.10	1.00	1.00	0.26	1.00	1.00
Satd.Flow(perm)	532	3579	1601	104	3579	1408	178	4641	1210	423	4768	1498
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	119	973	202	105	642	149	55	705	88	231	1838	86
RTOR Reduction (vph)	0	0	118	0	0	101	0	0	63	0	0	53
Lane Group Flow (vph)	119	973	84	105	642	48	55	705	25	231	1838	33
Heavy Vehicles (%)	3%	2%	2%	64%	2%	16%	7%	13%	35%	18%	10%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases	8		8	4		4	6		6	2		2
Actuated Green, G (s)	54.0	43.0	43.0	58.0	45.0	45.0	50.4	40.4	40.4	67.4	54.4	54.4
Effective Green, g (s)	54.0	43.0	43.0	58.0	45.0	45.0	50.4	40.4	40.4	67.4	54.4	54.4
Actuated g/C Ratio	0.39	0.31	0.31	0.41	0.32	0.32	0.36	0.29	0.29	0.48	0.39	0.39
Clearance Time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.6	6.6	3.0	6.6	6.6
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	302	1099	491	136	1150	452	173	1339	349	396	1852	582
v/s Ratio Prot	0.03	c0.27		c0.07	0.18		0.02	0.15		c0.10	c0.39	
v/s Ratio Perm	0.12		0.05	0.25		0.03	0.09		0.02	0.18		0.02
v/c Ratio	0.39	0.89	0.17	0.77	0.56	0.11	0.32	0.53	0.07	0.58	0.99	0.06
Uniform Delay, d1	29.0	46.2	35.5	32.2	39.3	33.4	33.2	41.8	36.2	23.1	42.6	26.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	8.7	0.2	23.3	0.6	0.1	4.8	1.5	0.4	6.2	19.2	0.2
Delay (s)	29.9	54.9	35.6	55.5	39.9	33.5	38.0	43.3	36.6	29.3	61.8	27.0
Level of Service	C	D	D	E	D	C	D	D	D	C	E	C
Approach Delay (s)		49.6			40.6			42.2			56.9	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM 2000 Control Delay	49.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity	0.90		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	90.4	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	85	26	900	73	18	2070
Future Volume (vph)	85	26	900	73	18	2070
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.7	7.7	6.8	6.8	3.0	6.8
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	2345	1210	3318	1266	1496	3349
Flt Permitted	0.95	1.00	1.00	1.00	0.30	1.00
Satd.Flow(perm)	2345	1210	3318	1266	476	3349
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	85	26	900	73	18	2070
RTOR Reduction (vph)	0	24	0	19	0	0
Lane Group Flow (vph)	85	2	900	54	18	2070
Heavy Vehicles (%)	51%	35%	10%	29%	22%	9%
Turn Type	Prot	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	2
Permitted Phases		4		2	2	
Actuated Green, G (s)	9.8	9.8	85.2	85.2	87.5	85.2
Effective Green, g (s)	9.8	9.8	85.2	85.2	87.5	85.2
Actuated g/C Ratio	0.09	0.09	0.74	0.74	0.76	0.74
Clearance Time (s)	7.7	7.7	6.8	6.8	3.0	6.8
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	200	103	2462	939	383	2485
v/s Ratio Prot	c0.04		0.27		c0.00	c0.62
v/s Ratio Perm		0.00		0.04	0.03	
v/c Ratio	0.42	0.02	0.37	0.06	0.05	0.83
Uniform Delay, d1	49.8	48.1	5.2	4.0	3.3	10.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.5	0.1	0.1	0.0	0.1	2.5
Delay (s)	51.3	48.2	5.3	4.0	3.4	12.5
Level of Service	D	D	A	A	A	B
Approach Delay (s)	50.6		5.2			12.5
Approach LOS	D		A			B

Intersection Summary			
HCM 2000 Control Delay	11.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity	0.77		
Actuated Cycle Length (s)	114.8	Sum of lost time (s)	17.5
Intersection Capacity Utilization	76.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	125	263	84	57	25	48	805	74	95	1740	0
Future Volume (vph)	0	125	263	84	57	25	48	805	74	95	1740	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		9.2			9.2		6.6	6.6		6.6	6.6	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.91			0.98		1.00	0.99		1.00	1.00	
Flt Protected		1.00			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1711			1605		1706	3239		1755	3579	
Flt Permitted		1.00			0.47		0.06	1.00		0.25	1.00	
Satd.Flow(perm)		1711			774		108	3239		458	3579	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	125	263	84	57	25	48	805	74	95	1740	0
RTOR Reduction (vph)	0	7	0	0	5	0	0	5	0	0	0	0
Lane Group Flow (vph)	0	381	0	0	161	0	48	874	0	95	1740	0
Heavy Vehicles (%)	2%	2%	2%	20%	5%	17%	7%	10%	25%	4%	2%	2%
Turn Type		NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		8			4			6			2	
Permitted Phases	8			4			6			2		
Actuated Green, G (s)		48.0			48.0		66.3	66.3		66.3	66.3	
Effective Green, g (s)		48.0			48.0		66.3	66.3		66.3	66.3	
Actuated g/C Ratio		0.37			0.37		0.51	0.51		0.51	0.51	
Clearance Time (s)		9.2			9.2		6.6	6.6		6.6	6.6	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		631			285		55	1650		233	1823	
v/s Ratio Prot		c0.22						0.27			c0.49	
v/s Ratio Perm					0.21		0.44			0.21		
v/c Ratio		0.60			0.56		0.87	0.53		0.41	0.95	
Uniform Delay, d1		33.3			32.7		28.2	21.4		19.7	30.5	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		4.2			7.9		76.2	0.3		1.2	12.0	
Delay (s)		37.6			40.6		104.4	21.7		20.9	42.5	
Level of Service		D			D		F	C		C	D	
Approach Delay (s)		37.6			40.6			26.0			41.3	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM 2000 Control Delay	36.6	HCM 2000 Level of	D
HCM 2000 Volume to Capacity	0.81		
Actuated Cycle Length (s)	130.1	Sum of lost time (s)	15.8
Intersection Capacity Utilization	117.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	7	161	13	106	115	182	14	781	35	171	1716	20
Future Volume (vph)	7	161	13	106	115	182	14	781	35	171	1716	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Total Lost time (s)		6.6		6.6	6.6	6.6	6.6	6.6		3.0	6.6	6.6
Lane Util. Factor		1.00		1.00	1.00	1.00	1.00	0.95		1.00	0.95	1.00
Frt		0.99		1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected		1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		1845		1496	1883	1601	1601	3236		1789	3411	1601
Flt Permitted		0.99		0.47	1.00	1.00	0.06	1.00		0.31	1.00	1.00
Satd. Flow (perm)		1825		745	1883	1601	104	3236		579	3411	1601
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	7	161	13	106	115	182	14	781	35	171	1716	20
RTOR Reduction (vph)	0	2	0	0	0	151	0	2	0	0	0	8
Lane Group Flow (vph)	0	179	0	106	115	31	14	814	0	171	1716	12
HeavyVehicles(%)	14%	2%	8%	22%	2%	2%	14%	12%	14%	2%	7%	2%
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		pm+pt	NA	Perm
Protected Phases		4			4			2		1	2	
Permitted Phases	4			4		4	2			2		2
Actuated Green, G (s)		19.2		19.2	19.2	19.2	67.3	67.3		75.7	67.3	67.3
Effective Green, g (s)		19.2		19.2	19.2	19.2	67.3	67.3		75.7	67.3	67.3
Actuated g/C Ratio		0.17		0.17	0.17	0.17	0.61	0.61		0.68	0.61	0.61
Clearance Time (s)		6.6		6.6	6.6	6.6	6.6	6.6		3.0	6.6	6.6
VehicleExtension(s)		3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		315		128	325	276	62	1960		485	2066	969
v/s Ratio Prot					0.06			0.25		c0.03	c0.50	
v/s Ratio Perm		0.10		c0.14		0.02	0.13			0.21		0.01
v/c Ratio		0.57		0.83	0.35	0.11	0.23	0.42		0.35	0.83	0.01
Uniform Delay, d1		42.1		44.4	40.5	38.8	10.0	11.5		6.5	17.4	8.7
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		2.3		33.6	0.7	0.2	1.9	0.1		0.4	3.0	0.0
Delay (s)		44.5		78.0	41.2	39.0	11.9	11.7		7.0	20.4	8.7
Level of Service		D		E	D	D	B	B		A	C	A
Approach Delay (s)		44.5			49.8			11.7			19.0	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of	C
HCM 2000 Volume to Capacity	0.79		
Actuated Cycle Length (s)	111.1	Sum of lost time (s)	16.2
Intersection Capacity Utilization	106.1%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	132	133	86	544	271	14	74	782	114	6	1277	163
Future Volume (vph)	132	133	86	544	271	14	74	782	114	6	1277	163
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.6	6.6	3.0	6.6	6.6	3.0	6.6	6.6	6.6	6.6	6.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1722	1628	1060	1772	1830	1512	1193	3380	1372	1789	3411	1498
Flt Permitted	0.59	1.00	1.00	0.50	1.00	1.00	0.11	1.00	1.00	0.36	1.00	1.00
Satd.Flow(perm)	1065	1628	1060	935	1830	1512	138	3380	1372	670	3411	1498
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	132	133	86	544	271	14	74	782	114	6	1277	163
RTOR Reduction (vph)	0	0	75	0	0	11	0	0	46	0	0	80
Lane Group Flow (vph)	132	133	11	544	271	3	74	782	68	6	1277	83
Heavy Vehicles (%)	6%	18%	54%	3%	5%	8%	53%	8%	19%	2%	7%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8		1	6			2	
Permitted Phases	4		4	8		8	6		6	2		2
Actuated Green, G (s)	22.6	15.6	15.6	35.6	25.6	25.6	71.2	71.2	71.2	61.0	61.0	61.0
Effective Green, g (s)	22.6	15.6	15.6	35.6	25.6	25.6	71.2	71.2	71.2	61.0	61.0	61.0
Actuated g/C Ratio	0.19	0.13	0.13	0.30	0.21	0.21	0.59	0.59	0.59	0.51	0.51	0.51
Clearance Time (s)	3.0	6.6	6.6	3.0	6.6	6.6	3.0	6.6	6.6	6.6	6.6	6.6
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	238	211	137	395	390	322	145	2005	814	340	1733	761
v/s Ratio Prot	0.03	0.08		c0.19	0.15		c0.03	0.23			c0.37	
v/s Ratio Perm	0.07		0.01	c0.21		0.00	0.27		0.05	0.01		0.06
v/c Ratio	0.55	0.63	0.08	1.38	0.69	0.01	0.51	0.39	0.08	0.02	0.74	0.11
Uniform Delay, d1	42.9	49.5	45.9	40.2	43.6	37.2	16.3	12.9	10.4	14.6	23.2	15.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.8	6.0	0.3	185.0	5.3	0.0	3.0	0.6	0.2	0.1	2.8	0.3
Delay (s)	45.7	55.5	46.2	225.2	48.9	37.2	19.3	13.5	10.6	14.7	26.0	15.6
Level of Service	D	E	D	F	D	D	B	B	B	B	C	B
Approach Delay (s)		49.5			164.4			13.6			24.8	
Approach LOS		D			F			B			C	

Intersection Summary			
HCM 2000 Control Delay	56.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity	0.96		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.2
Intersection Capacity Utilization	98.3	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	248	316	53	47	441	21	21	115	10	16	348	142
Future Volume (vph)	248	316	53	47	441	21	21	115	10	16	348	142
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	7.0		7.0	7.0		7.0	7.0		3.0	7.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.98		1.00	0.99		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1706	3230		1789	3228		1659	3419		1242	3265	
Flt Permitted	0.46	1.00		0.53	1.00		0.45	1.00		0.56	1.00	
Satd.Flow(perm)	826	3230		1002	3228		789	3419		728	3265	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	248	316	53	47	441	21	21	115	10	16	348	142
RTOR Reduction (vph)	0	8	0	0	2	0	0	5	0	0	39	0
Lane Group Flow (vph)	248	361	0	47	460	0	21	120	0	16	451	0
Heavy Vehicles (%)	7%	12%	2%	2%	11%	40%	10%	5%	11%	47%	2%	19%
Turn Type	pm+pt	NA		Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases	5	2			6			4		3	8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	91.6	91.6		77.0	77.0		14.4	14.4		24.4	24.4	
Effective Green, g (s)	91.6	91.6		77.0	77.0		14.4	14.4		24.4	24.4	
Actuated g/C Ratio	0.70	0.70		0.59	0.59		0.11	0.11		0.19	0.19	
Clearance Time (s)	3.0	7.0		7.0	7.0		7.0	7.0		3.0	7.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	660	2275		593	1911		87	378		164	612	
v/s Ratio Prot	c0.03	0.11			0.14			0.04		0.01	c0.14	
v/s Ratio Perm	c0.23			0.05			0.03			0.01		
v/c Ratio	0.38	0.16		0.08	0.24		0.24	0.32		0.10	0.74	
Uniform Delay, d1	6.7	6.4		11.3	12.6		52.8	53.3		43.5	49.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4	0.1		0.3	0.3		1.4	0.5		0.3	4.6	
Delay (s)	7.1	6.5		11.6	12.9		54.3	53.7		43.7	54.4	
Level of Service	A	A		B	B		D	D		D	D	
Approach Delay (s)		6.8			12.8			53.8			54.1	
Approach LOS		A			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	25.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	59.0	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	13	564	67	52	546	5	12	71	31	17	325	50
Future Volume (vph)	13	564	67	52	546	5	12	71	31	17	325	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.96			0.98	
Flt Protected		1.00			1.00			0.99			1.00	
Satd. Flow (prot)		1693			1674			1597			1818	
Flt Permitted		0.99			0.90			0.93			0.98	
Satd.Flow(perm)		1670			1518			1493			1794	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	13	564	67	52	546	5	12	71	31	17	325	50
RTOR Reduction (vph)	0	3	0	0	0	0	0	13	0	0	5	0
Lane Group Flow (vph)	0	641	0	0	603	0	0	101	0	0	387	0
Heavy Vehicles (%)	8%	11%	19%	6%	15%	2%	18%	11%	24%	19%	2%	9%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		1			1			2			2	
Permitted Phases	1			1			2			2		
Actuated Green, G (s)		76.6			76.6			31.4			31.4	
Effective Green, g (s)		76.6			76.6			31.4			31.4	
Actuated g/C Ratio		0.64			0.64			0.26			0.26	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		1066			968			390			469	
v/s Ratio Prot												
v/s Ratio Perm		0.38			c0.40			0.07			c0.22	
v/c Ratio		0.60			0.62			0.26			0.82	
Uniform Delay, d1		12.7			13.0			35.1			41.7	
Progression Factor		1.00			0.41			1.00			1.00	
Incremental Delay, d2		2.5			2.7			0.4			11.3	
Delay (s)		15.3			8.0			35.5			53.0	
Level of Service		B			A			D			D	
Approach Delay (s)		15.3			8.0			35.5			53.0	
Approach LOS		B			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	22.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	120.0
Intersection Capacity Utilization	90.5%	ICU Level of Service	E
Analysis Period	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	22	244	98	25	139	14	19	77	10	30	392	22
Future Volume (vph)	22	244	98	25	139	14	19	77	10	30	392	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.6			6.6		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Frt		0.96			0.99		1.00	0.98		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1778			1850		1722	1663		1706	1851	
Flt Permitted		0.97			0.81		0.48	1.00		0.70	1.00	
Satd.Flow(perm)		1733			1518		868	1663		1258	1851	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	22	244	98	25	139	14	19	77	10	30	392	22
RTOR Reduction (vph)	0	11	0	0	3	0	0	3	0	0	1	0
Lane Group Flow (vph)	0	353	0	0	175	0	19	84	0	30	413	0
Heavy Vehicles (%)	19%	2%	5%	2%	2%	2%	6%	15%	2%	7%	3%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		8			4			6			2	
Permitted Phases	8			4			6			2		
Actuated Green, G (s)		27.1			27.1		74.2	74.2		74.2	74.2	
Effective Green, g (s)		27.1			27.1		74.2	74.2		74.2	74.2	
Actuated g/C Ratio		0.24			0.24		0.65	0.65		0.65	0.65	
Clearance Time (s)		6.6			6.6		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		412			361		565	1083		819	1205	
v/s Ratio Prot								0.05			c0.22	
v/s Ratio Perm		c0.20			0.12		0.02			0.02		
v/c Ratio		0.86			0.48		0.03	0.08		0.04	0.34	
Uniform Delay, d1		41.5			37.4		7.1	7.3		7.1	8.9	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		15.8			1.0		0.1	0.1		0.1	0.8	
Delay (s)		57.4			38.4		7.2	7.4		7.2	9.7	
Level of Service		E			D		A	A		A	A	
Approach Delay (s)		57.4			38.4			7.4			9.5	
Approach LOS		E			D			A			A	

Intersection Summary			
HCM 2000 Control Delay	30.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	113.9	Sum of Lost time (s)	12.6
Intersection Capacity Utilization	55.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	19	1114	428	50	852	27	225	61	47	53	414	48
Future Volume (vph)	19	1114	428	50	852	27	225	61	47	53	414	48
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6	6.6	6.8	6.8	6.8	6.8	6.8	6.8
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1644	3579	1555	1789	3510	1276	1722	3318	1498	1630	3476	1570
Flt Permitted	0.28	1.00	1.00	0.19	1.00	1.00	0.46	1.00	1.00	0.72	1.00	1.00
Satd.Flow(perm)	491	3579	1555	354	3510	1276	841	3318	1498	1227	3476	1570
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	19	1114	428	50	852	27	225	61	47	53	414	48
RTOR Reduction (vph)	0	0	143	0	0	12	0	0	27	0	0	33
Lane Group Flow (vph)	19	1114	285	50	852	15	225	61	20	53	414	15
Heavy Vehicles (%)	11%	2%	5%	2%	4%	28%	6%	10%	9%	12%	5%	4%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		8			4			6			2	
Permitted Phases	8		8	4		4	6		6	2		2
Actuated Green, G (s)	55.8	55.8	55.8	55.8	55.8	55.8	30.8	30.8	30.8	30.8	30.8	30.8
Effective Green, g (s)	55.8	55.8	55.8	55.8	55.8	55.8	30.8	30.8	30.8	30.8	30.8	30.8
Actuated g/C Ratio	0.56	0.56	0.56	0.56	0.56	0.56	0.31	0.31	0.31	0.31	0.31	0.31
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6	6.6	6.8	6.8	6.8	6.8	6.8	6.8
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	273	1997	867	197	1958	712	259	1021	461	377	1070	483
v/s Ratio Prot		c0.31			0.24			0.02			0.12	
v/s Ratio Perm	0.04		0.18	0.14		0.01	c0.27		0.01	0.04		0.01
v/c Ratio	0.07	0.56	0.33	0.25	0.44	0.02	0.87	0.06	0.04	0.14	0.39	0.03
Uniform Delay, d1	10.2	14.2	12.0	11.4	12.9	9.9	32.7	24.4	24.3	25.0	27.2	24.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	1.1	1.0	3.1	0.7	0.1	25.1	0.0	0.0	0.2	0.2	0.0
Delay (s)	10.7	15.3	13.0	14.5	13.6	9.9	57.7	24.4	24.3	25.2	27.4	24.2
Level of Service	B	B	B	B	B	A	E	C	C	C	C	C
Approach Delay (s)		14.6			13.5			46.9			26.9	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	19.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	100.0	Sum of Lost time (s)	13.4
Intersection Capacity Utilization	82.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	1148	57	17	753	15	49	20	30	96	164	35
Future Volume (vph)	30	1148	57	17	753	15	49	20	30	96	164	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1789	3579	1445	1722	5142	1526	1722	3579	1601	1789	3579	1585
Flt Permitted	0.35	1.00	1.00	0.22	1.00	1.00	0.65	1.00	1.00	0.74	1.00	1.00
Satd.Flow(perm)	667	3579	1445	405	5142	1526	1175	3579	1601	1401	3579	1585
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	30	1148	57	17	753	15	49	20	30	96	164	35
RTOR Reduction (vph)	0	0	15	0	0	4	0	0	26	0	0	30
Lane Group Flow (vph)	30	1148	42	17	753	11	49	20	4	96	164	5
Heavy Vehicles (%)	2%	2%	13%	6%	2%	7%	6%	2%	2%	2%	2%	3%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		2			6			4			8	
Permitted Phases	2		2	6		6	4		4	8		8
Actuated Green, G (s)	80.9	80.9	80.9	80.9	80.9	80.9	15.1	15.1	15.1	15.1	15.1	15.1
Effective Green, g (s)	80.9	80.9	80.9	80.9	80.9	80.9	15.1	15.1	15.1	15.1	15.1	15.1
Actuated g/C Ratio	0.74	0.74	0.74	0.74	0.74	0.74	0.14	0.14	0.14	0.14	0.14	0.14
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	490	2632	1062	297	3781	1122	161	491	219	192	491	217
v/s Ratio Prot		c0.32			0.15			0.01			0.05	
v/s Ratio Perm	0.04		0.03	0.04		0.01	0.04		0.00	c0.07		0.00
v/c Ratio	0.06	0.44	0.04	0.06	0.20	0.01	0.30	0.04	0.02	0.50	0.33	0.02
Uniform Delay, d1	4.0	5.7	4.0	4.0	4.5	3.9	42.7	41.2	41.0	44.0	42.9	41.1
Progression Factor	0.29	0.56	0.58	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.5	0.1	0.4	0.1	0.0	2.2	0.1	0.1	4.2	0.8	0.1
Delay (s)	1.4	3.7	2.3	4.4	4.6	3.9	45.0	41.2	41.1	48.2	43.7	41.1
Level of Service	A	A	A	A	A	A	D	D	D	D	D	D
Approach Delay (s)		3.6			4.6			43.0			44.9	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	10.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	110.0	Sum of Lost time (s)	14.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	8	592	11	12	586	6	7	29	10	6	189	11
Future Volume (vph)	8	592	11	12	586	6	7	29	10	6	189	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.3			7.3			7.0			7.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			1.00			0.97			0.99	
Flt Protected		1.00			1.00			0.99			1.00	
Satd. Flow (prot)		1745			1714			1782			1843	
Flt Permitted		0.99			0.99			0.90			0.94	
Satd.Flow(perm)		1732			1691			1621			1733	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	8	592	11	12	586	6	7	29	10	6	189	11
RTOR Reduction (vph)	0	0	0	0	0	0	0	8	0	0	2	0
Lane Group Flow (vph)	0	611	0	0	604	0	0	38	0	0	204	0
Heavy Vehicles (%)	2%	10%	2%	2%	12%	17%	14%	2%	2%	2%	3%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			4			3	
Permitted Phases	2			6			4			3		
Actuated Green, G (s)		78.3			78.3			7.4			13.0	
Effective Green, g (s)		78.3			78.3			7.4			13.0	
Actuated g/C Ratio		0.65			0.65			0.06			0.11	
Clearance Time (s)		7.3			7.3			7.0			7.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		1130			1103			99			187	
v/s Ratio Prot												
v/s Ratio Perm		0.35			c0.36			c0.02			c0.12	
v/c Ratio		0.54			0.55			0.38			1.09	
Uniform Delay, d1		11.2			11.3			54.1			53.5	
Progression Factor		0.38			1.00			1.00			1.00	
Incremental Delay, d2		1.6			2.0			2.4			92.5	
Delay (s)		5.8			13.2			56.5			146.0	
Level of Service		A			B			E			F	
Approach Delay (s)		5.8			13.2			56.5			146.0	
Approach LOS		A			B			E			F	

Intersection Summary

HCM 2000 Control Delay	30.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	120.0	Sum of Lost time (s)	21.3
Intersection Capacity Utilization	61.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1260	14	8	775	11	34
Future Volume (vph)	1260	14	8	775	11	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3579	1601	1789	3544	1674	1585
Flt Permitted	1.00	1.00	0.21	1.00	0.95	1.00
Satd.Flow(perm)	3579	1601	399	3544	1674	1585
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1260	14	8	775	11	34
RTOR Reduction (vph)	0	2	0	0	0	32
Lane Group Flow (vph)	1260	12	8	775	11	2
Heavy Vehicles (%)	2%	2%	2%	3%	9%	3%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	93.1	93.1	93.1	93.1	4.9	4.9
Effective Green, g (s)	93.1	93.1	93.1	93.1	4.9	4.9
Actuated g/C Ratio	0.85	0.85	0.85	0.85	0.04	0.04
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	3.0	3.0
Lane Grp Cap (vph)	3029	1355	337	2999	74	70
v/s Ratio Prot	c0.35			0.22	c0.01	
v/s Ratio Perm		0.01	0.02			0.00
v/c Ratio	0.42	0.01	0.02	0.26	0.15	0.02
Uniform Delay, d1	2.0	1.3	1.3	1.7	50.5	50.3
Progression Factor	0.43	0.41	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.0	0.1	0.2	0.9	0.1
Delay (s)	1.3	0.5	1.5	1.9	51.5	50.4
Level of Service	A	A	A	A	D	D
Approach Delay (s)	1.3			1.9	50.6	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	2.5	HCM 2000 Level of Service	
HCM 2000 Volume to Capacity	0.40		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	
Intersection Capacity Utilization	51.5%	ICU Level of Service	
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1209	28	7	830	0	51	0	26	0	0	0
Future Volume (vph)	0	1209	28	7	830	0	51	0	26	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0		6.0	6.0				
Lane Util. Factor		0.95	1.00	1.00	0.91		1.00	1.00				
Frt		1.00	0.85	1.00	1.00		1.00	0.85				
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00				
Satd. Flow (prot)		3579	1384	1276	5092		1659	1570				
Flt Permitted		1.00	1.00	0.22	1.00		0.76	1.00				
Satd.Flow(perm)		3579	1384	294	5092		1322	1570				
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	1209	28	7	830	0	51	0	26	0	0	0
RTOR Reduction (vph)	0	0	5	0	0	0	0	24	0	0	0	0
Lane Group Flow (vph)	0	1209	23	7	830	0	51	2	0	0	0	0
Heavy Vehicles (%)	2%	2%	18%	43%	3%	2%	10%	2%	4%	2%	2%	2%
Turn Type	Perm	NA	Perm	Perm	NA		Perm	NA				
Protected Phases		2			6			4			4	
Permitted Phases	2		2	6			4			4		
Actuated Green, G (s)		89.4	89.4	89.4	89.4		8.6	8.6				
Effective Green, g (s)		89.4	89.4	89.4	89.4		8.6	8.6				
Actuated g/C Ratio		0.81	0.81	0.81	0.81		0.08	0.08				
Clearance Time (s)		6.0	6.0	6.0	6.0		6.0	6.0				
Vehicle Extension (s)		5.0	5.0	5.0	5.0		3.0	3.0				
Lane Grp Cap (vph)		2908	1124	238	4138		103	122				
v/s Ratio Prot		c0.34			0.16			0.00				
v/s Ratio Perm			0.02	0.02			c0.04					
v/c Ratio		0.42	0.02	0.03	0.20		0.50	0.02				
Uniform Delay, d1		2.9	2.0	2.0	2.3		48.6	46.8				
Progression Factor		1.00	1.00	0.93	0.91		1.00	1.00				
Incremental Delay, d2		0.4	0.0	0.2	0.1		3.7	0.1				
Delay (s)		3.4	2.0	2.1	2.2		52.3	46.9				
Level of Service		A	A	A	A		D	D				
Approach Delay (s)		3.3			2.2			50.5			0.0	
Approach LOS		A			A			D			A	

Intersection Summary

HCM 2000 Control Delay	4.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	110.0	Sum of Lost time (s)	12.0
Intersection Capacity Utilization	50.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1207	25	19	862	33	30
Future Volume (vph)	1207	25	19	862	33	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3579	1512	1508	3544	1772	1526
Flt Permitted	1.00	1.00	0.22	1.00	0.95	1.00
Satd.Flow(perm)	3579	1512	350	3544	1772	1526
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1207	25	19	862	33	30
RTOR Reduction (vph)	0	5	0	0	0	28
Lane Group Flow (vph)	1207	20	19	862	33	2
Heavy Vehicles (%)	2%	8%	21%	3%	3%	7%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	90.0	90.0	90.0	90.0	8.0	8.0
Effective Green, g (s)	90.0	90.0	90.0	90.0	8.0	8.0
Actuated g/C Ratio	0.82	0.82	0.82	0.82	0.07	0.07
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	2928	1237	286	2899	128	110
v/s Ratio Prot	c0.34			0.24	c0.02	
v/s Ratio Perm		0.01	0.05			0.00
v/c Ratio	0.41	0.02	0.07	0.30	0.26	0.02
Uniform Delay, d1	2.7	1.8	1.9	2.4	48.2	47.4
Progression Factor	0.17	0.01	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.0	0.4	0.3	2.2	0.2
Delay (s)	0.9	0.0	2.4	2.7	50.4	47.5
Level of Service	A	A	A	A	D	D
Approach Delay (s)	0.8			2.7	49.0	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	3.0	HCM 2000 Level of Service	
HCM 2000 Volume to Capacity	0.40		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	
Intersection Capacity Utilization	50.0%	ICU Level of Service	
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1204	10	5	890	39	28
Future Volume (vph)	1204	10	5	890	39	28
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3579	1484	1521	3510	1789	1526
Flt Permitted	1.00	1.00	0.22	1.00	0.95	1.00
Satd.Flow(perm)	3579	1484	356	3510	1789	1526
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1204	10	5	890	39	28
RTOR Reduction (vph)	0	2	0	0	0	26
Lane Group Flow (vph)	1204	8	5	890	39	2
Heavy Vehicles (%)	2%	10%	20%	4%	2%	7%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	90.9	90.9	90.9	90.9	7.1	7.1
Effective Green, g (s)	90.9	90.9	90.9	90.9	7.1	7.1
Actuated g/C Ratio	0.83	0.83	0.83	0.83	0.06	0.06
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2957	1226	294	2900	115	98
v/s Ratio Prot	c0.34			0.25	c0.02	
v/s Ratio Perm		0.01	0.01			0.00
v/c Ratio	0.41	0.01	0.02	0.31	0.34	0.02
Uniform Delay, d1	2.5	1.7	1.7	2.2	49.2	48.2
Progression Factor	1.00	1.00	0.99	0.95	1.00	1.00
Incremental Delay, d2	0.4	0.0	0.1	0.3	1.8	0.1
Delay (s)	2.9	1.7	1.8	2.4	51.0	48.3
Level of Service	A	A	A	A	D	D
Approach Delay (s)	2.9			2.4	49.8	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	4.1	HCM 2000 Level of Service	
HCM 2000 Volume to Capacity	0.40		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	
Intersection Capacity Utilization	49.9%	ICU Level of Service	
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	96	651	102	135	1041	224	178	1580	154	172	1027	159
Future Volume (vph)	96	651	102	135	1041	224	178	1580	154	172	1027	159
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.6	6.6	3.0	6.6	6.6
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1772	3579	1601	1242	3579	1372	1789	4768	1237	1560	4683	1601
Flt Permitted	0.15	1.00	1.00	0.14	1.00	1.00	0.23	1.00	1.00	0.07	1.00	1.00
Satd.Flow(perm)	287	3579	1601	180	3579	1372	431	4768	1237	120	4683	1601
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	96	651	102	135	1041	224	178	1580	154	172	1027	159
RTOR Reduction (vph)	0	0	83	0	0	110	0	0	85	0	0	84
Lane Group Flow (vph)	96	651	19	135	1041	114	178	1580	69	172	1027	75
Heavy Vehicles (%)	3%	2%	2%	47%	2%	19%	2%	10%	32%	17%	12%	2%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases	8		8	4		4	6		6	2		2
Actuated Green, G (s)	35.0	26.0	26.0	50.0	38.0	38.0	69.4	62.4	62.4	76.4	66.4	66.4
Effective Green, g (s)	35.0	26.0	26.0	50.0	38.0	38.0	69.4	62.4	62.4	76.4	66.4	66.4
Actuated g/C Ratio	0.25	0.19	0.19	0.36	0.27	0.27	0.50	0.45	0.45	0.55	0.47	0.47
Clearance Time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.6	6.6	3.0	6.6	6.6
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	167	664	297	223	971	372	281	2125	551	178	2221	759
v/s Ratio Prot	0.04	0.18		c0.09	c0.29		0.03	0.33		c0.08	0.22	
v/s Ratio Perm	0.11		0.01	0.12		0.08	0.28		0.06	c0.45		0.05
v/c Ratio	0.57	0.98	0.06	0.61	1.07	0.31	0.63	0.74	0.12	0.97	0.46	0.10
Uniform Delay, d1	43.5	56.7	47.0	34.7	51.0	40.5	21.0	32.2	22.8	36.4	24.8	20.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.7	29.9	0.1	4.6	50.2	0.5	10.4	2.4	0.5	59.2	0.7	0.3
Delay (s)	48.2	86.7	47.1	39.3	101.2	41.0	31.4	34.6	23.2	95.6	25.5	20.6
Level of Service	D	F	D	D	F	D	C	C	C	F	C	C
Approach Delay (s)		77.5			85.6			33.4			33.8	
Approach LOS		E			F			C			C	

Intersection Summary			
HCM 2000 Control Delay	53.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity	0.99		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	92.2	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	135	26	1813	86	7	1223
Future Volume (vph)	135	26	1813	86	7	1223
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.7	7.7	6.8	6.8	3.0	6.8
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	2603	1458	3380	892	1276	3380
Flt Permitted	0.95	1.00	1.00	1.00	0.09	1.00
Satd. Flow (perm)	2603	1458	3380	892	116	3380
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	135	26	1813	86	7	1223
RTOR Reduction (vph)	0	23	0	19	0	0
Lane Group Flow (vph)	135	3	1813	67	7	1223
Heavy Vehicles (%)	36%	12%	8%	83%	43%	8%
Turn Type	Prot	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	2
Permitted Phases		4		2	2	
Actuated Green, G (s)	11.2	11.2	85.2	85.2	86.3	85.2
Effective Green, g (s)	11.2	11.2	85.2	85.2	86.3	85.2
Actuated g/C Ratio	0.10	0.10	0.74	0.74	0.75	0.74
Clearance Time (s)	7.7	7.7	6.8	6.8	3.0	6.8
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	253	141	2504	660	98	2504
v/s Ratio Prot	c0.05		c0.54		c0.00	0.36
v/s Ratio Perm		0.00		0.07	0.05	
v/c Ratio	0.53	0.02	0.72	0.10	0.07	0.49
Uniform Delay, d1	49.4	46.9	8.3	4.2	6.9	6.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.2	0.1	1.1	0.1	0.3	0.2
Delay (s)	51.6	47.0	9.4	4.2	7.2	6.2
Level of Service	D	D	A	A	A	A
Approach Delay (s)	50.8		9.2			6.2
Approach LOS	D		A			A

Intersection Summary			
HCM 2000 Control Delay	10.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity	0.69		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	17.5
Intersection Capacity Utilization	68.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	55	104	76	100	97	222	1539	79	155	1050	25
Future Volume (vph)	1	55	104	76	100	97	222	1539	79	155	1050	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		9.2			9.2		6.6	6.6		6.6	6.6	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.91			0.95		1.00	0.99		1.00	1.00	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1718			1681		1789	3204		1630	3433	
Flt Permitted		1.00			0.86		0.18	1.00		0.06	1.00	
Satd. Flow (perm)		1716			1459		334	3204		101	3433	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1	55	104	76	100	97	222	1539	79	155	1050	25
RTOR Reduction (vph)	0	46	0	0	12	0	0	3	0	0	1	0
Lane Group Flow (vph)	0	114	0	0	261	0	222	1615	0	155	1074	0
Heavy Vehicles (%)	2%	2%	2%	21%	2%	2%	2%	11%	54%	12%	6%	4%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		8			4			6			2	
Permitted Phases	8			4			6			2		
Actuated Green, G (s)		48.0			48.0		68.0	68.0		68.0	68.0	
Effective Green, g (s)		48.0			48.0		68.0	68.0		68.0	68.0	
Actuated g/C Ratio		0.36			0.36		0.52	0.52		0.52	0.52	
Clearance Time (s)		9.2			9.2		6.6	6.6		6.6	6.6	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		624			531		172	1653		52	1771	
v/s Ratio Prot								0.50			0.31	
v/s Ratio Perm		0.07			c0.18		0.66			c1.54		
v/c Ratio		0.18			0.49		1.29	0.98		2.98	0.61	
Uniform Delay, d1		28.5			32.4		31.9	31.1		31.9	22.5	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			3.2		167.2	16.8		940.7	0.6	
Delay (s)		29.2			35.7		199.1	47.9		972.6	23.1	
Level of Service		C			D		F	D		F	C	
Approach Delay (s)		29.2			35.7			66.2			142.7	
Approach LOS		C			D			E			F	

Intersection Summary			
HCM 2000 Control Delay	89.0	HCM 2000 Level of	F
HCM 2000 Volume to Capacity	1.95		
Actuated Cycle Length (s)	131.8	Sum of lost time (s)	15.8
Intersection Capacity Utilization	106.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

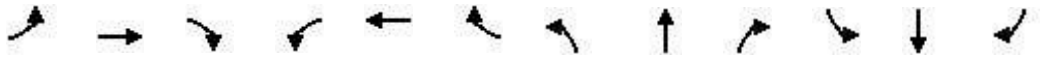
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	14	162	4	31	160	238	38	1539	59	238	1187	44
Future Volume (vph)	14	162	4	31	160	238	38	1539	59	238	1187	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Total Lost time (s)		6.6		6.6	6.6	4.0	6.6	6.6		3.0	6.6	6.6
Lane Util. Factor		1.00		1.00	1.00	1.00	1.00	0.95		1.00	0.95	1.00
Frt		1.00		1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected		1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		1871		1615	1883	1601	1738	3428		1789	3444	1601
Flt Permitted		0.96		0.46	1.00	1.00	0.18	1.00		0.08	1.00	1.00
Satd. Flow (perm)		1808		789	1883	1601	323	3428		150	3444	1601
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	14	162	4	31	160	238	38	1539	59	238	1187	44
RTOR Reduction (vph)	0	1	0	0	0	238	0	2	0	0	0	18
Lane Group Flow (vph)	0	179	0	31	160	0	38	1596	0	238	1187	26
Heavy Vehicles (%)	2%	2%	2%	13%	2%	2%	5%	6%	3%	2%	6%	
Turn Type	Perm	NA		Perm	NA	NA	Perm	NA		pm+pt	NA	Perm
Protected Phases		4			4			2		1	2	
Permitted Phases	4			4			2			2		2
Actuated Green, G (s)		16.2		16.2	16.2	0.0	62.3	62.3		72.4	62.3	62.3
Effective Green, g (s)		16.2		16.2	16.2	0.0	62.3	62.3		72.4	62.3	62.3
Actuated g/C Ratio		0.15		0.15	0.15	0.00	0.59	0.59		0.69	0.59	0.59
Clearance Time (s)		6.6		6.6	6.6		6.6	6.6		3.0	6.6	6.6
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		279		121	291	0	192	2037		261	2047	951
v/s Ratio Prot					0.08			0.47		c0.09	0.34	
v/s Ratio Perm		c0.10		0.04			0.12			c0.54		0.02
v/c Ratio		0.64		0.26	0.55	0.00	0.20	0.78		0.91	0.58	0.03
Uniform Delay, d1		41.6		39.0	40.9	52.4	9.8	16.1		27.0	13.2	8.8
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		5.0		1.1	2.1	0.0	0.5	2.0		33.2	0.4	0.0
Delay (s)		46.6		40.1	43.1	52.4	10.3	18.2		60.2	13.6	8.8
Level of Service		D		D	D	D	B	B		E	B	A
Approach Delay (s)		46.6			48.0			18.0			21.0	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	24.0	HCM 2000 Level of	C
HCM 2000 Volume to Capacity	0.86		
Actuated Cycle Length (s)	104.8	Sum of lost time (s)	16.2
Intersection Capacity Utilization	92.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	191	276	68	161	231	33	97	1086	608	15	1240	212
Future Volume (vph)	191	276	68	161	231	33	97	1086	608	15	1240	212
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.6	6.6	3.0	6.6	6.6	3.0	6.6	6.6	6.6	6.6	6.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1772	1779	1276	1706	1700	1601	1383	3411	1526	1789	3444	1570
Flt Permitted	0.41	1.00	1.00	0.31	1.00	1.00	0.13	1.00	1.00	0.24	1.00	1.00
Satd.Flow(perm)	766	1779	1276	557	1700	1601	187	3411	1526	459	3444	1570
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	191	276	68	161	231	33	97	1086	608	15	1240	212
RTOR Reduction (vph)	0	0	55	0	0	27	0	0	157	0	0	100
Lane Group Flow (vph)	191	276	13	161	231	6	97	1086	451	15	1240	112
Heavy Vehicles (%)	3%	8%	28%	7%	13%	2%	32%	7%	7%	2%	6%	4%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8		1	6			2	
Permitted Phases	4		4	8		8	6		6	2		2
Actuated Green, G (s)	30.1	23.1	23.1	30.1	23.1	23.1	73.7	73.7	73.7	63.4	63.4	63.4
Effective Green, g (s)	30.1	23.1	23.1	30.1	23.1	23.1	73.7	73.7	73.7	63.4	63.4	63.4
Actuated g/C Ratio	0.25	0.19	0.19	0.25	0.19	0.19	0.61	0.61	0.61	0.53	0.53	0.53
Clearance Time (s)	3.0	6.6	6.6	3.0	6.6	6.6	3.0	6.6	6.6	6.6	6.6	6.6
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	250	342	245	206	327	308	187	2094	937	242	1819	829
v/s Ratio Prot	0.04	c0.16		c0.05	0.14		0.03	c0.32			c0.36	
v/s Ratio Perm	0.15		0.01	0.15		0.00	0.29		0.30	0.03		0.07
v/c Ratio	0.76	0.81	0.05	0.78	0.71	0.02	0.52	0.52	0.48	0.06	0.68	0.14
Uniform Delay, d1	40.8	46.3	39.5	40.4	45.3	39.3	14.4	13.1	12.7	13.8	20.9	14.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	13.0	13.0	0.1	17.3	6.8	0.0	2.4	0.9	1.8	0.5	2.1	0.3
Delay (s)	53.8	59.3	39.6	57.7	52.1	39.3	16.9	14.0	14.4	14.3	23.0	14.7
Level of Service	D	E	D	E	D	D	B	B	B	B	C	B
Approach Delay (s)		54.8			53.2			14.3			21.7	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	25.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity	0.71		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.2
Intersection Capacity Utilization	90.0	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	178	486	31	14	486	40	55	280	22	27	167	232
Future Volume (vph)	178	486	31	14	486	40	55	280	22	27	167	232
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	7.0		7.0	7.0		7.0	7.0		3.0	7.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.99		1.00	0.99		1.00	0.99		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1534	3303		1690	3231		1789	3539		1342	3090	
Flt Permitted	0.43	1.00		0.46	1.00		0.52	1.00		0.36	1.00	
Satd.Flow(perm)	691	3303		820	3231		974	3539		509	3090	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	178	486	31	14	486	40	55	280	22	27	167	232
RTOR Reduction (vph)	0	3	0	0	3	0	0	5	0	0	190	0
Lane Group Flow (vph)	178	514	0	14	523	0	55	297	0	27	209	0
Heavy Vehicles (%)	19%	10%	2%	8%	10%	32%	2%	2%	2%	36%	2%	12%
Turn Type	pm+pt	NA		Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases	5	2			6			4		3	8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	92.6	92.6		79.5	79.5		16.2	16.2		23.4	23.4	
Effective Green, g (s)	92.6	92.6		79.5	79.5		16.2	16.2		23.4	23.4	
Actuated g/C Ratio	0.71	0.71		0.61	0.61		0.12	0.12		0.18	0.18	
Clearance Time (s)	3.0	7.0		7.0	7.0		7.0	7.0		3.0	7.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	557	2352		501	1975		121	441		118	556	
v/s Ratio Prot	c0.02	0.16			0.16			c0.08		0.01	c0.07	
v/s Ratio Perm	c0.20			0.02			0.06			0.03		
v/c Ratio	0.32	0.22		0.03	0.26		0.45	0.67		0.23	0.38	
Uniform Delay, d1	6.2	6.4		10.0	11.7		52.8	54.4		44.8	46.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	0.2		0.1	0.3		2.7	4.0		1.0	0.4	
Delay (s)	6.6	6.6		10.1	12.0		55.5	58.4		45.8	47.3	
Level of Service	A	A		B	B		E	E		D	D	
Approach Delay (s)		6.6			12.0			57.9			47.2	
Approach LOS		A			B			E			D	

Intersection Summary			
HCM 2000 Control Delay	25.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	69.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	37	659	19	20	720	30	66	267	31	13	71	12
Future Volume (vph)	37	659	19	20	720	30	66	267	31	13	71	12
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.99			0.99			0.98	
Flt Protected		1.00			1.00			0.99			0.99	
Satd. Flow (prot)		1698			1774			1842			1669	
Flt Permitted		0.93			0.97			0.92			0.91	
Satd.Flow(perm)		1591			1730			1716			1530	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	37	659	19	20	720	30	66	267	31	13	71	12
RTOR Reduction (vph)	0	1	0	0	1	0	0	3	0	0	5	0
Lane Group Flow (vph)	0	714	0	0	769	0	0	361	0	0	91	0
Heavy Vehicles (%)	3%	13%	11%	2%	8%	2%	3%	2%	2%	8%	15%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		1			1			2			2	
Permitted Phases	1			1			2			2		
Actuated Green, G (s)		78.6			78.6			29.4			29.4	
Effective Green, g (s)		78.6			78.6			29.4			29.4	
Actuated g/C Ratio		0.65			0.65			0.24			0.24	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		1042			1133			420			374	
v/s Ratio Prot												
v/s Ratio Perm		c0.45			0.44			c0.21			0.06	
v/c Ratio		0.69			0.68			0.86			0.24	
Uniform Delay, d1		13.0			12.9			43.3			36.4	
Progression Factor		1.00			0.33			1.00			1.00	
Incremental Delay, d2		3.7			2.6			15.9			0.3	
Delay (s)		16.6			6.9			59.2			36.7	
Level of Service		B			A			E			D	
Approach Delay (s)		16.6			6.9			59.2			36.7	
Approach LOS		B			A			E			D	

Intersection Summary			
HCM 2000 Control Delay	21.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	18	197	42	7	326	19	105	350	23	10	86	15
Future Volume (vph)	18	197	42	7	326	19	105	350	23	10	86	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.6			6.6		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Frt		0.98			0.99		1.00	0.99		1.00	0.98	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1830			1859		1789	1829		1789	1811	
Flt Permitted		0.93			0.99		0.69	1.00		0.51	1.00	
Satd. Flow (perm)		1702			1845		1303	1829		960	1811	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	18	197	42	7	326	19	105	350	23	10	86	15
RTOR Reduction (vph)	0	7	0	0	2	0	0	1	0	0	4	0
Lane Group Flow (vph)	0	250	0	0	350	0	105	372	0	10	97	0
Heavy Vehicles (%)	6%	2%	2%	2%	2%	11%	2%	4%	5%	2%	4%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		8			4			6			2	
Permitted Phases	8			4			6			2		
Actuated Green, G (s)		24.0			24.0		64.2	64.2		64.2	64.2	
Effective Green, g (s)		24.0			24.0		64.2	64.2		64.2	64.2	
Actuated g/C Ratio		0.24			0.24		0.64	0.64		0.64	0.64	
Clearance Time (s)		6.6			6.6		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		405			439		829	1164		611	1153	
v/s Ratio Prot								c0.20			0.05	
v/s Ratio Perm		0.15			c0.19		0.08			0.01		
v/c Ratio		0.62			0.80		0.13	0.32		0.02	0.08	
Uniform Delay, d1		34.3			36.1		7.2	8.3		6.7	7.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		2.8			9.7		0.3	0.7		0.0	0.1	
Delay (s)		37.1			45.8		7.5	9.1		6.8	7.2	
Level of Service		D			D		A	A		A	A	
Approach Delay (s)		37.1			45.8			8.7			7.1	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM 2000 Control Delay	25.6	HCM 2000 Level of	C
HCM 2000 Volume to Capacity	0.45		
Actuated Cycle Length (s)	100.8	Sum of lost time (s)	12.6
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	68	914	219	45	1251	87	306	323	66	28	68	40
Future Volume (vph)	68	914	219	45	1251	87	306	323	66	28	68	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6	6.6	6.8	6.8	6.8	6.8	6.8	6.8
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1789	3579	1585	1789	3579	1601	1789	3544	1585	1630	3544	1585
Flt Permitted	0.15	1.00	1.00	0.26	1.00	1.00	0.71	1.00	1.00	0.55	1.00	1.00
Satd.Flow(perm)	284	3579	1585	493	3579	1601	1338	3544	1585	938	3544	1585
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	68	914	219	45	1251	87	306	323	66	28	68	40
RTOR Reduction (vph)	0	0	95	0	0	38	0	0	31	0	0	27
Lane Group Flow (vph)	68	914	124	45	1251	49	306	323	35	28	68	13
Heavy Vehicles (%)	2%	2%	3%	2%	2%	2%	2%	3%	3%	12%	3%	3%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		8			4			6			2	
Permitted Phases	8		8	4		4	6		6	2		2
Actuated Green, G (s)	56.7	56.7	56.7	56.7	56.7	56.7	29.9	29.9	29.9	29.9	29.9	29.9
Effective Green, g (s)	56.7	56.7	56.7	56.7	56.7	56.7	29.9	29.9	29.9	29.9	29.9	29.9
Actuated g/C Ratio	0.57	0.57	0.57	0.57	0.57	0.57	0.30	0.30	0.30	0.30	0.30	0.30
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6	6.6	6.8	6.8	6.8	6.8	6.8	6.8
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	161	2029	898	279	2029	907	400	1059	473	280	1059	473
v/s Ratio Prot		0.26			c0.35			0.09			0.02	
v/s Ratio Perm	0.24		0.08	0.09		0.03	c0.23		0.02	0.03		0.01
v/c Ratio	0.42	0.45	0.14	0.16	0.62	0.05	0.77	0.31	0.07	0.10	0.06	0.03
Uniform Delay, d1	12.3	12.6	10.2	10.3	14.4	9.7	31.9	27.0	25.1	25.3	25.1	24.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	7.9	0.7	0.3	1.2	1.4	0.1	8.5	0.2	0.1	0.2	0.0	0.0
Delay (s)	20.3	13.3	10.5	11.6	15.8	9.8	40.3	27.2	25.2	25.5	25.1	24.8
Level of Service	C	B	B	B	B	A	D	C	C	C	C	C
Approach Delay (s)		13.2			15.3			32.8			25.1	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	18.5	HCM 2000 Level of	B
HCM 2000 Volume to Capacity	0.67		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	13.4
Intersection Capacity Utilization	84.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	54	794	73	34	1224	90	84	86	30	38	87	18
Future Volume (vph)	54	794	73	34	1224	90	84	86	30	38	87	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1789	3544	1512	1789	5142	1601	1755	3579	1601	1772	3444	1601
Flt Permitted	0.21	1.00	1.00	0.34	1.00	1.00	0.70	1.00	1.00	0.70	1.00	1.00
Satd. Flow (perm)	397	3544	1512	649	5142	1601	1289	3579	1601	1302	3444	1601
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	54	794	73	34	1224	90	84	86	30	38	87	18
RTOR Reduction (vph)	0	0	16	0	0	20	0	0	26	0	0	16
Lane Group Flow (vph)	54	794	57	34	1224	70	84	86	4	38	87	2
Heavy Vehicles (%)	2%	3%	8%	2%	2%	2%	4%	2%	2%	3%	6%	2%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		2			6			4			8	
Permitted Phases	2		2	6		6	4		4	8		8
Actuated Green, G (s)	109.6	109.6	109.6	109.6	109.6	109.6	16.4	16.4	16.4	16.4	16.4	16.4
Effective Green, g (s)	109.6	109.6	109.6	109.6	109.6	109.6	16.4	16.4	16.4	16.4	16.4	16.4
Actuated g/C Ratio	0.78	0.78	0.78	0.78	0.78	0.78	0.12	0.12	0.12	0.12	0.12	0.12
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	310	2774	1183	508	4025	1253	150	419	187	152	403	187
v/s Ratio Prot		0.22			c0.24			0.02			0.03	
v/s Ratio Perm	0.14		0.04	0.05		0.04	c0.07		0.00	0.03		0.00
v/c Ratio	0.17	0.29	0.05	0.07	0.30	0.06	0.56	0.21	0.02	0.25	0.22	0.01
Uniform Delay, d1	3.8	4.3	3.4	3.5	4.3	3.5	58.4	55.9	54.7	56.2	56.0	54.6
Progression Factor	0.92	0.92	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.3	0.1	0.3	0.2	0.1	7.6	0.5	0.1	1.8	0.6	0.1
Delay (s)	4.7	4.2	3.2	3.7	4.5	3.5	66.0	56.4	54.8	58.0	56.5	54.7
Level of Service	A	A	A	A	A	A	E	E	D	E	E	D
Approach Delay (s)		4.1			4.4			60.2			56.7	
Approach LOS		A			A			E			E	

Intersection Summary

HCM 2000 Control Delay	11.5	HCM 2000 Level of	B
HCM 2000 Volume to Capacity	0.34		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	59.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	676	12	6	740	28	13	135	13	6	54	17
Future Volume (vph)	15	676	12	6	740	28	13	135	13	6	54	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.3			7.3			7.0			7.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			1.00			0.99			0.97	
Flt Protected		1.00			1.00			1.00			1.00	
Satd. Flow (prot)		1668			1735			1788			1805	
Flt Permitted		0.98			0.99			0.97			0.82	
Satd. Flow (perm)		1634			1727			1733			1477	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	15	676	12	6	740	28	13	135	13	6	54	17
RTOR Reduction (vph)	0	0	0	0	1	0	0	3	0	0	9	0
Lane Group Flow (vph)	0	703	0	0	773	0	0	158	0	0	68	0
Heavy Vehicles (%)	2%	15%	18%	17%	10%	12%	8%	6%	2%	2%	2%	6%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			4			3	
Permitted Phases	2			6			4			3		
Actuated Green, G (s)		76.0			76.0			13.7			9.0	
Effective Green, g (s)		76.0			76.0			13.7			9.0	
Actuated g/C Ratio		0.63			0.63			0.11			0.08	
Clearance Time (s)		7.3			7.3			7.0			7.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		1034			1093			197			110	
v/s Ratio Prot												
v/s Ratio Perm		0.43			c0.45			c0.09			c0.05	
v/c Ratio		0.68			0.71			0.80			0.62	
Uniform Delay, d1		14.2			14.6			51.8			53.8	
Progression Factor		0.55			1.00			1.00			1.00	
Incremental Delay, d2		2.9			3.9			20.6			9.8	
Delay (s)		10.7			18.5			72.5			63.7	
Level of Service		B			B			E			E	
Approach Delay (s)		10.7			18.5			72.5			63.7	
Approach LOS		B			B			E			E	

Intersection Summary

HCM 2000 Control Delay	22.4	HCM 2000 Level of	C
HCM 2000 Volume to Capacity	0.71		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	21.3
Intersection Capacity Utilization	69.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	836	25	40	1338	10	13
Future Volume (vph)	836	25	40	1338	10	13
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3579	1512	1789	3579	1789	1512
Flt Permitted	1.00	1.00	0.34	1.00	0.95	1.00
Satd. Flow (perm)	3579	1512	635	3579	1789	1512
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	836	25	40	1338	10	13
RTOR Reduction (vph)	0	3	0	0	0	13
Lane Group Flow (vph)	836	22	40	1338	10	0
Heavy Vehicles (%)	2%	8%	2%	2%	2%	8%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	120.2	120.2	120.2	120.2	4.8	4.8
Effective Green, g (s)	120.2	120.2	120.2	120.2	4.8	4.8
Actuated g/C Ratio	0.88	0.88	0.88	0.88	0.04	0.04
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	3.0	3.0
Lane Grp Cap (vph)	3140	1326	557	3140	62	52
v/s Ratio Prot	0.23			c0.37	c0.01	
v/s Ratio Perm		0.01	0.06			0.00
v/c Ratio	0.27	0.02	0.07	0.43	0.16	0.01
Uniform Delay, d1	1.3	1.0	1.1	1.6	64.1	63.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.0	0.2	0.4	1.2	0.1
Delay (s)	1.6	1.1	1.3	2.1	65.4	63.9
Level of Service	A	A	A	A	E	E
Approach Delay (s)	1.5			2.0	64.5	
Approach LOS	A			A	E	

Intersection Summary			
HCM 2000 Control Delay	2.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity	0.42		
Actuated Cycle Length (s)	137.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	53.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	911	49	15	1311	0	53	0	10	0	0	0
Future Volume (vph)	0	911	49	15	1311	0	53	0	10	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0		6.0	6.0				
Lane Util. Factor		0.95	1.00	1.00	0.91		1.00	1.00				
Frt		1.00	0.85	1.00	1.00		1.00	0.85				
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00				
Satd. Flow (prot)		3579	1601	1706	5142		1722	1601				
Flt Permitted		1.00	1.00	0.31	1.00		0.76	1.00				
Satd. Flow (perm)		3579	1601	553	5142		1372	1601				
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	911	49	15	1311	0	53	0	10	0	0	0
RTOR Reduction (vph)	0	0	8	0	0	0	0	9	0	0	0	0
Lane Group Flow (vph)	0	911	41	15	1311	0	53	1	0	0	0	0
Heavy Vehicles (%)	2%	2%	2%	7%	2%	2%	6%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	Perm	Perm	NA		Perm	NA				
Protected Phases		2			6			4			4	
Permitted Phases	2		2	6			4			4		
Actuated Green, G (s)		118.4	118.4	118.4	118.4		9.6	9.6				
Effective Green, g (s)		118.4	118.4	118.4	118.4		9.6	9.6				
Actuated g/C Ratio		0.85	0.85	0.85	0.85		0.07	0.07				
Clearance Time (s)		6.0	6.0	6.0	6.0		6.0	6.0				
Vehicle Extension (s)		5.0	5.0	5.0	5.0		3.0	3.0				
Lane Grp Cap (vph)		3026	1353	467	4348		94	109				
v/s Ratio Prot		0.25			c0.25			0.00				
v/s Ratio Perm			0.03	0.03			c0.04					
v/c Ratio		0.30	0.03	0.03	0.30		0.56	0.01				
Uniform Delay, d1		2.2	1.7	1.7	2.2		63.2	60.8				
Progression Factor		0.84	0.83	0.42	0.35		1.00	1.00				
Incremental Delay, d2		0.2	0.0	0.1	0.2		7.5	0.0				
Delay (s)		2.1	1.5	0.8	1.0		70.7	60.8				
Level of Service		A	A	A	A		E	E				
Approach Delay (s)		2.1			1.0			69.1			0.0	
Approach LOS		A			A			E			A	

Intersection Summary

HCM 2000 Control Delay	3.2	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity	0.32		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	949	22	29	1335	28	11
Future Volume (vph)	949	22	29	1335	28	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3579	1432	1772	3579	1644	1498
Flt Permitted	1.00	1.00	0.30	1.00	0.95	1.00
Satd. Flow (perm)	3579	1432	557	3579	1644	1498
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	949	22	29	1335	28	11
RTOR Reduction (vph)	0	3	0	0	0	10
Lane Group Flow (vph)	949	19	29	1335	28	1
Heavy Vehicles (%)	2%	14%	3%	2%	11%	9%
Turn Type	NA	Perm	Perm	NA	Perm	Perm
Protected Phases	2			6		
Permitted Phases		2	6		4	4
Actuated Green, G (s)	121.3	121.3	121.3	121.3	6.7	6.7
Effective Green, g (s)	121.3	121.3	121.3	121.3	6.7	6.7
Actuated g/C Ratio	0.87	0.87	0.87	0.87	0.05	0.05
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	3100	1240	482	3100	78	71
v/s Ratio Prot	0.27			c0.37		
v/s Ratio Perm		0.01	0.05		c0.02	0.00
v/c Ratio	0.31	0.02	0.06	0.43	0.36	0.01
Uniform Delay, d1	1.7	1.3	1.3	2.0	64.6	63.5
Progression Factor	0.52	0.33	0.30	0.53	1.00	1.00
Incremental Delay, d2	0.2	0.0	0.2	0.4	5.8	0.1
Delay (s)	1.1	0.4	0.6	1.5	70.4	63.6
Level of Service	A	A	A	A	E	E
Approach Delay (s)	1.1			1.5	68.5	
Approach LOS	A			A	E	

Intersection Summary			
HCM 2000 Control Delay	2.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	53.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	958	50	15	1348	35	13
Future Volume (vph)	958	50	15	1348	35	13
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3579	1601	1789	3579	1789	1601
Flt Permitted	1.00	1.00	0.30	1.00	0.95	1.00
Satd. Flow (perm)	3579	1601	556	3579	1789	1601
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	958	50	15	1348	35	13
RTOR Reduction (vph)	0	7	0	0	0	12
Lane Group Flow (vph)	958	43	15	1348	35	1
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	120.7	120.7	120.7	120.7	7.3	7.3
Effective Green, g (s)	120.7	120.7	120.7	120.7	7.3	7.3
Actuated g/C Ratio	0.86	0.86	0.86	0.86	0.05	0.05
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	3.0	3.0
Lane Grp Cap (vph)	3085	1380	479	3085	93	83
v/s Ratio Prot	0.27			c0.38	c0.02	
v/s Ratio Perm		0.03	0.03			0.00
v/c Ratio	0.31	0.03	0.03	0.44	0.38	0.01
Uniform Delay, d1	1.8	1.4	1.4	2.1	64.1	62.9
Progression Factor	1.00	1.00	0.91	0.82	1.00	1.00
Incremental Delay, d2	0.3	0.0	0.1	0.4	2.5	0.0
Delay (s)	2.1	1.4	1.4	2.2	66.7	63.0
Level of Service	A	A	A	A	E	E
Approach Delay (s)	2.0			2.2	65.7	
Approach LOS	A			A	E	

Intersection Summary			
HCM 2000 Control Delay	3.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

E

Appendix E - Turning Movement Calibration Details (GEH check)

AM Peak Period - Turning Movement Calibration Details (GEH Check)

Intersection	Movement	Observed Count	Model Average	Model/Observed	GEH	RMS
Mayfield & Regional Road 50	EBL	132	173	1.31	3.36	1714.81
	EBT	133	128	0.96	0.41	21.6318
	EBR	86	29	0.34	7.51	3244.2
	WBL	544	475	0.87	3.07	4816.32
	WBT	271	282	1.04	0.68	126.109
	WBR	14	1	0.07	4.70	163.73
	NBL	74	26	0.35	6.82	2331.4
	NBT	782	723	0.92	2.15	3489.14
	NBR	114	120	1.06	0.60	41.6121
	SBL	6	0	0.00	3.57	40.5418
	SBT	1277	1343	1.05	1.83	4404.55
	SBR	163	138	0.84	2.07	646.483
Countryside/Nashville & RR50	EBL	7	47	6.71	7.70	1600
	EBT	161	196	1.22	2.62	1225
	EBR	13	0	0.00	5.10	169
	WBL	106	116	1.09	0.95	100
	WBT	115	129	1.12	1.27	196
	WBR	182	152	0.84	2.32	900
	NBL	14	0	0.00	5.29	196
	NBT	781	681	0.87	3.70	10000
	NBR	35	13	0.37	4.49	484
	SBL	171	147	0.86	1.90	576
	SBT	1716	1659	0.97	1.39	3249
	SBR	20	22	1.10	0.44	4
Coleraine Drive/Major Mack & RR50	EBL	0	0	0.00	0.00	0
	EBT	125	99	0.79	2.50	699.285
	EBR	263	286	1.09	1.37	518.874
	WBL	84	66	0.78	2.11	333.881
	WBT	57	84	1.47	3.21	724.665
	WBR	25	11	0.44	3.29	195.15
	NBL	48	74	1.55	3.35	683.383
	NBT	805	686	0.85	4.35	14112.4
	NBR	74	89	1.20	1.68	228.965
	SBL	95	98	1.04	0.34	11.0463
	SBT	1740	1668	0.96	1.75	5245.29
	SBR	0	1	0.00	0.00	1
Sears Entrance & RR50	EBL	1	0	0.00	1.41	1
	EBT	0	0	0.00	0.00	0
	EBR	0	0	0.00	0.00	0
	WBL	85	89	1.05	0.43	16
	WBT	0	0	0.00	0.00	0
	WBR	26	21	0.81	1.03	25
	NBT	900	843	0.94	1.93	3249
	NBR	73	62	0.85	1.34	121
	SBL	18	27	1.50	1.90	81
	SBT	2070	1987	0.96	1.84	6889
	SBR	0	0	0.00	0.00	0
Castlemore & RR50	EBL	119	32	0.27	10.01	7569
	EBT	973	1043	1.07	2.20	4900
	EBR	202	193	0.96	0.64	81
	WBL	105	87	0.83	1.84	324
	WBT	642	675	1.05	1.29	1089
	WBR	149	130	0.87	1.61	361
	NBL	55	47	0.85	1.12	64
	NBT	705	734	1.04	1.08	841
	NBR	88	78	0.89	1.10	100
	SBL	231	153	0.66	5.63	6084
	SBT	1838	1769	0.96	1.62	4761
Castlemore & Apple Valley Way	SBR	86	127	1.48	3.97	1681
	EBT	1260	1235	0.98	0.71	625
	EBR	14	13	0.93	0.27	1
	WBL	8	7	0.88	0.37	1
	WBT	775	842	1.09	2.36	4489

Intersection	Movement	Observed Count	Model Average	Model/Observed	GEH	RMS
Castlemore & Clarkway	NBL	11	19	1.73	2.07	64
	NBR	34	22	0.65	2.27	144
	EBL	96	78	0.81	1.92	319.694
	EBT	1148	1168	1.02	0.58	388.878
	EBR	57	33	0.58	3.59	581.774
	WBL	17	33	1.90	3.12	245.236
	WBT	753	816	1.08	2.23	3916.26
	WBR	15	10	0.65	1.49	28.09
	NBL	49	37	0.76	1.82	143.042
	NBT	20	29	1.42	1.73	73.6164
	NBR	30	33	1.12	0.61	11.6964
	SBL	96	59	0.62	4.19	1360.13
	SBT	164	153	0.93	0.85	113.636
	SBR	35	52	1.50	2.63	299.982
Castlemore & Drummondville/Private Driveway	EBL	0	0	0.00	0.00	0
	EBT	1209	1227	1.01	0.52	324
	EBR	28	18	0.64	2.09	100
	WBL	7	13	1.86	1.90	36
	WBT	830	875	1.05	1.54	2025
	WBR	0	0	0.00	0.00	0
	NBL	51	21	0.41	5.00	900
	NBT	0	0	0.00	0.00	0
	NBR	26	53	2.04	4.30	729
	SBL	0	0	0.00	0.00	0
	SBT	0	0	0.00	0.00	0
	SBR	0	0	0.00	0.00	0
Castlemore & Gardenbrooke	EBT	1207	1201	1.00	0.17	36
	EBR	25	11	0.44	3.30	196
	WBL	19	33	1.74	2.75	196
	WBT	862	859	1.00	0.10	9
	NBL	33	18	0.55	2.97	225
	NBR	30	44	1.47	2.30	196
Castlemore & Bloom	EBT	1204	1166	0.97	1.10	1444
	EBR	10	2	0.20	3.27	64
	WBL	5	12	2.40	2.40	49
	WBT	890	865	0.97	0.84	625
	NBL	39	19	0.49	3.71	400
	NBR	28	48	1.71	3.24	400
	EBL	19	24	1.26	1.06	23.9929
Castlemore & The Gore	EBT	1114	1036	0.93	2.38	6107.55
	EBR	428	485	1.13	2.68	3287.09
	WBL	50	46	0.92	0.56	15.0294
	WBT	852	838	0.98	0.49	205.5
	WBR	27	8	0.30	4.46	343.368
	NBL	225	199	0.88	1.78	674.758
	NBT	61	67	1.11	0.80	40.5624
	NBR	47	65	1.39	2.45	335.141
	SBL	53	67	1.26	1.80	194.312
	SBT	414	349	0.84	3.32	4200.32
	SBR	48	68	1.42	2.66	409.886
The Gore & Countryside	EBL	22	22	0.99	0.06	0.08143
	EBT	244	197	0.81	3.19	2243.27
	EBR	98	140	1.43	3.89	1795.12
	WBL	25	8	0.31	4.27	305.166
	WBT	139	127	0.92	1.02	139.081
	WBR	14	1	0.07	4.70	163.73
	NBL	19	15	0.79	0.99	16.8243
	NBT	77	48	0.62	3.72	868.374
	NBR	10	23	2.41	3.33	180.879
	SBL	30	51	1.72	3.35	453.101
	SBT	392	328	0.84	3.35	4043.15
	SBR	22	34	1.53	2.21	137.233
The Gore & Mayfield	EBL	13	20	1.57	1.80	52.7875
	EBT	564	516	0.92	2.05	2279.71
	EBR	67	85	1.27	2.08	329.201

Intersection	Movement	Observed Count	Model Average	Model/Observed	GEH	RMS
Mayfield & Clarkway/Humber Station	WBL	52	5	0.10	8.80	2208.92
	WBT	546	520	0.95	1.14	690.496
	WBR	5	1	0.19	2.43	18.542
	NBL	12	0	0.00	4.83	136.266
	NBT	71	66	0.93	0.64	27.717
	NBR	31	4	0.13	6.42	716.902
	SBL	17	13	0.77	1.03	15.8351
	SBT	325	325	1.00	0.00	0.00213
	SBR	50	51	1.02	0.16	1.26163
	EBL	8	0	0.00	4.12	72.0744
	EBT	592	504	0.85	3.77	7771.14
	EBR	11	26	2.45	3.60	236.788
	WBL	12	7	0.60	1.53	21.8396
	WBT	586	528	0.90	2.45	3339.32
	WBR	6	0	0.00	3.57	40.5418
	NBL	7	1	0.13	3.13	41.325
	NBT	29	43	1.47	2.30	190.892
	NBR	10	3	0.31	2.62	42.9139
	SBL	6	0	0.00	3.57	40.5418
	SBT	189	190	1.01	0.11	2.10231
	SBR	11	1	0.09	3.99	92.3921
	EBL	248	223	0.90	1.65	641.238
	EBT	316	268	0.85	2.83	2342.84
	EBR	53	11	0.21	7.43	1769.08
Mayfield & Coleraine	WBL	47	0	0.00	9.66	2180.25
	WBT	441	408	0.93	1.59	1067.12
	WBR	21	12	0.57	2.26	85.0851
	NBL	21	1	0.05	6.07	409.017
	NBT	115	139	1.21	2.17	594.849
	NBR	10	43	4.50	6.53	1118.84
	SBL	16	12	0.75	1.05	15.3517
	SBT	348	366	1.05	0.97	333.08
	SBR	142	132	0.93	0.87	104.078
	EBL	42	33	0.79	1.44	77.7924
	EBT	132	229	1.74	7.26	9490.66
	EBR	48	37	0.77	1.68	119.684
	WBL	0	29	0.00	0.00	841
	WBT	135	122	0.91	1.12	159.77
	WBR	14	0	0.00	5.34	203.918
	NBL	15	25	1.63	2.16	94.09
	NBT	89	126	1.41	3.55	1354.24
	NBR	0	0	0.00	0.00	0
	SBL	59	16	0.27	7.04	1862.79
	SBT	341	353	1.04	0.66	151.782
Coleraine & Countryside	SBR	48	10	0.21	7.05	1439.44
	EBL	2	0	0.00	2.04	4.32973
	EBT	204	242	1.18	2.51	1406.7
	EBR	72	26	0.36	6.55	2096.5
	WBL	29	25	0.86	0.79	17.0668
	WBT	164	137	0.83	2.23	751.505
	WBR	4	1	0.24	1.97	9.99571
	NBL	8	2	0.24	2.78	39.9829
	NBT	40	46	1.16	0.99	41.7936
	NBR	18	70	3.96	7.90	2736.67
	SBL	12	1	0.08	4.42	131.901
	SBT	194	220	1.14	1.84	701.487
Countryside & Clarkway	SBR	5	0	0.00	3.23	27.0608

PM Peak Period - Turning Movement Calibration Details (GEH Check)

Intersection	Movement	Observed Count	Model Average	Model/Observed	GEH	RMSE
Mayfield & Regional Road 50	EBL	191	181	0.95	0.73	100.349
	EBT	276	293	1.06	0.99	277.444
	EBR	68	25	0.37	6.30	1841.9
	WBL	161	152	0.94	0.74	86.5573
	WBT	231	243	1.05	0.78	145.531
	WBR	33	22	0.67	2.08	118.754
	NBL	97	16	0.17	10.74	6491.51
	NBT	1086	1066	0.98	0.61	406.596
	NBR	608	570	0.94	1.57	1449.49
	SBL	15	1	0.07	4.92	192.014
	SBT	1240	1263	1.02	0.66	541.998
	SBR	212	226	1.06	0.93	189.294
Countryside/Nashville & RR50	EBL	14	40	2.86	5.00	676
	EBT	162	169	1.04	0.54	49
	EBR	4	0	0.00	2.83	16
	WBL	31	37	1.19	1.03	36
	WBT	160	233	1.46	5.21	5329
	WBR	238	156	0.66	5.84	6724
	NBL	38	0	0.00	8.72	1444
	NBT	1539	1460	0.95	2.04	6241
	NBR	59	34	0.58	3.67	625
	SBL	238	243	1.02	0.32	25
	SBT	1187	1161	0.98	0.76	676
	SBR	44	14	0.32	5.57	900
Coleraine Drive/Major Mack & RR50	EBL	1	0	0.00	1.44	1.08243
	EBT	55	75	1.37	2.49	402.837
	EBR	104	114	1.10	0.95	99.2016
	WBL	76	102	1.34	2.76	678.644
	WBT	100	116	1.16	1.56	262.842
	WBR	97	50	0.52	5.46	2186.24
	NBL	222	264	1.19	2.72	1797.32
	NBT	1539	1447	0.94	2.37	8375.91
	NBR	79	86	1.09	0.76	48.0194
	SBL	155	115	0.74	3.44	1601.57
	SBT	1050	1070	1.02	0.62	412.805
	SBR	25	0	0.00	7.07	623.481
Sears Entrance & RR50	EBL	0	0	0.00	0.00	0
	EBT	0	0	0.00	0.00	0
	EBR	0	0	0.00	0.00	0
	WBL	135	62	0.46	7.36	5329
	WBT	0	0	0.00	0.00	0
	WBR	26	94	3.62	8.78	4624
	NBT	1813	1735	0.96	1.85	6084
	NBR	86	70	0.81	1.81	256
	SBL	7	22	3.14	3.94	225
	SBT	1223	1266	1.04	1.22	1849
	SBR	0	0	0.00	0.00	0
Castlemore & RR50	EBL	96	113	1.18	1.66	289
	EBT	651	700	1.08	1.89	2401
	EBR	102	89	0.87	1.33	169
	WBL	135	167	1.24	2.60	1024
	WBT	1041	1041	1.00	0.00	0
	WBR	224	177	0.79	3.32	2209
	NBL	178	243	1.37	4.48	4225
	NBT	1580	1513	0.96	1.70	4489
	NBR	154	153	0.99	0.08	1
	SBL	172	112	0.65	5.04	3600
	SBT	1027	1004	0.98	0.72	529
	SBR	159	197	1.24	2.85	1444
Castlemore & Apple Valley Way	EBT	836	900	1.08	2.17	4096
	EBR	25	27	1.08	0.39	4
	WBL	40	37	0.93	0.48	9
	WBT	1338	1445	1.08	2.87	11449
	NBL	10	17	1.70	1.91	49

Intersection	Movement	Observed Count	Model Average	Model/Observed	GEH	RMSE
Castlemore & Clarkway	NBR	13	5	0.38	2.67	64
	EBL	38	74	1.96	4.85	1314.79
	EBT	794	865	1.09	2.47	5046.68
	EBR	73	73	0.99	0.05	0.1936
	WBL	34	73	2.17	5.39	1547.64
	WBT	1224	1256	1.03	0.90	1007.43
	WBR	90	125	1.39	3.40	1241.86
	NBL	84	61	0.73	2.66	512.57
	NBT	86	109	1.27	2.36	542.89
	NBR	30	29	0.98	0.11	0.3364
	SBL	38	26	0.69	2.08	137.828
	SBT	87	44	0.51	5.28	1821.58
	SBR	18	58	3.16	6.42	1571.33
Castlemore & Drummondville/Private Driveway	EBL	0	0	0.00	0.00	0
	EBT	911	997	1.09	2.78	7396
	EBR	49	24	0.49	4.14	625
	WBL	15	36	2.40	4.16	441
	WBT	1311	1327	1.01	0.44	256
	WBR	0	0	0.00	0.00	0
	NBL	53	40	0.75	1.91	169
	NBT	0	0	0.00	0.00	0
	NBR	10	21	2.10	2.79	121
	SBL	0	0	0.00	0.00	0
	SBT	0	0	0.00	0.00	0
	SBR	0	0	0.00	0.00	0
Castlemore & Gardenbrooke	EBT	949	1005	1.06	1.79	3136
	EBR	22	19	0.86	0.66	9
	WBL	29	34	1.17	0.89	25
	WBT	1335	1322	0.99	0.36	169
	NBL	28	14	0.50	3.06	196
	NBR	11	24	2.18	3.11	169
Castlemore & Bloom	EBT	958	991	1.03	1.06	1089
	EBR	50	36	0.72	2.13	196
	WBL	15	28	1.87	2.80	169
	WBT	1348	1307	0.97	1.13	1681
	NBL	35	16	0.46	3.76	361
	NBR	13	30	2.31	3.67	289
	EBL	68	61	0.90	0.86	47.8492
Castlemore & The Gore	EBT	914	957	1.05	1.40	1832.44
	EBR	219	188	0.86	2.15	936.902
	WBL	45	55	1.23	1.48	108.77
	WBT	1251	1196	0.96	1.59	3075.2
	WBR	87	89	1.02	0.21	3.92414
	NBL	306	354	1.16	2.66	2339.86
	NBT	323	284	0.88	2.25	1542.83
	NBR	66	54	0.82	1.52	139.12
	SBL	28	17	0.62	2.24	112.178
	SBT	68	84	1.24	1.86	263.302
	SBR	40	30	0.74	1.74	106.624
The Gore & Countryside	EBL	18	22	1.22	0.88	15.6774
	EBT	197	220	1.11	1.57	511.452
	EBR	42	18	0.42	4.45	597.72
	WBL	7	17	2.29	2.74	91.6145
	WBT	326	332	1.02	0.34	38.5535
	WBR	19	55	2.88	5.90	1288.68
	NBL	105	102	0.97	0.30	9.3611
	NBT	350	291	0.83	3.31	3504.48
	NBR	23	29	1.24	1.11	31.9612
	SBL	10	0	0.00	4.37	91.2192
	SBT	86	85	0.99	0.10	0.91747
The Gore &	SBR	15	4	0.27	3.54	117.873
	EBL	37	37	1.00	0.02	0.02024
	EBT	659	655	0.99	0.14	12.8287
	EBR	19	10	0.52	2.39	82.8417
	WBL	20	6	0.30	3.92	200.589

Intersection	Movement	Observed Count	Model Average	Model/Observed	GEH	RMSE
Mayfield & Clarkway/Humber Station	WBT	720	675	0.94	1.71	2051.61
	WBR	30	24	0.81	1.10	32.6478
	NBL	66	91	1.38	2.85	635.297
	NBT	267	262	0.98	0.33	29.4243
	NBR	31	8	0.26	5.17	518.702
	SBL	13	9	0.71	1.13	13.9465
	SBT	71	74	1.04	0.31	6.93564
	SBR	12	13	1.11	0.38	1.76016
	EBL	15	23	1.55	1.87	66.3099
	EBT	676	637	0.94	1.51	1490.08
	EBR	12	0	0.00	4.83	136.266
	WBL	6	11	1.73	1.57	21.4624
	WBT	740	667	0.90	2.75	5330.25
	WBR	28	24	0.87	0.71	12.8982
	NBL	13	46	3.61	6.14	1106.59
	NBT	135	130	0.96	0.45	26.443
	NBR	13	9	0.71	1.13	13.9465
	SBL	6	3	0.47	1.56	11.3384
	SBT	54	71	1.30	2.08	272.591
	SBR	17	2	0.12	4.86	224.38
	EBL	178	189	1.06	0.79	114.855
	EBT	486	452	0.93	1.57	1158.26
	EBR	31	3	0.10	6.76	771.452
Mayfield & Coleraine	WBL	14	1	0.07	4.70	163.73
	WBT	486	448	0.92	1.76	1446.53
	WBR	40	22	0.55	3.28	335.839
	NBL	55	9	0.16	8.15	2132.85
	NBT	280	267	0.95	0.77	163.627
	NBR	22	31	1.39	1.69	75.9448
	SBL	27	13	0.49	3.04	183.066
	SBT	167	173	1.04	0.49	40.8365
	SBR	232	245	1.05	0.82	158.645
	EBL	45	33	0.74	1.90	141.134
	EBT	145	204	1.41	4.48	3499.91
	EBR	14	45	3.15	5.64	943.718
Coleraine & Countryside	WBL	2	24	11.76	6.09	482.242
	WBT	199	220	1.10	1.44	431.808
	WBR	41	0	0.00	9.03	1664.64
	NBL	74	124	1.67	4.97	2454.21
	NBT	271	254	0.94	1.07	299.982
	NBR	1	0	0.00	1.43	1.0404
	SBL	34	10	0.30	5.06	559.796
	SBT	144	142	0.99	0.18	4.41
	SBR	34	26	0.77	1.40	58.6756
	EBL	10	3	0.29	2.86	54.8192
	EBT	170	225	1.33	3.94	3065.22
	EBR	50	10	0.20	7.30	1595.14
Countryside & Clarkway	WBL	36	44	1.21	1.20	57.5474
	WBT	293	321	1.10	1.61	791.454
	WBR	4	14	3.36	3.26	96.7941
	NBL	49	82	1.68	4.09	1095.69
	NBT	146	175	1.20	2.32	861.07
	NBR	35	44	1.24	1.37	74.4148
	SBL	6	3	0.48	1.51	10.5132
	SBT	56	76	1.35	2.44	392.769
	SBR	10	2	0.19	3.37	70.6272

F

Appendix F - Travel Time Validation Details

AM Peak Period - Travel Time Validation Details

Corridor Name	Movement	Section	ID	Observed TT	Model Average	Model/Observed	Diff	Diff %	RMS
Castlemore Rd. / RR50 / Mayfield Rd. / The Gore Rd.	EB	Gore - Bloom	1	23	21.40	0.93	-1.60	-7%	2.54933
		Bloom - Gardenbrooke	2	23	27.32	1.19	4.32	19%	18.6998
		Gardenbrooke - Drummondville	3	22	19.70	0.90	-2.30	-10%	5.27204
		Drummondville - Clarkway	4	38	21.87	0.58	-16.13	-42%	260.023
		Clarkway - Apple Valley	5	21	21.10	1.00	0.10	0%	0.00932
		Apple Valley - RR50	6	64	53.39	0.83	-10.61	-17%	112.58
		Total		**191.00**	**164.79**	**0.86**	**-26.21**	**-14%**	**686.833**
	WB	RR 50 - Apple Valley	7	26	24.49	0.94	-1.51	-6%	2.28978
		Apple Valley - Clarkway	8	24	27.80	1.16	3.80	16%	14.46
		Clarkway - Drummondville	9	34	18.72	0.55	-15.28	-45%	233.466
		Drummondville - Gardenbrooke	10	21	22.37	1.07	1.37	7%	1.88764
		Gardenbrooke - Bloom	11	18	20.48	1.14	2.48	14%	6.15612
		Bloom - Gore	12	22	33.54	1.52	11.54	52%	133.173
		Total		**145.00**	**147.40**	**1.02**	**2.40**	**2%**	**5.78384**
	NB	Castlemore - Sears	13	62	81.55	1.32	19.55	32%	382.347
		Sears - Coleraine	14	40	61.29	1.53	21.29	53%	453.46
		Coleraine - Countryside	15	99	108.91	1.10	9.91	10%	98.2421
		Countryside - Mayfield	16	93	85.75	0.92	-7.25	-8%	52.5808
		Total		**294.00**	**337.51**	**1.15**	**43.51**	**15%**	**1893.01**
	SB	Mayfield - Countryside	17	75	85.66	1.14	10.66	14%	113.567
		Countryside- Coleraine	18	142	115.96	0.82	-26.04	-18%	678.245
		Coleraine - Sears	19	55	55.63	1.01	0.63	1%	0.39283
		Sears - Castlemore	20	84	113.70	1.35	29.70	35%	882.263
		Total		**356.00**	**370.94**	**1.04**	**14.94**	**4%**	**223.304**
	WB	RR 50 - Coleraine	21	84	94.93	1.13	10.93	13%	119.572
		Coleraine - Clarkway	22	75	75.14	1.00	0.14	0%	0.0197
		Clarkway - Gore	23	123	92.07	0.75	-30.93	-25%	956.43
		Total		**282.00**	**262.15**	**0.93**	**-19.85**	**-7%**	**394.06**
	EB	Gore - Clarkway	24	78	85.64	1.10	7.64	10%	58.4021
		Clarkway - Coleraine	25	85	72.05	0.85	-12.95	-15%	167.662
		Coleraine - RR50	26	139	111.24	0.80	-27.76	-20%	770.698
		Total		**302.00**	**268.93**	**0.89**	**-33.07**	**-11%**	**1093.48**
	SB	Mayfield - Countryside	27	101	79.55	0.79	-21.45	-21%	460.179
		Countryside - Castlemore	28	172	188.15	1.09	16.15	9%	260.894
		Total		**273.00**	**267.70**	**0.98**	**-5.30**	**-2%**	**28.0854**
	NB	Castlemore- Countryside	29	168	171.11	1.02	3.11	2%	9.68051
		Countryside - Mayfield	30	101	111.97	1.11	10.97	11%	120.401
		Total		**269.00**	**283.08**	**1.05**	**14.08**	**5%**	**198.361**

PM Peak Period - Travel Time Validation Details

Corridor Name	Movement	Section	ID	Observed TT	Model Average	Model/Observed	Diff	Diff %	RMSE
Castlemore Rd.	EB	Gore - Bloom	1	21	21.34	1.02	0.34	2%	0.11474
		Bloom - Gardenbrooke	2	19	22.81	1.20	3.81	20%	14.5303
		Gardenbrooke - Drummondville	3	23	19.53	0.85	-3.47	-15%	12.0453
		Drummondville - Clarkway	4	15	21.76	1.45	6.76	45%	45.7453
		Clarkway - Apple Valley	5	19	21.61	1.14	2.61	14%	6.79683
		Apple Valley - RR50	6	88	71.91	0.82	-16.09	-18%	258.998
		Total		**185.00**	**178.96**	**0.97**	**-6.04**	**-3%**	**36.516**
RR50	WB	RR 50 - Apple Valley	7	23	24.05	1.05	1.05	5%	1.10704
		Apple Valley - Clarkway	8	21	22.13	1.05	1.13	5%	1.27516
		Clarkway - Drummondville	9	18	17.84	0.99	-0.16	-1%	0.02569
		Drummondville - Gardenbrooke	10	17	19.33	1.14	2.33	14%	5.43953
		Gardenbrooke - Bloom	11	29	20.29	0.70	-8.71	-30%	75.7905
		Bloom - Gore	12	21	37.28	1.78	16.28	78%	265.006
		Total		**129.00**	**140.93**	**1.09**	**11.93**	**9%**	**142.244**
	NB	Castlemore - Sears	13	69	85.75	1.24	16.75	24%	280.41
		Sears - Coleraine	14	65	67.67	1.04	2.67	4%	7.11121
		Coleraine - Countryside	15	113	112.58	1.00	-0.42	0%	0.17344
		Countryside - Mayfield	16	91	86.84	0.95	-4.16	-5%	17.3408
		Total		**338.00**	**352.83**	**1.04**	**14.83**	**4%**	**219.971**
Mayfield Rd.	SB	Mayfield - Countryside	17	78	88.06	1.13	10.06	13%	101.294
		Countryside- Coleraine	18	109	112.01	1.03	3.01	3%	9.03795
		Coleraine - Sears	19	49	51.88	1.06	2.88	6%	8.27849
		Sears - Castlemore	20	71	97.94	1.38	26.94	38%	725.664
		Total		**307.00**	**349.89**	**1.14**	**42.89**	**14%**	**1839.23**
	WB	RR 50 - Coleraine	21	77	92.52	1.20	15.52	20%	240.92
		Coleraine - Clarkway	22	74	80.56	1.09	6.56	9%	42.9816
		Clarkway - Gore	23	101	89.07	0.88	-11.93	-12%	142.323
		Total		**252.00**	**262.15**	**1.04**	**10.15**	**4%**	**102.977**
The Gore Rd.	EB	Gore - Clarkway	24	80	91.10	1.14	11.10	14%	123.113
		Clarkway - Coleraine	25	69	72.65	1.05	3.65	5%	13.2943
		Coleraine - RR50	26	121	114.84	0.95	-6.16	-5%	37.9228
		Total		**270.00**	**278.58**	**1.03**	**8.58**	**3%**	**73.6787**
	SB	Mayfield - Countryside	27	73	76.45	1.05	3.45	5%	11.8691
		Countryside - Castlemore	28	185	181.71	0.98	-3.29	-2%	10.8081
		Total		**258.00**	**258.16**	**1.00**	**0.16**	**0%**	**0.02483**
	NB	Castlemore- Countryside	29	192	178.22	0.93	-13.78	-7%	189.956
		Countryside - Mayfield	30	125	127.85	1.02	2.85	2%	8.13238
		Total		**317.00**	**306.07**	**0.97**	**-10.93**	**-3%**	**119.481**
		Countryside - RR50	42	164	131.33	0.80	-32.67	-20%	1067.26
		Total		**253.00**	**218.47**	**0.86**	**-34.53**	**-14%**	**1191.98**
	NB	RR50 - Countryside	43	113	123.78	1.10	10.78	10%	116.239
		Countryside - Mayfield	44	129	111.22	0.86	-17.78	-14%	316.209
		Total		**242.00**	**235.00**	**0.97**	**-7.00**	**-3%**	**49.0122**

G

Appendix G - Critical Intersections MOE

2031 AM Critical Intersections

Table 1. 2031 AM - Major Mackenzie Dr./Highway 50

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	94	5	22	61	A
NBT	395	56	20	55	E
NBL	191	68	20	55	E
EBT	1419	40	43	191	D
EBR	682	22	48	199	C
EBL	50	44	43	191	D
SBL	472	56	30	98	E
SBT	830	43	30	98	D
SBR	69	7	31	102	A
WBL	102	20	8	66	B
WBR	693	6	10	73	A
WBT	1072	13	8	66	B
Overall	6068	32	27	199	C

Table 2. 2031 AM - Arterial A2 / Coleraine Dr.

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
SBR	6	27	74	268	C
SBL	726	64	74	268	E
EBL	112	29	20	104	C
EBT	1436	24	20	104	C
WBR	658	8	3	60	A
WBT	672	21	12	84	C
Overall	3610	29	27	268	C

2031 PM Critical Intersections

Table 3. 2031 PM - Major Mackenzie/Highway 50

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	69	18	54	217	B
NBT	1380	44	52	211	D
NBL	547	56	52	211	E
EBT	840	34	19	83	C
EBR	266	6	22	90	A
EBL	12	57	19	83	E
SBL	694	61	39	167	E
SBT	533	28	39	167	C
SBR	33	5	34	169	A
WBL	57	31	35	136	C
WBR	678	14	40	144	B
WBT	1622	35	35	136	D
Overall	6731	37	37	218	D

Table 4. 2031 PM - Arterial A2/Coleraine Dr.

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
SBR	44	13	49	182	B
SBL	400	69	49	182	E
EBL	56	18	3	48	B
EBT	723	8	3	48	A
WBR	941	20	16	116	B
WBT	1253	20	30	138	B
Overall	3417	23	24	182	C

2041 AM Critical Intersections

Table 5. 2041 AM - Major Mackenzie/Highway 50

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	82	17	51	154	B
NBT	601	71	47	149	E
NBL	412	102	47	149	F
EBT	1339	44	81	273	D
EBR	834	51	86	281	D
EBL	80	50	81	273	D
SBL	423	65	79	250	E
SBT	1157	88	79	250	F
SBR	57	40	83	254	D
WBL	79	24	10	76	C
WBR	529	5	13	84	A
WBT	1311	15	10	76	B
Overall	6904	50	56	291	B

Table 6. 2041 AM - Clarkway / Castlemore

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBT	228.0	50.4	14.0	49.5	D
NBL	96.0	56.0	14.0	49.5	E
NBR	244.0	12.0	14.7	50.5	B
EBL	104.0	26.6	26.8	153.6	C
EBT	1580.0	26.7	26.8	153.6	C
EBR	137.0	11.1	28.3	156.6	B
SBR	49.0	39.1	105.3	308.9	D
SBL	605.0	114.6	105.0	306.9	F
SBT	323.0	83.0	105.0	306.9	F
WBR	716.0	5.8	12.2	69.5	A
WBT	434.0	25.3	12.2	69.5	C
WBL	112.0	60.8	12.2	69.5	E
Overall	4628.0	40.4	43.8	308.9	D

Table 7. 2041 AM - Highway 50/Castlemore

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
SBR	115	115	13	24	B
SBL	318	318	79	50	E
SBT	1207	1207	57	50	E
EBT	1498	0		50	D
EBR	406	1498	36	50	B
EBL	565	406	17	48	E
NBL	342	565	65	50	E
NBR	157	342	80	32	A
NBT	798	157	6	28	D
WBT	787	798	40	32	D
WBL	85	0		32	E
WBR	375	787	38	21	A
Overall	6654	85	62	21	D

Table 8. 2041 AM - ArterialA2 / Coleraine

Movement	**Volume**	**Delay (s)**	**Avg. Queue (m)**	**Max. Queue (m)**	**LOS**
SBR	7	40	88	263	D
SBL	697	86	88	263	F
EBL	117	43	39	188	D
EBT	1602	40	39	188	D
WBR	921	12	8	76	B
WBT	855	30	22	100	C
Overall	4199	39	39	266	D

2041 PM Critical Intersections

Table 9. 2041 PM - Major Mackenzie/Highway 50

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	32	18	63	254	B
NBT	1632	43	62	249	D
NBL	621	62	62	249	E
EBT	927	42	27	121	D
EBR	599	13	31	128	B
EBL	9	61	27	121	E
SBL	612	53	34	126	D
SBT	726	33	34	126	C
SBR	70	7	34	130	A
WBL	73	30	30	125	C
WBR	573	13	35	133	B
WBT	1509	33	30	125	C
Overall	7382	37	39	254	D

Table 10. 2041 PM - Arterial A2/Coleraine

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
SBR	51	37	84	244	D
SBL	532	88	84	244	F
EBL	110	26	8	75	C
EBT	1014	13	8	75	B
WBR	873	19	16	111	B
WBT	1323	24	30	135	C
Overall	3901	29	34	244	C

Table 11. 2041 PM - Highway 50 / Mayfield

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBL	7	36	46	245	D
NBR	829	30	48	249	C
NBT	1300	33	46	245	C
WBT	457	43	46	127	D
WBL	533	59	46	127	E
WBR	0		45	130	A
EBT	458	53	34	153	D
EBR	6	13	34	154	B
EBL	407	46	34	153	D
SBR	29	5	14	79	A
SBL	0		14	78	A
SBT	658	25	14	78	C
Overall	4683	38	35	249	D

2041 AM Alternative Critical Intersections

Table 12. 2041 AM Coleraine Realignment Alternative - Major Mackenzie/Highway 50

Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	80	6	33	86	A
NBT	622	52	31	80	D
NBL	437	60	31	80	E
EBT	1047	41	54	225	D
EBR	815	38	60	232	D
EBL	78	50	54	225	D
SBL	702	70	59	243	E
SBT	1148	46	59	243	D
SBR	36	15	61	248	B
WBL	59	21	13	75	C
WBR	638	6	16	82	A
WBT	1220	19	13	75	B
Overall	6882	39	41	296	D

Table 13. 2041 AM Coleraine Realignment Alternative - Arterial A2/Coleraine Dr.

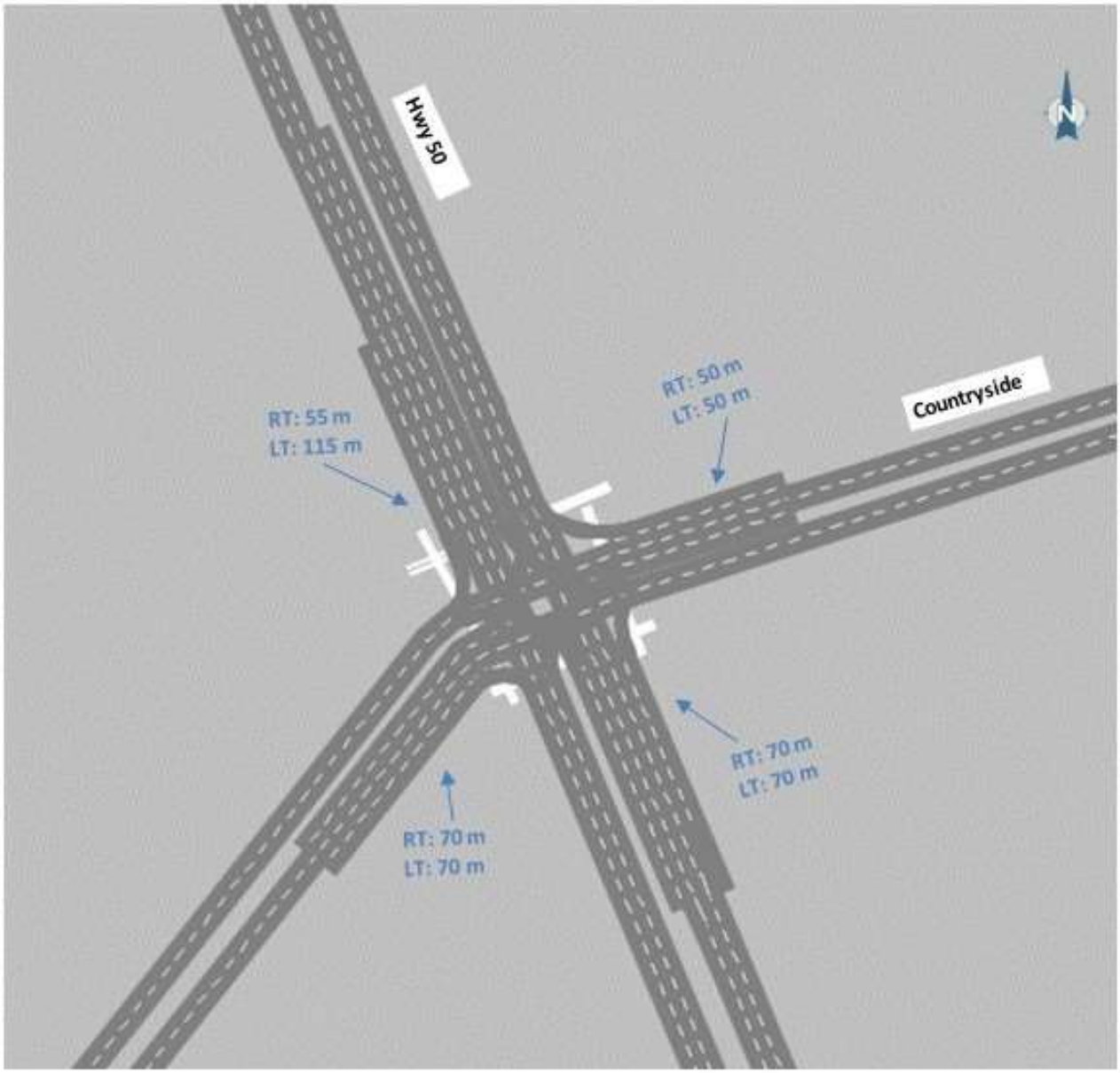
Movement	Volume	Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
SBT	41	45	46	150	D
SBR	2	30	56	163	C
SBL	471	63	46	150	E
NBL	45	57	120	199	E
NBR	325	51	128	208	D
NBT	266	61	120	199	E
WBL	275	54	23	93	D
WBT	595	27	23	93	C
WBR	809	9	25	101	A
EBR	23	6	35	126	A
EBT	1176	35	30	117	C
EBL	225	55	30	117	E
Overall	4251	37	58	228	D

H

Appendix H - 2041 Proposed Alternative Configurations

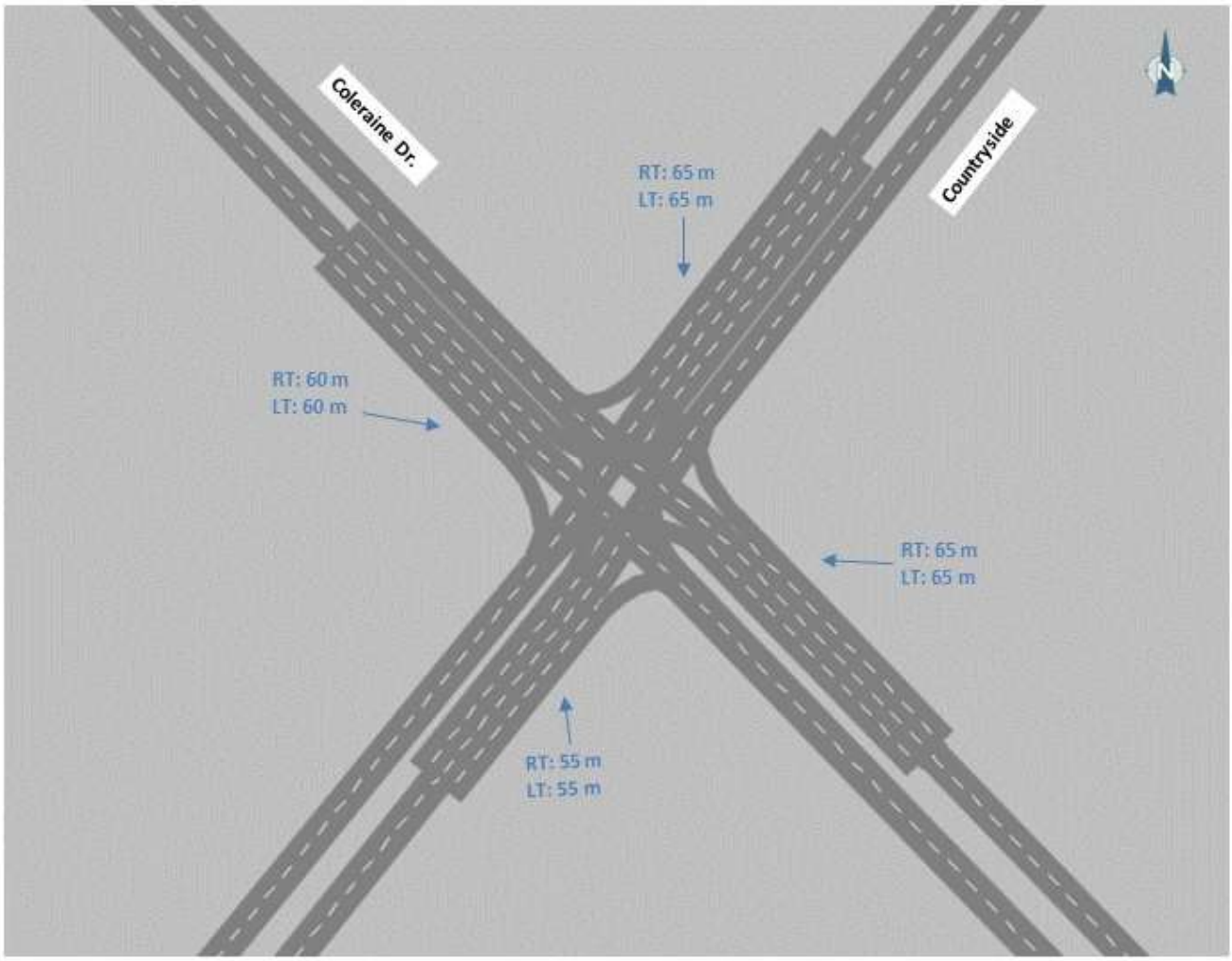
2041 Lane Configuration

Mayfield Rd./Coleraine Dr.



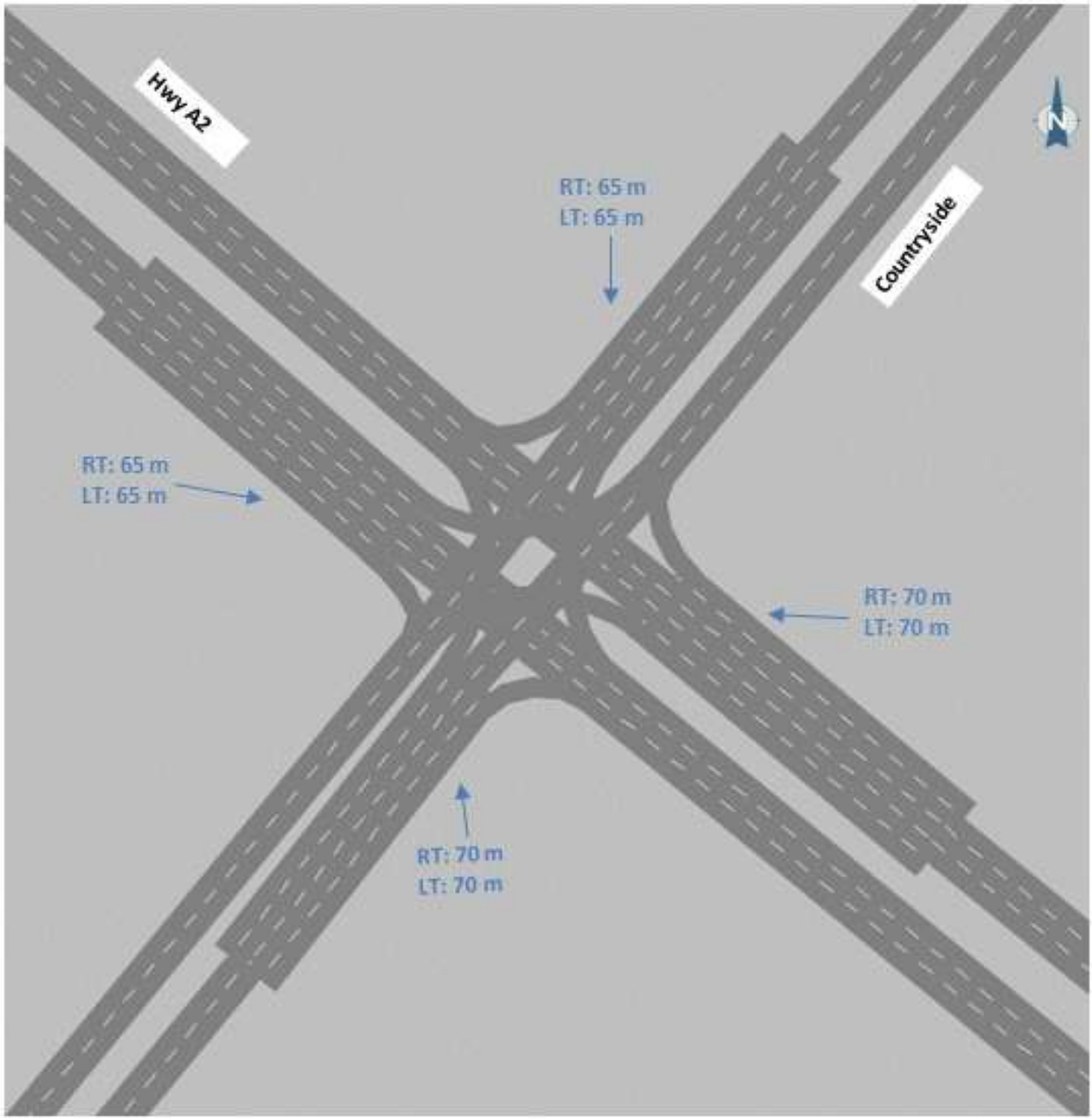
2041 Lane Configuration

Countryside/Coleraine Dr.



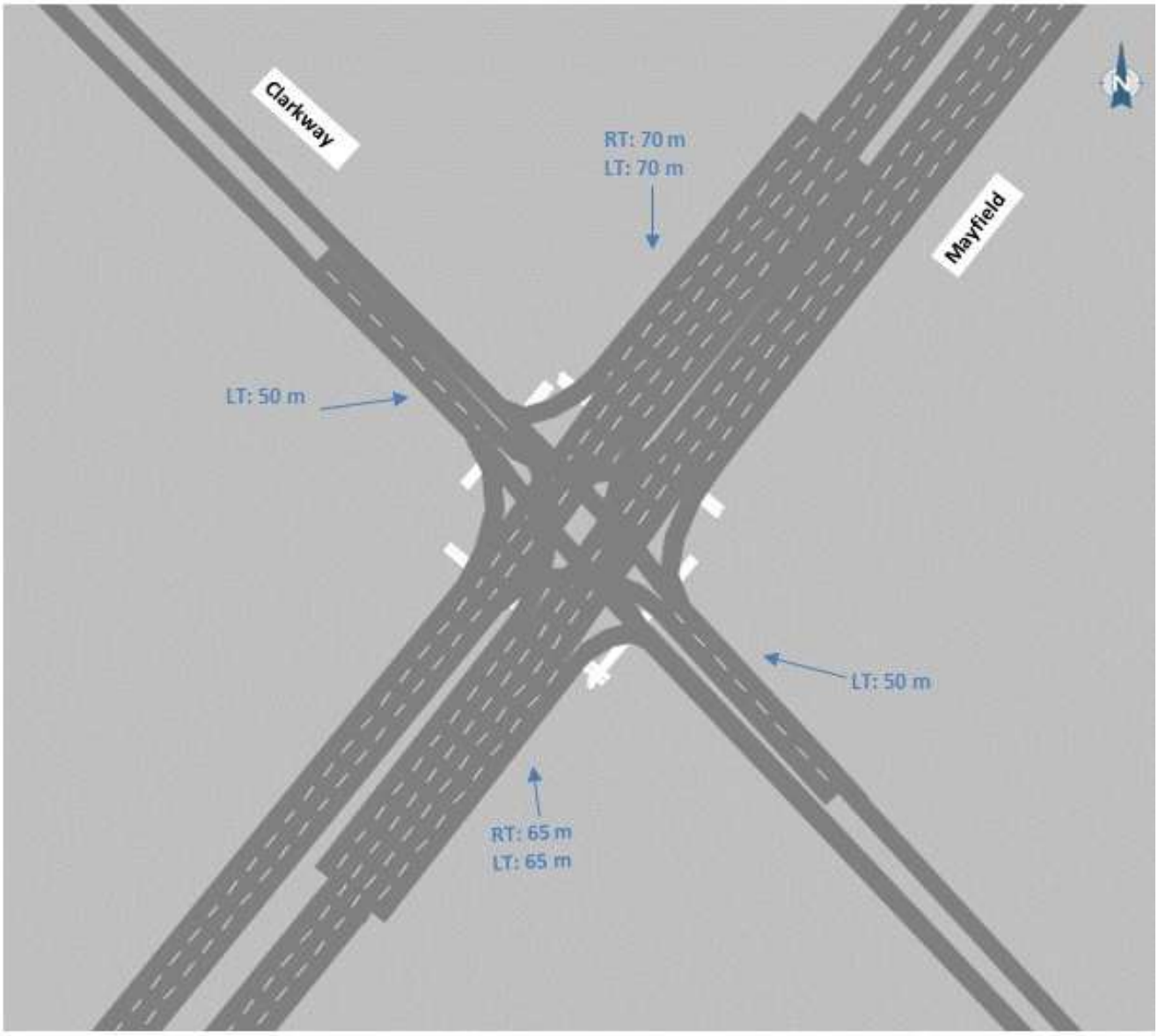
2041 Lane Configuration

Countryside/ Hwy A2



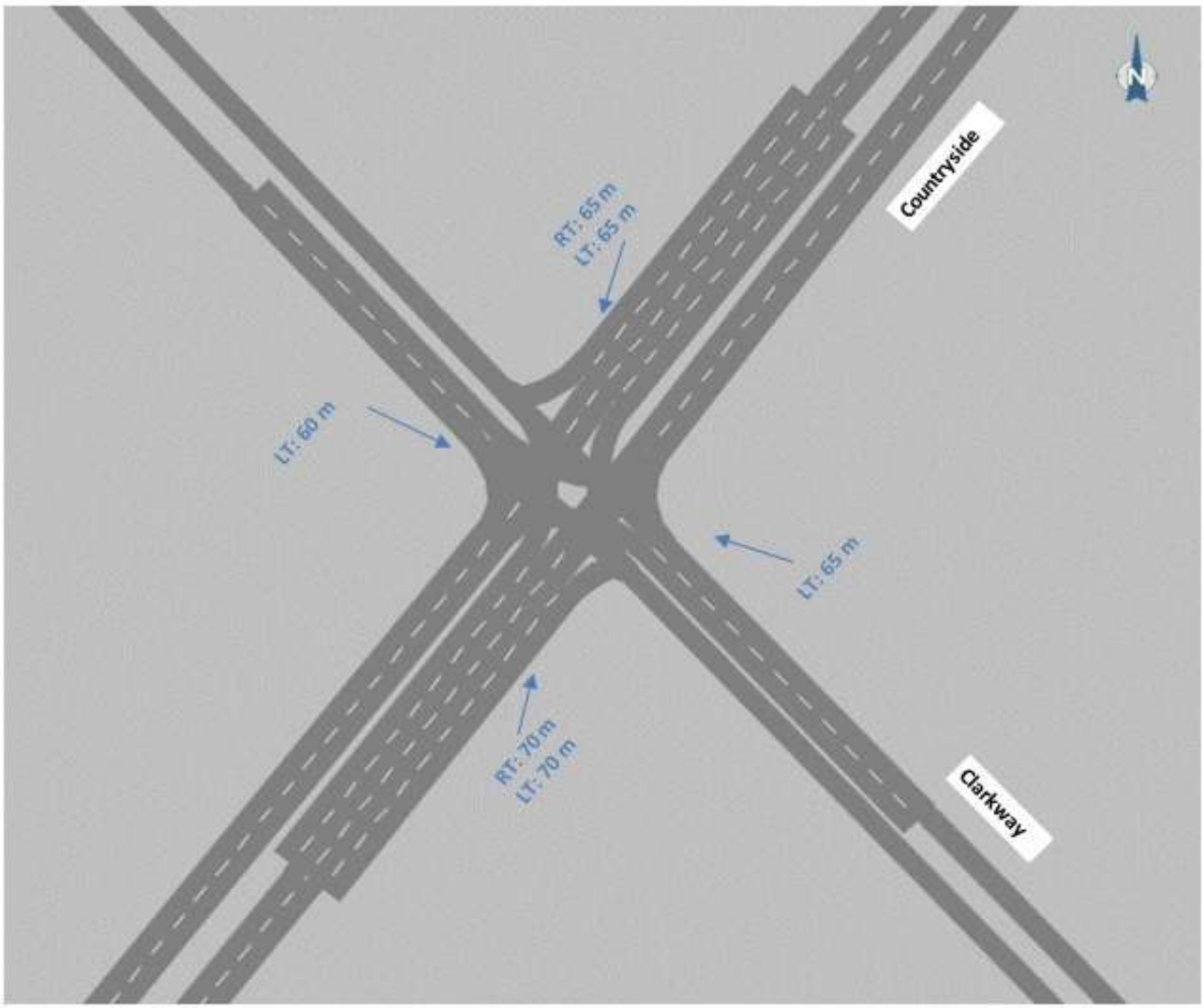
2041 Lane Configuration

Clarkway/ Mayfield



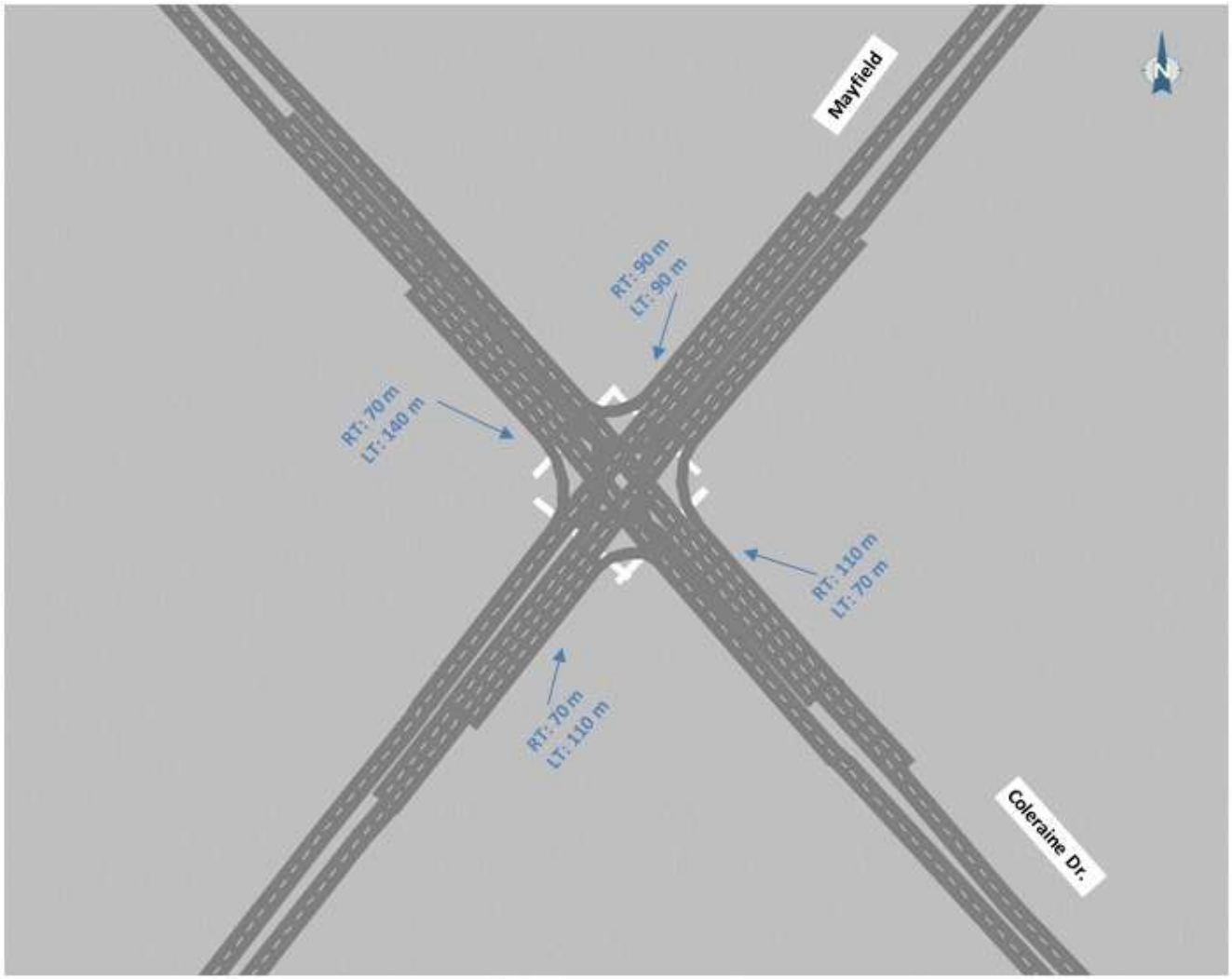
2041 Lane Configuration

Countryside/Clarkway



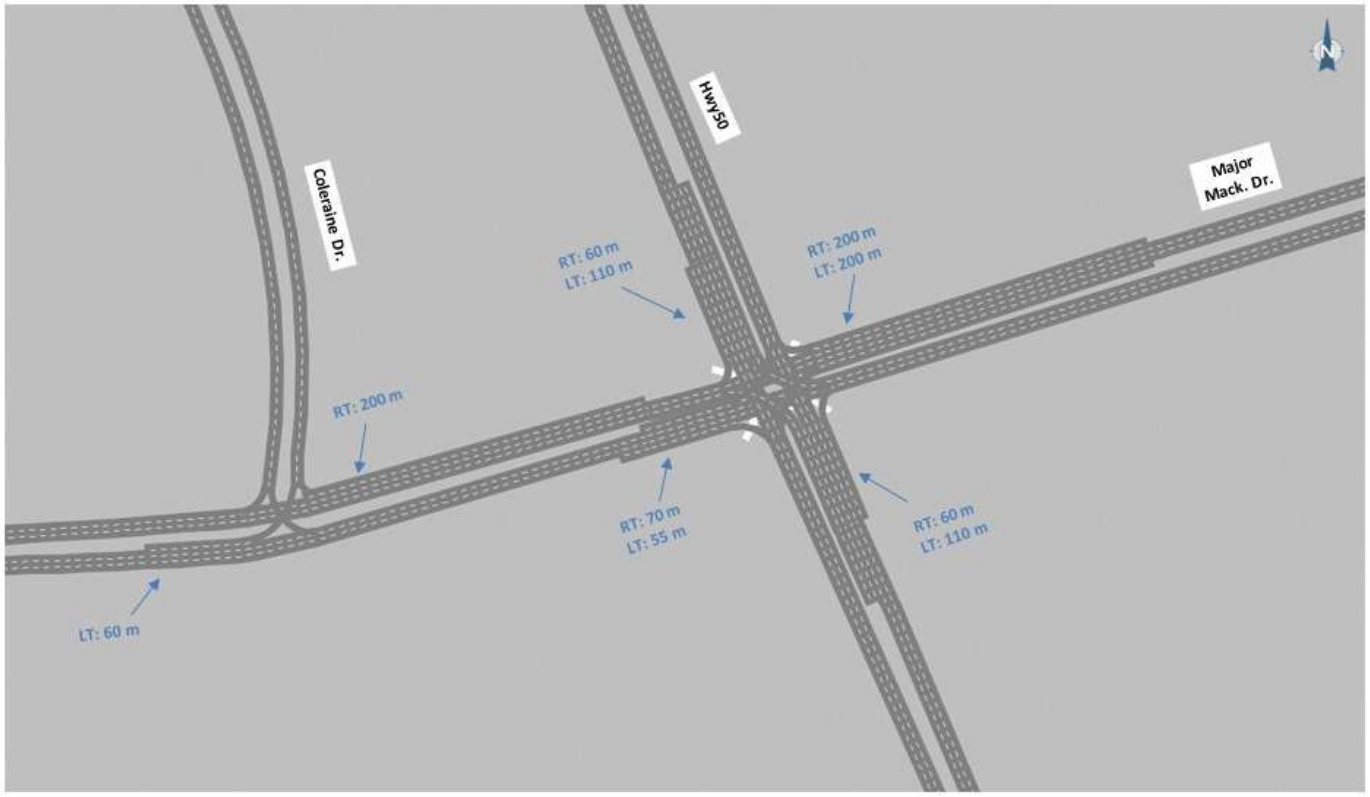
2041 Lane Configuration

Mayfield Rd./Coleraine Dr.



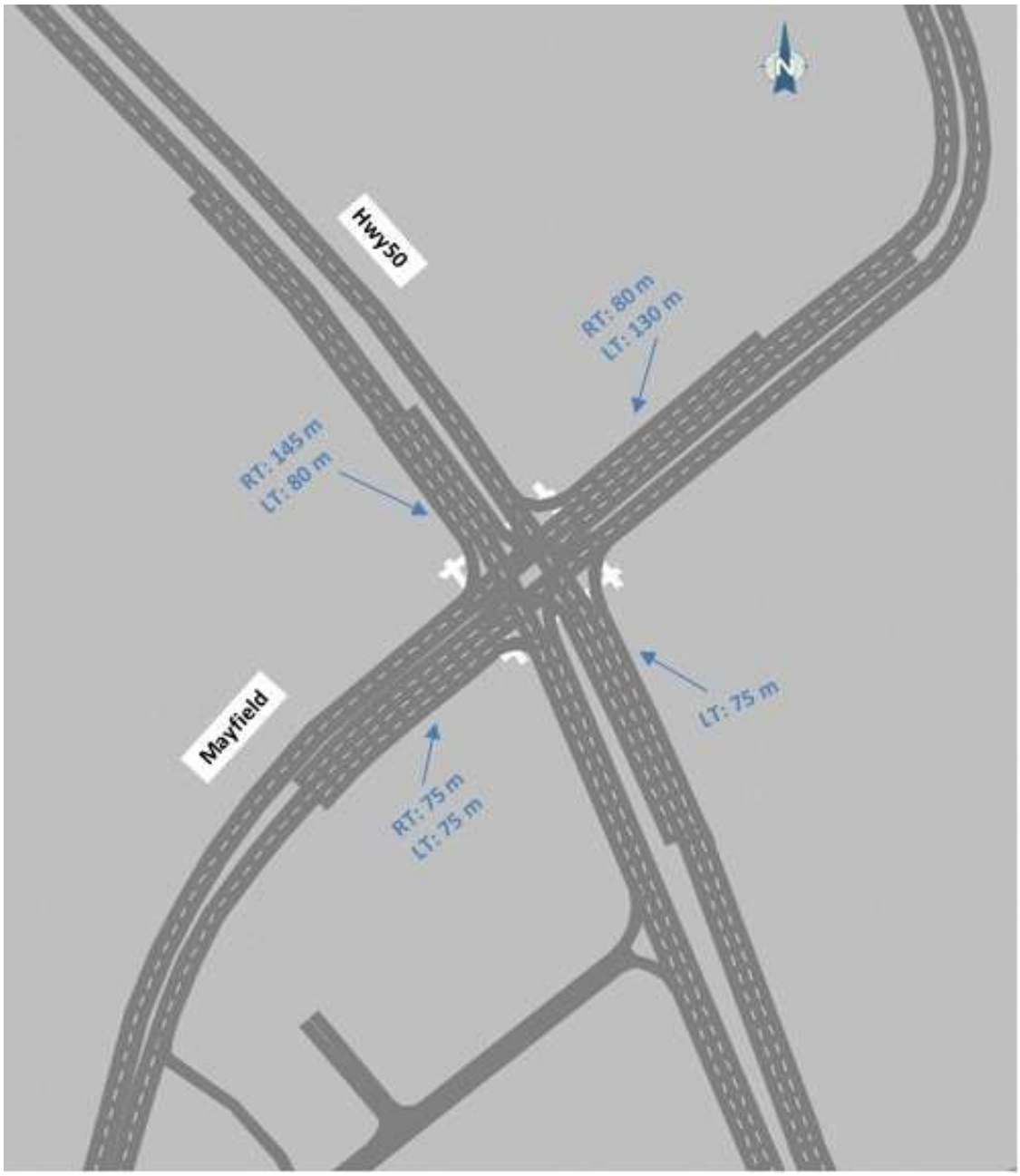
Critical Intersection Storage Length – 2031 & 2041

Arterial A2/ Coleraine Dr. and Major Mack/ Hwy 50



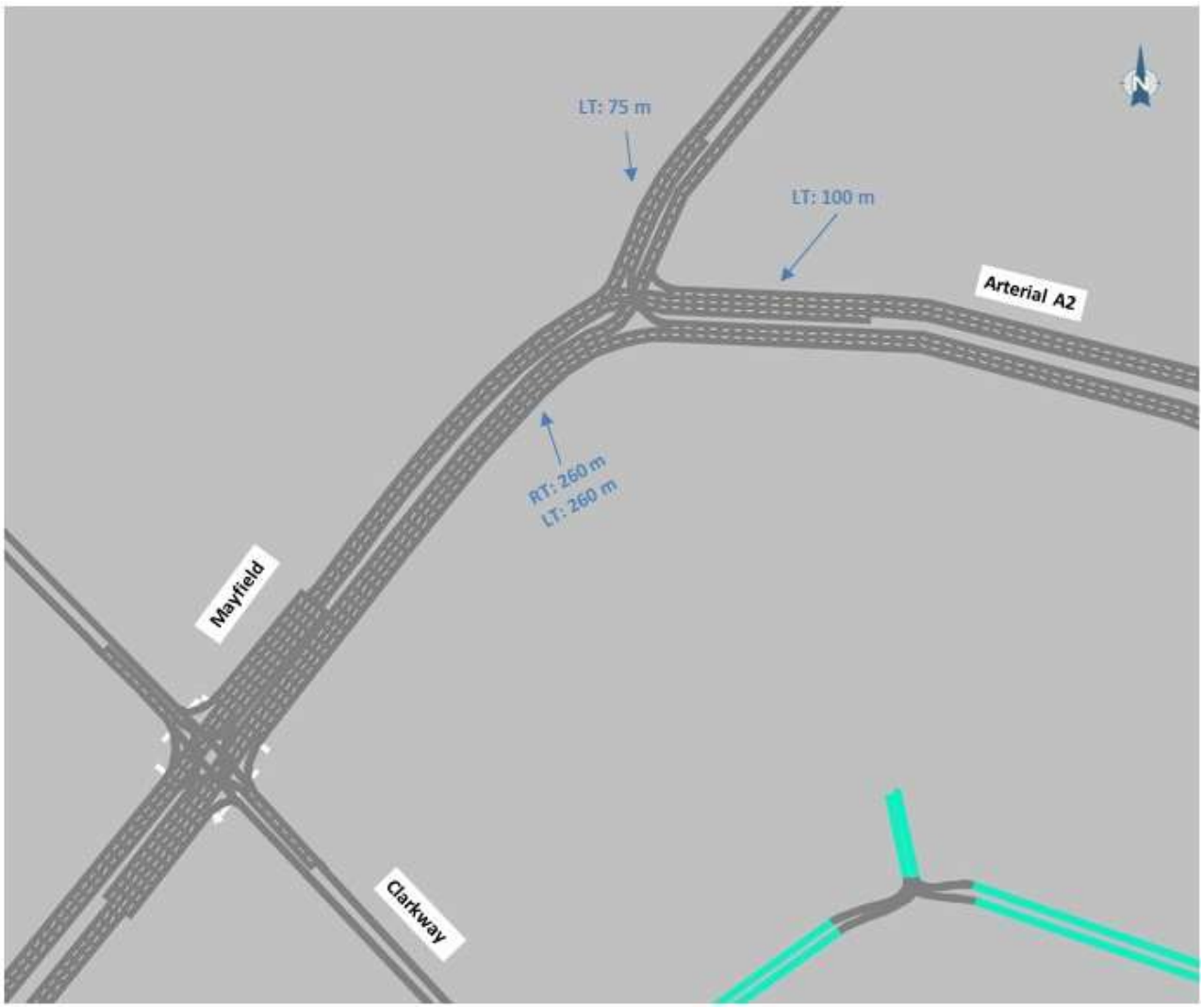
Critical Intersection Storage Length – 2031 & 2041

Hwy 50/ Mayfield Rd.



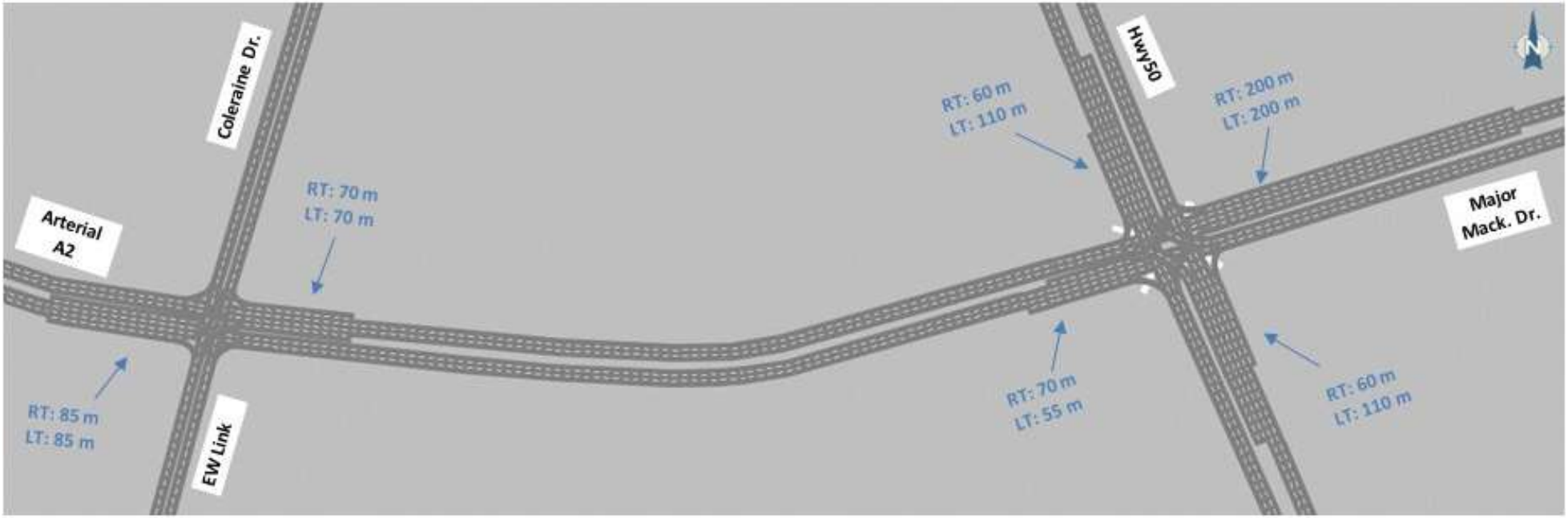
Critical Intersection Storage Length – 2031 & 2041

Arterial A2/ Mayfield Rd.



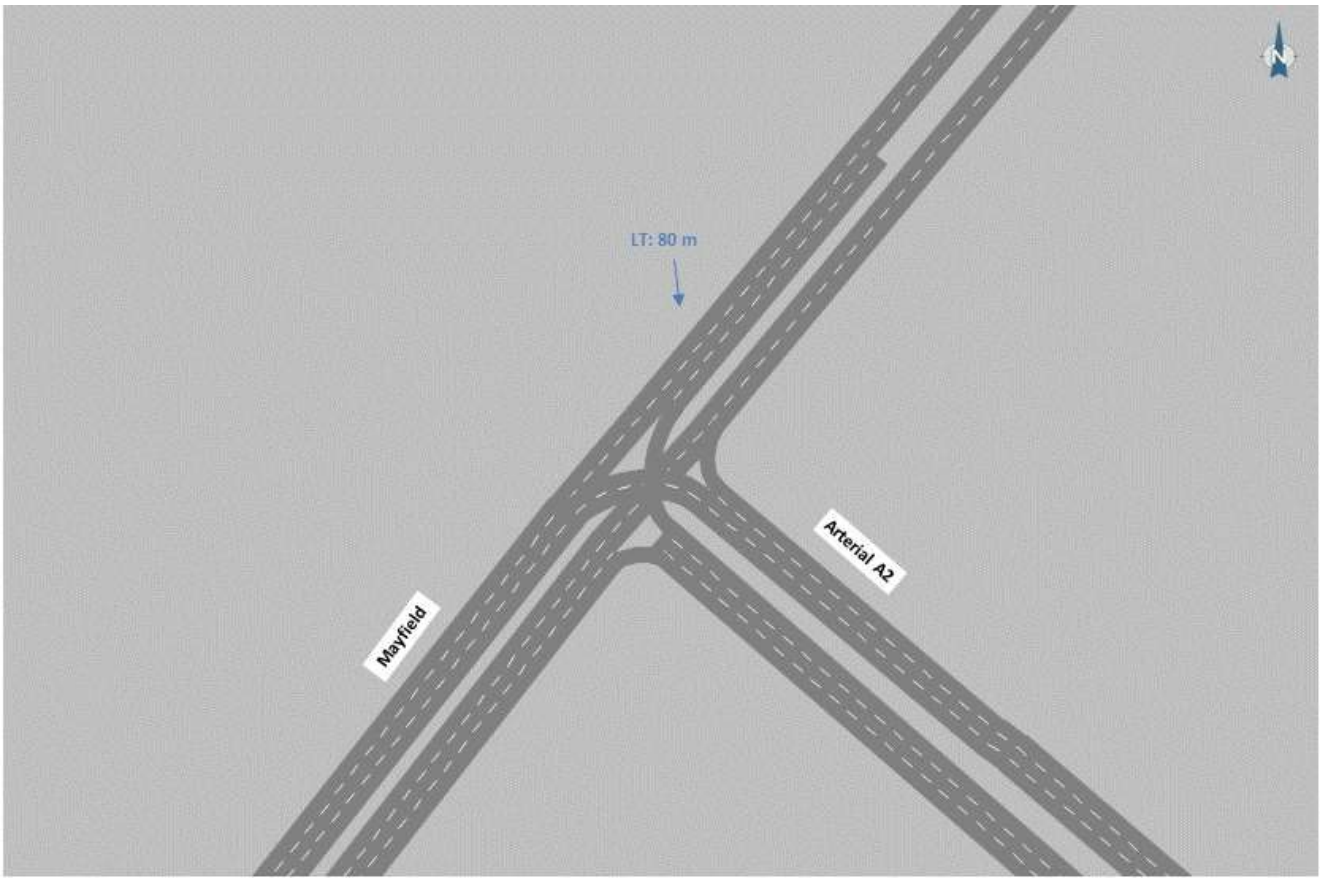
Critical Intersection Storage Length – 2041 Alternative Coleraine Dr. shift to EW Link

Arterial A2/ Coleraine Dr./EW Link and Major Mack/ Hwy 50



Critical Intersection Storage Length – 2041 Alternative T-Intersection at Arterial A2/Mayfield Rd.

Arterial A2/ Mayfield Rd.



Recommended Design Parameters

B000590 – Area 47

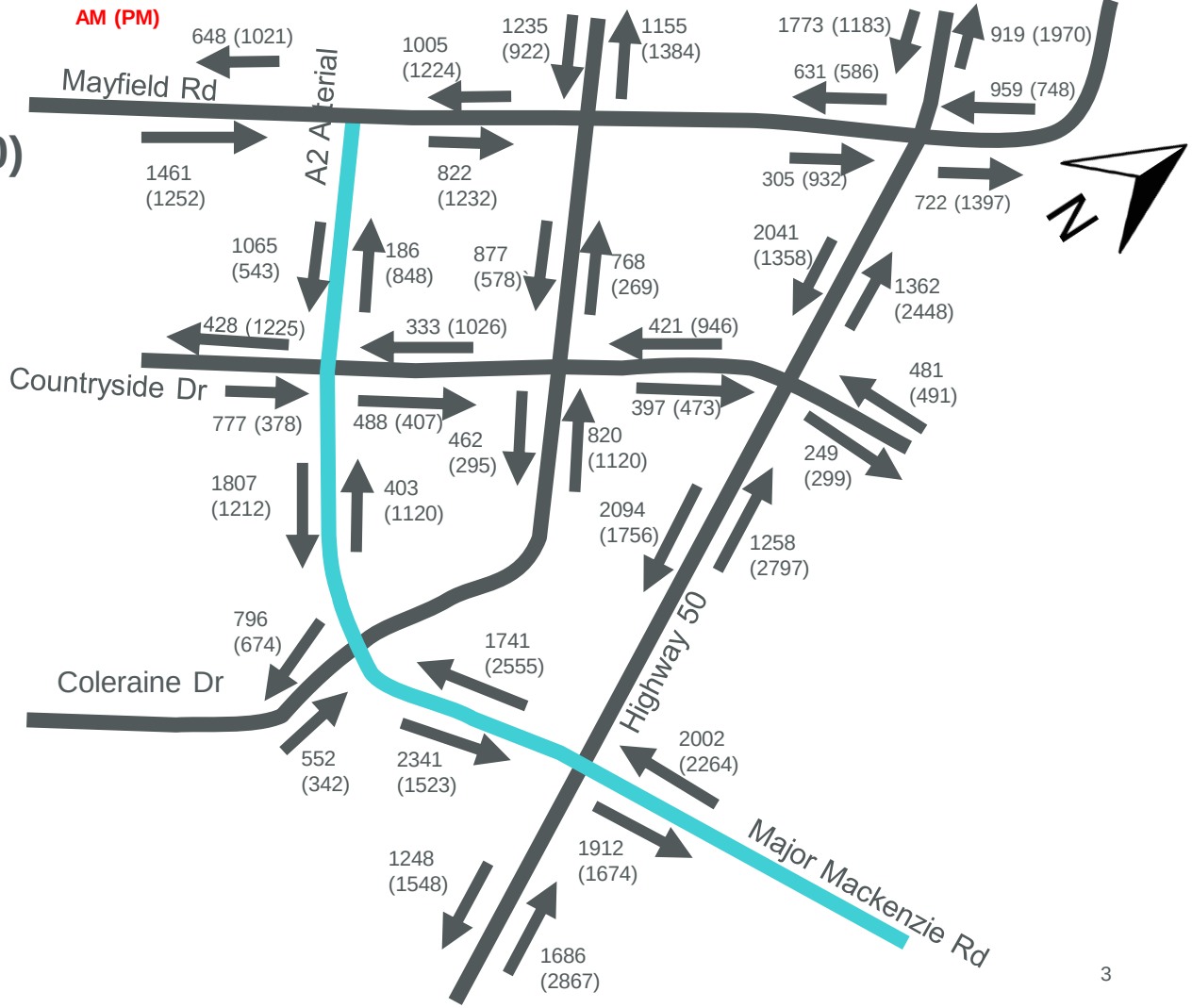
September 27th 2019

Design Parameters - Recommendations

- This presentation summarizes findings from the VISSIM and Synchro/SimTraffic analyses in order to define Functional Design parameters for the main arterial roads in the Area 47 Study Area.

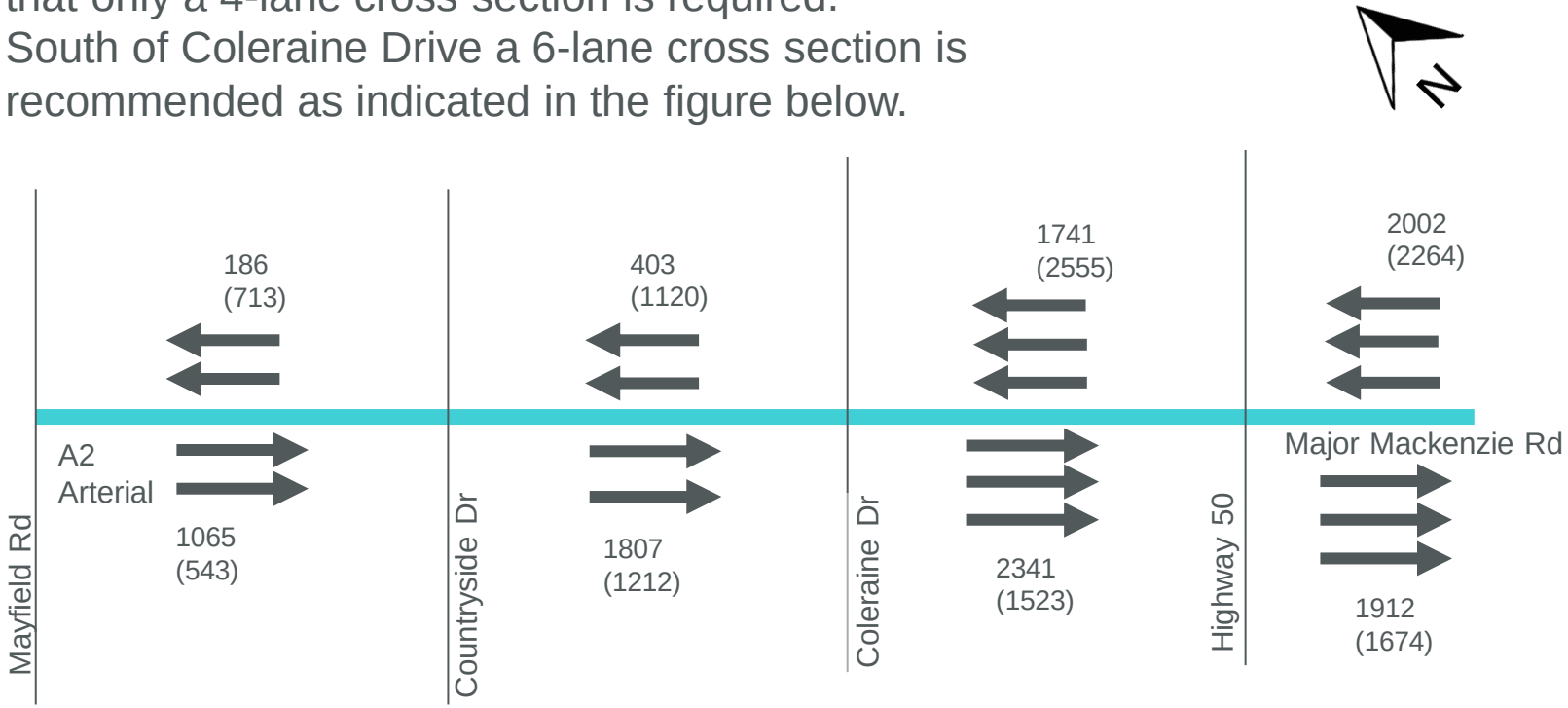
Network Link Volumes – 2041 VISSIM (with SPUI at A2/Major Mackenzie/Hwy 50)

- The figure highlights the link volume along the major corridors in the modelled network.
- The volumes are outputs from the 2041 VISSIM SPUI model.



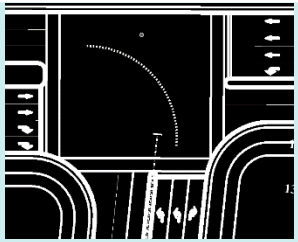
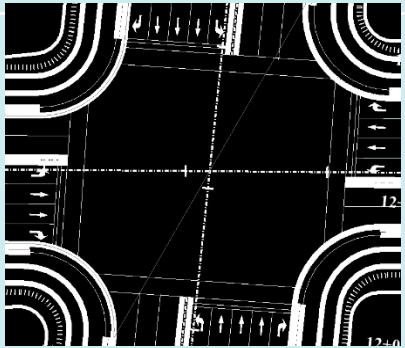
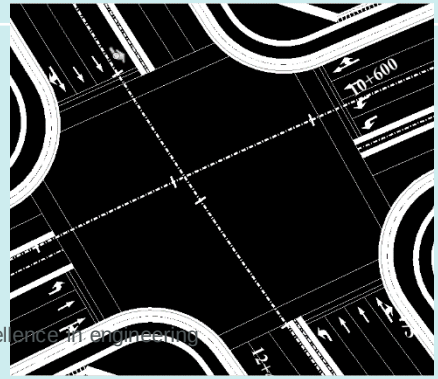
Link Volumes – Recommended Cross Section

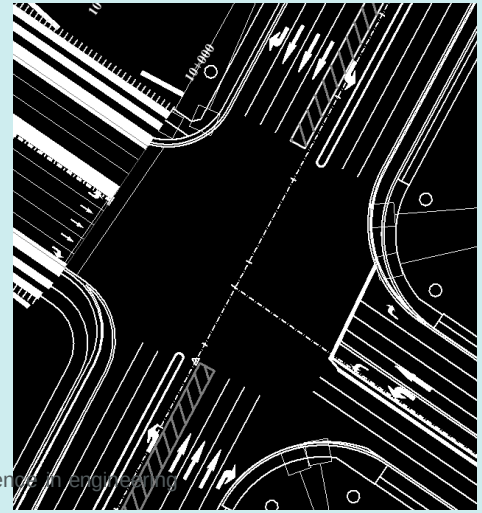
- Along Arterial A2 north of Coleraine the link-volumes indicate that only a 4-lane cross section is required.
- South of Coleraine Drive a 6-lane cross section is recommended as indicated in the figure below.

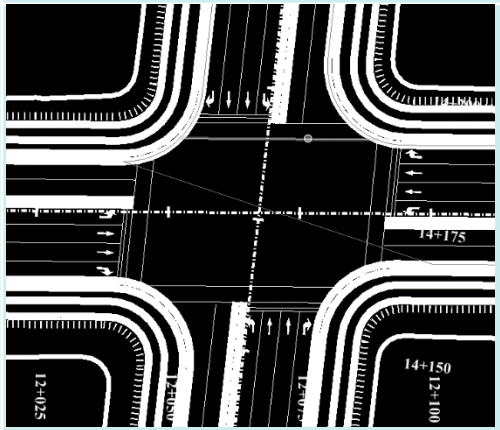


Review of Provided Functional Design

- The following tables highlights the results of a preliminary Synchro/SimTraffic analysis completed utilizing the functional design provided by Wood on August 1 2019
- The “recommended changes” column highlight proposed functional design changes based on the analysis

Intersection	Provided Design	Movement	95th Percentile Queue (SimTraffic)	Recommended changes
Mayfield Rd / A2		EBR	30 m	EBR is dual movement only outer (furthest from the median) right lane will have proposed storage length the other will be continuous.
		WBL	105 m	
		NBL	N/A	Should be continuous dual left.
		NBR	35 m	
A2 / Countryside Rd		NBL	75 m	
		NBR	15 m	
		SBL	20 m	
		SBR	15 m	
		EBL	50 m	
		EBR	50 m	
		WBL	90 m	
		WBR	20 m	
A2 (NB/SB)/ Coleraine (EB/WB)		NBL	210 m	A dual NBL turn lane is recommended
		NBR	530 m	It is recommended that a NBR turn lane be provided (or continuous right turn)
		SBL	125 m	
		SBR	95 m	A right turn storage lane is recommended
		EBL	15 m	
		EBR	90 m	A right turn storage lane is recommended
		WBL	35 m	

Intersection	Provided Design	Movement	95th Percentile Queue	Recommended changes
Highway 50 / A2 SPUI Hwy 50 (NB/SB) A2 (EB/WB)	SPUI design not available	NBL	285	Consider dual NBL
		NBR	90	
		SBL	135	
		SBR	10	
		EBL	10	
		EBR	110	
		WBL	100	
		WBR	95	
Highway 50 / A2 At Grade Hwy 50 (NB/SB) A2 (EB/WB)		NBL	155	
		NBR	25	
		SBL	155	
		SBR	15	
		EBL	210	Consider dual EBL
		EBR	170	
		WBL	45	
		WBR	185	

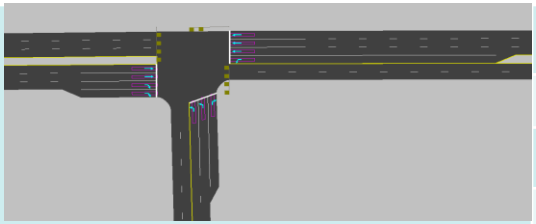
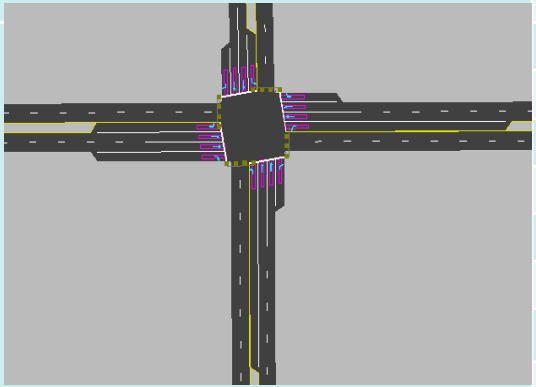
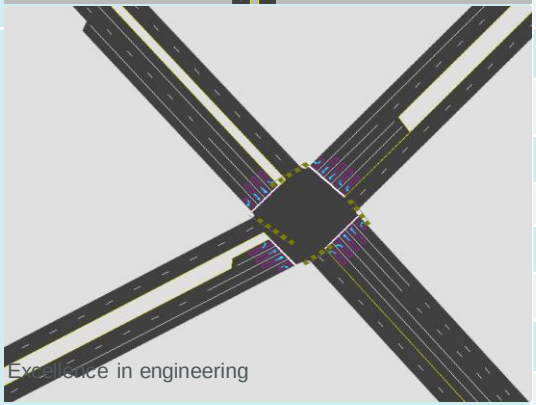
Intersection	Provided Design	Movement	95th Percentile Queue	Recommended changes
Mayfield Rd / Coleraine	Mayfield Rd and Coleraine design not available	NBL	65 m	
		NBR	15 m	
		SBL	10 m	
		SBR	80 m	
		EBL	185 m	
		EBR	10 m	
		WBL	55 m	
		WBR	10 m	
Coleraine / Country-side Rd		NBL	40 m	
		NBR	10 m	
		SBL	175 m	
		SBR	25 m	
		EBL	170 m	
		EBR	10 m	
		WBL	40 m	
		WBR	40 m	

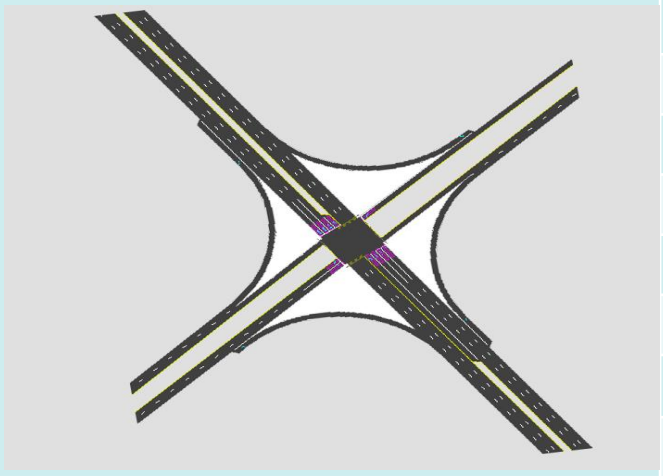
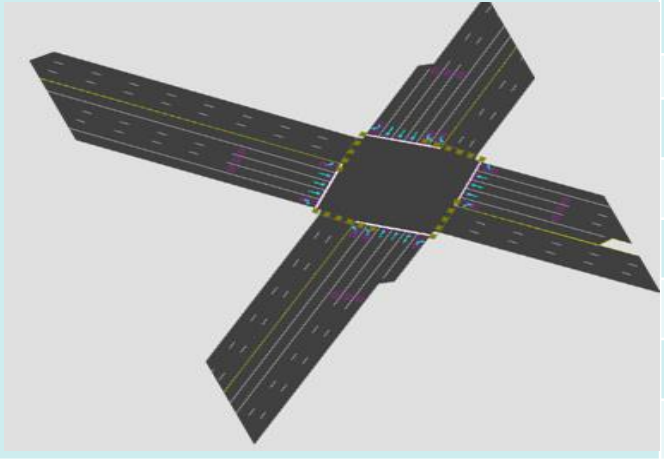
Recommended Functional Design based on preliminary analysis

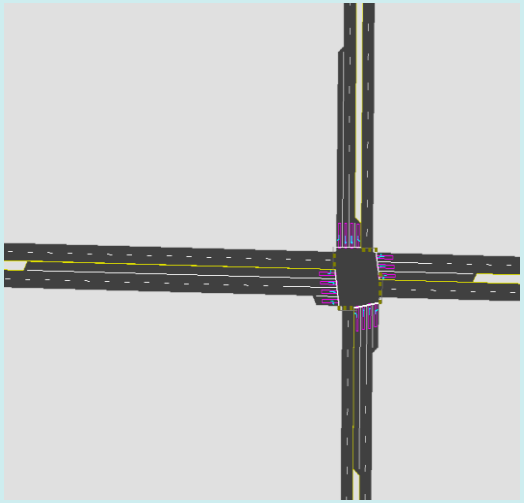
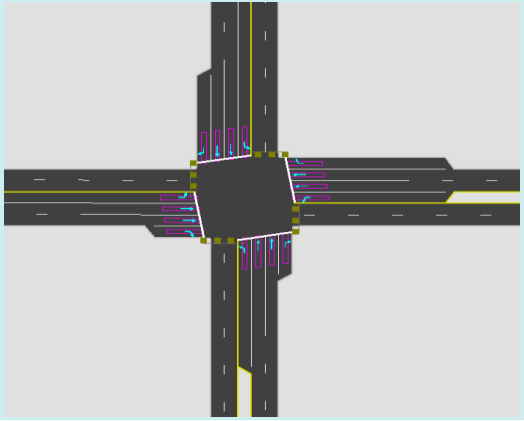
- It is recommended that a 4 lane cross section be utilized on Arterial A2 north of Coleraine.
- It is recommended that right-turn storage lanes (all approaches) be added at A2 and Coleraine
- There are several dual left-turn storage lanes recommended at:
  - Mayfield & A2 NBL
  - Coleraine & A2 NBL
  - Highway 50 & A2 (SPUI) NBL
  - Highway 50 & A2 (At Grade) EBL

Revised Synchro/SimTraffic Analysis

- The previously noted functional design changes were made to the Synchro/SimTraffic model
- The following tables summarize the recommended design parameters based for the updated intersection configurations.

Intersection	Recommended Configuration	Movement	Recommended Storage Length (m)	Comments
Mayfield Rd / A2		EBR	45	Dual EBR lanes (1-continuous 1-storage bay of 45 m for the right turn lane furthest from the median)
		WBL	105	
		NBL	-	Dual NBL lanes (both continuous since A2 terminates)
		NBR	55	
A2 / Country-side Rd		NBL	80	
		NBR	25	
		SBL	25	
		SBR	25	
		EBL	35	
		EBR	60	
		WBL	60	
		WBR	30	
A2 (NB/SB)/ Coleraine (EB/WB)		NBL	160	Dual NBL lanes (2 storage bays of 160 m)
		NBR	-	Through lane becomes NBR
		SBL	155	
		SBR	105	
		EBL	20	
		EBR	75	
		WBL	50	Dual WBL lanes (2 storage bays of 50 m)
		WBR	15	

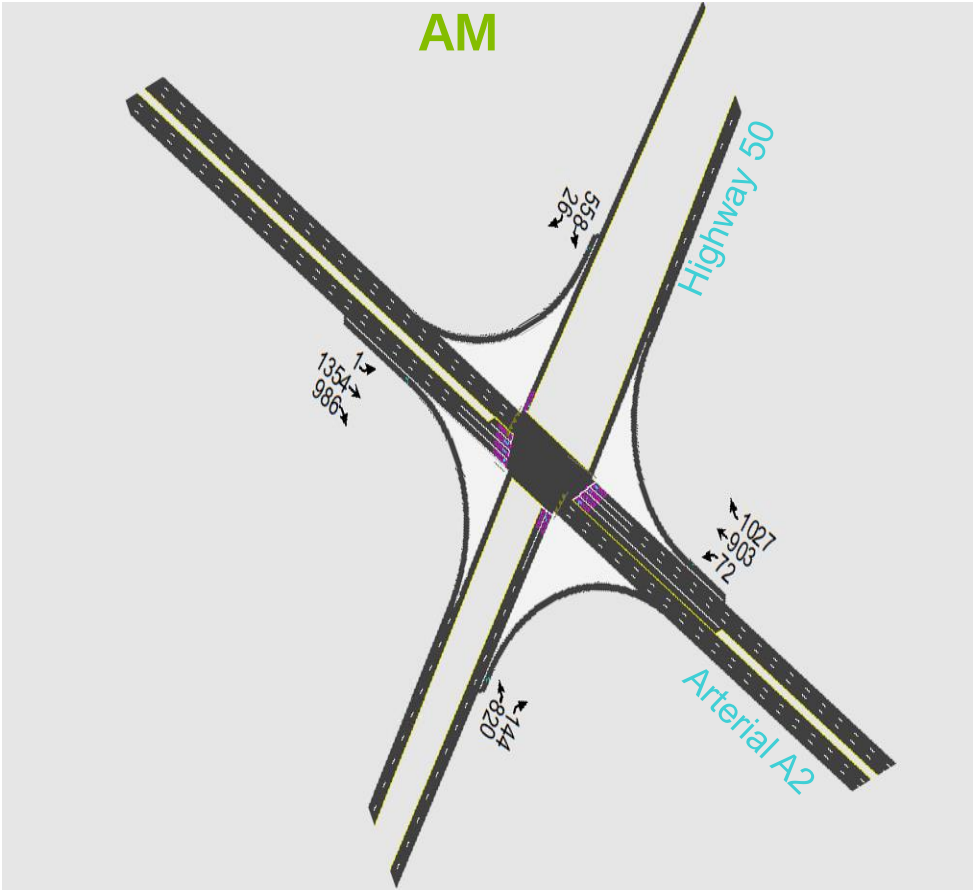
Intersection	Recommended Configuration	Movement	Recommended Storage Length	Comments
Highway 50 / A2/MMR SPUI Hwy 50 (NB/SB) A2 (EB/WB)		NBL	-	Double NBL lanes (both continuous)
		NBR	-	Channelized Right
		SBL	-	Continuous from ramp
		SBR	-	Channelized Right
		EBL	10	
		EBR	30	Modelled as a ramp
		WBL	70	
		WBR	125	Modelled as a ramp
Highway 50 / A2/MMR At Grade (no SPUI) Hwy 50 (NB/SB) A2 (EB/WB)		NBL	335	Double NBL lanes – 2 storage bays of 335 m
		NBR	35	
		SBL	300	Double SBL lanes – 2 storage bays of 300 m
		SBR	30	
		EBL	30	
		EBR	55	
		WBL	50	
		WBR	200	

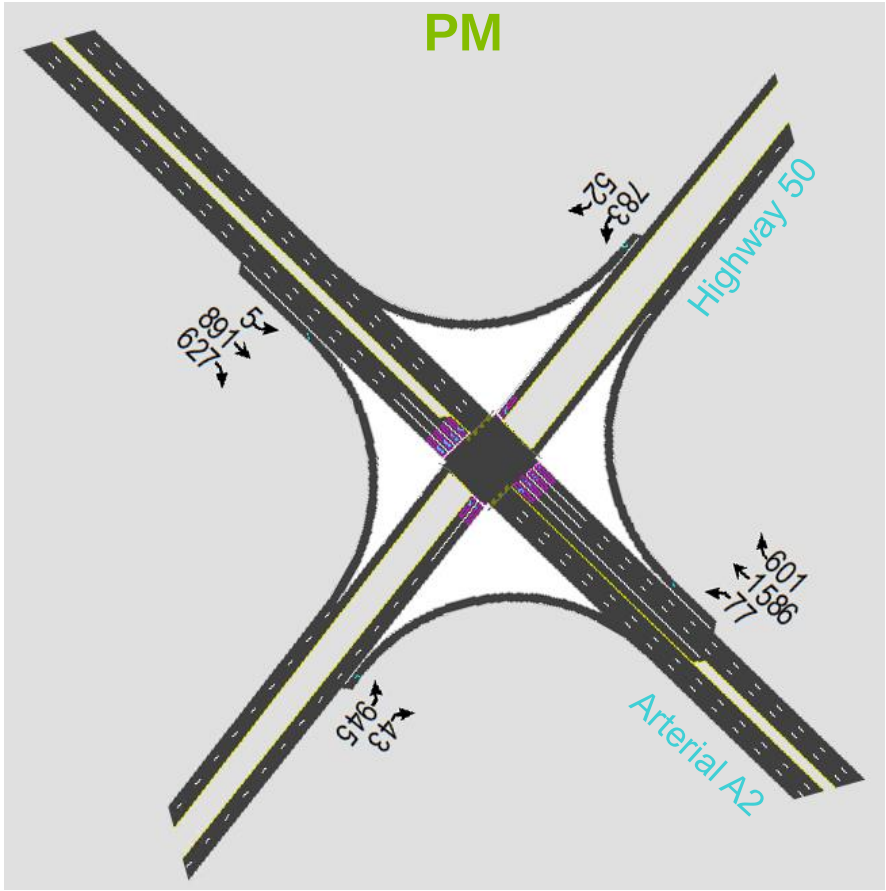
Intersection	Recommended Configuration	Movement	Recommended Storage Length	Comments
Mayfield Rd / Coleraine		NBL	75	
		NBR	20	
		SBL	10	
		SBR	75	
		EBL	135	
		EBR	15	
		WBL	45	
		WBR	-	Shared WBR/T Lane
Coleraine / Country-side Rd		NBL	40	
		NBR	15	
		SBL	190	
		SBR	25	
		EBL	205	
		EBR	20	
		WBL	40	
		WBR	50	

Summary of Analysis

- The following slides provide additional information on volumes and queueing experienced in the individual intersections.

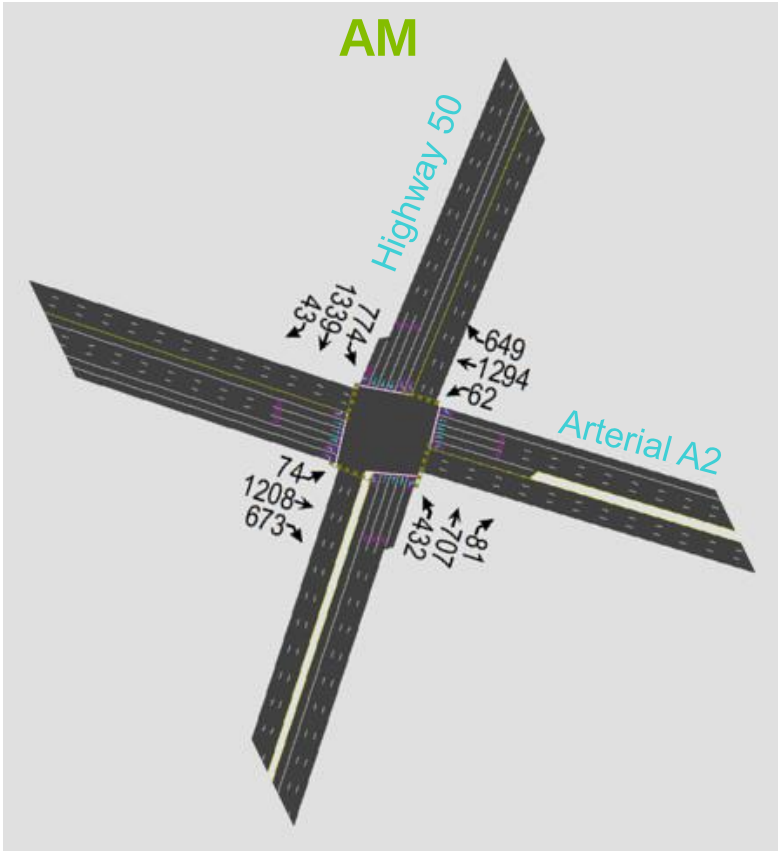
Traffic Volumes at Highway 50 and A2 (SPUI)

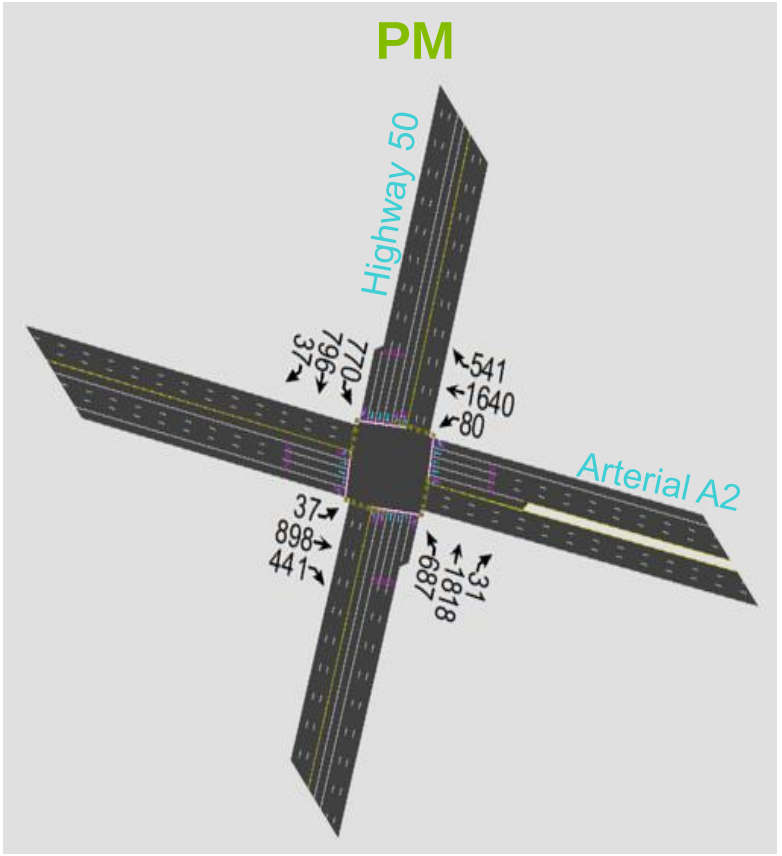




Note: Highway 50 Through Movement not modelled in Synchro

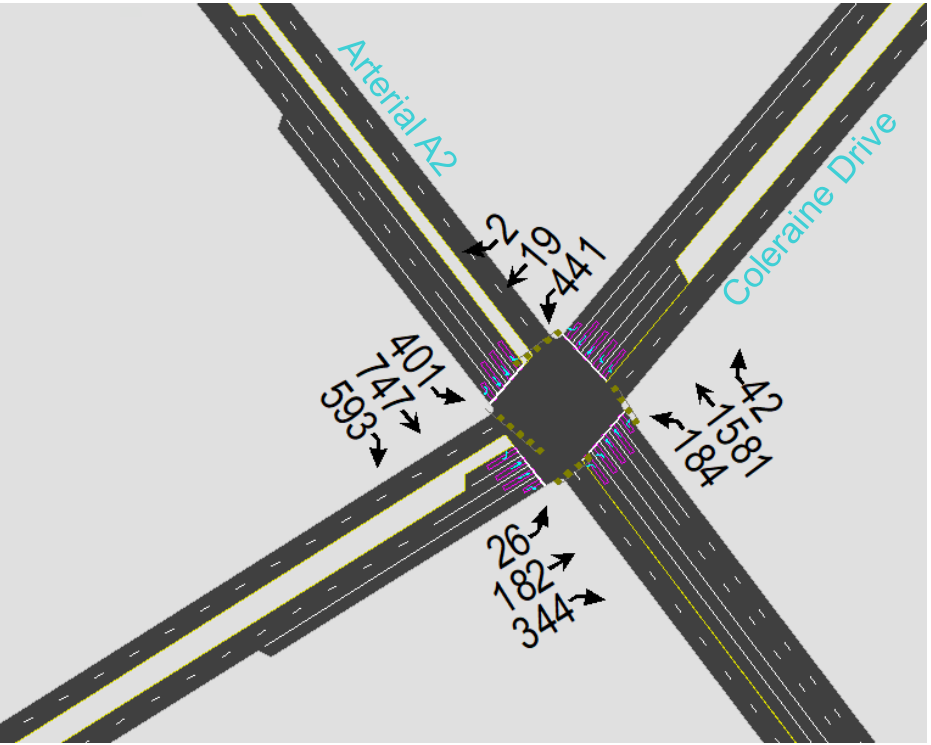
Traffic Volumes at Highway 50 and A2 (At Grade)



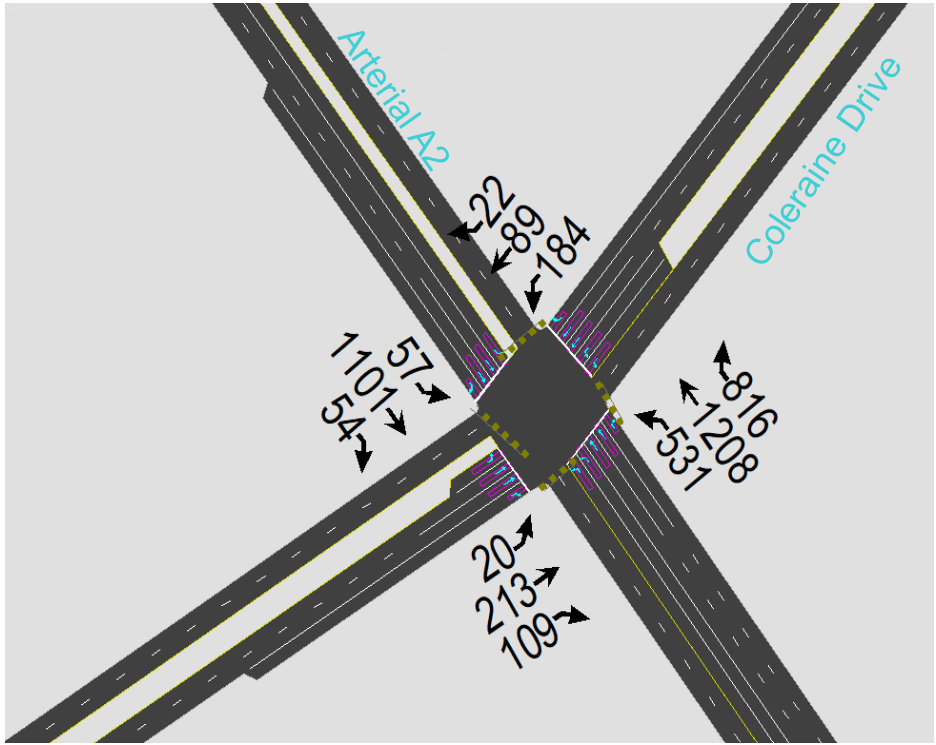


Traffic Volumes at Coleraine and A2

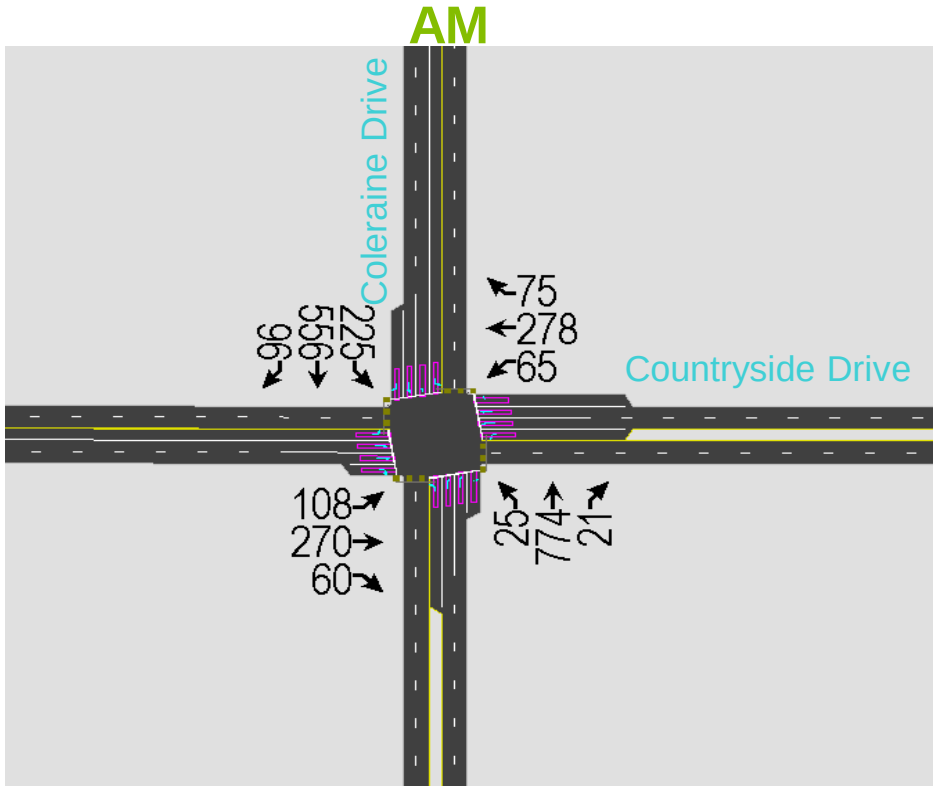
AM

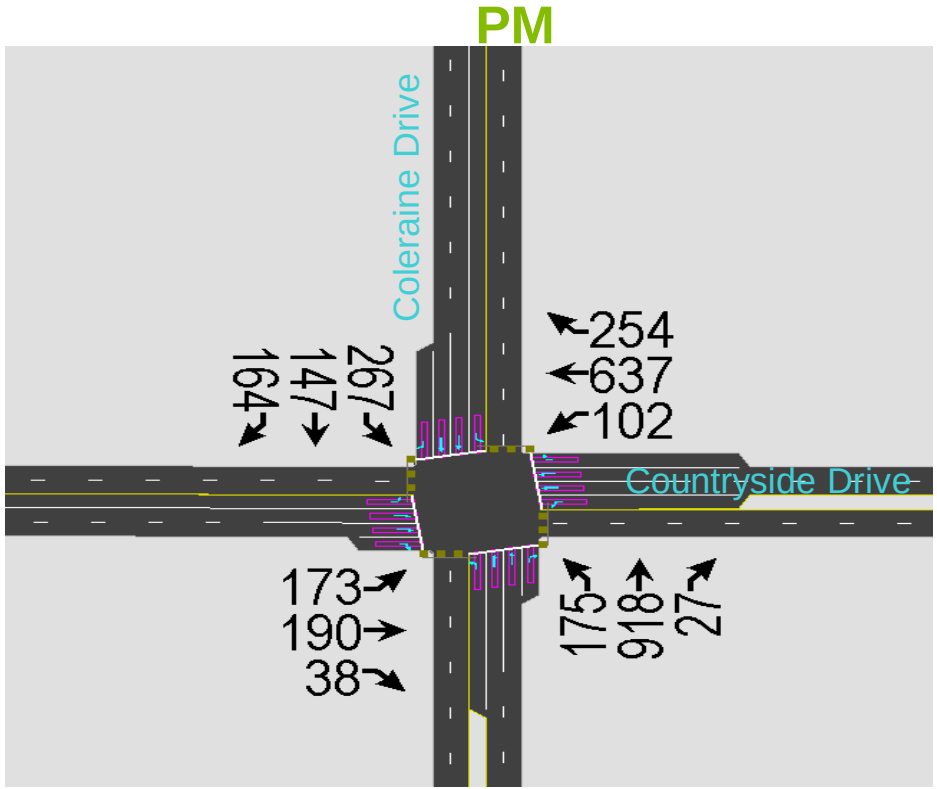


PM

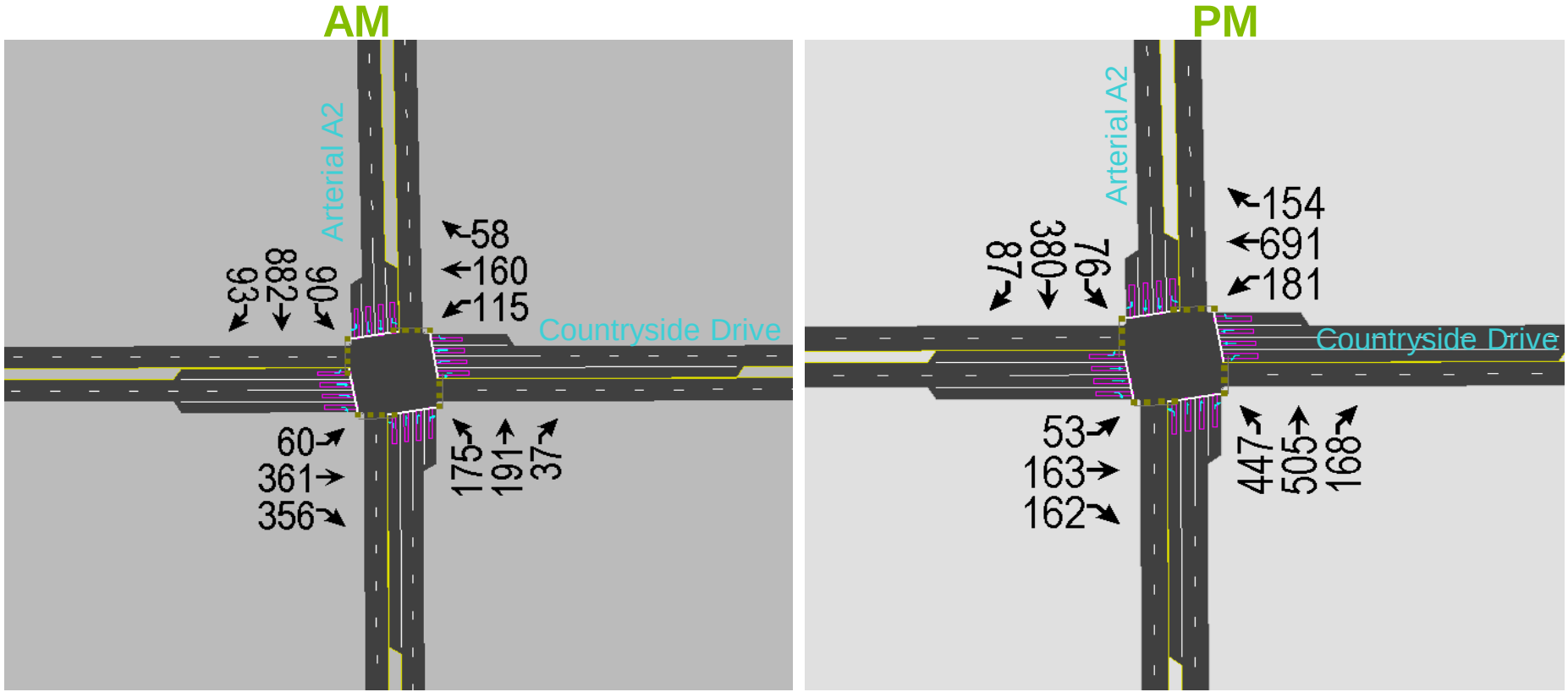


Traffic Volumes at Coleraine and Countryside

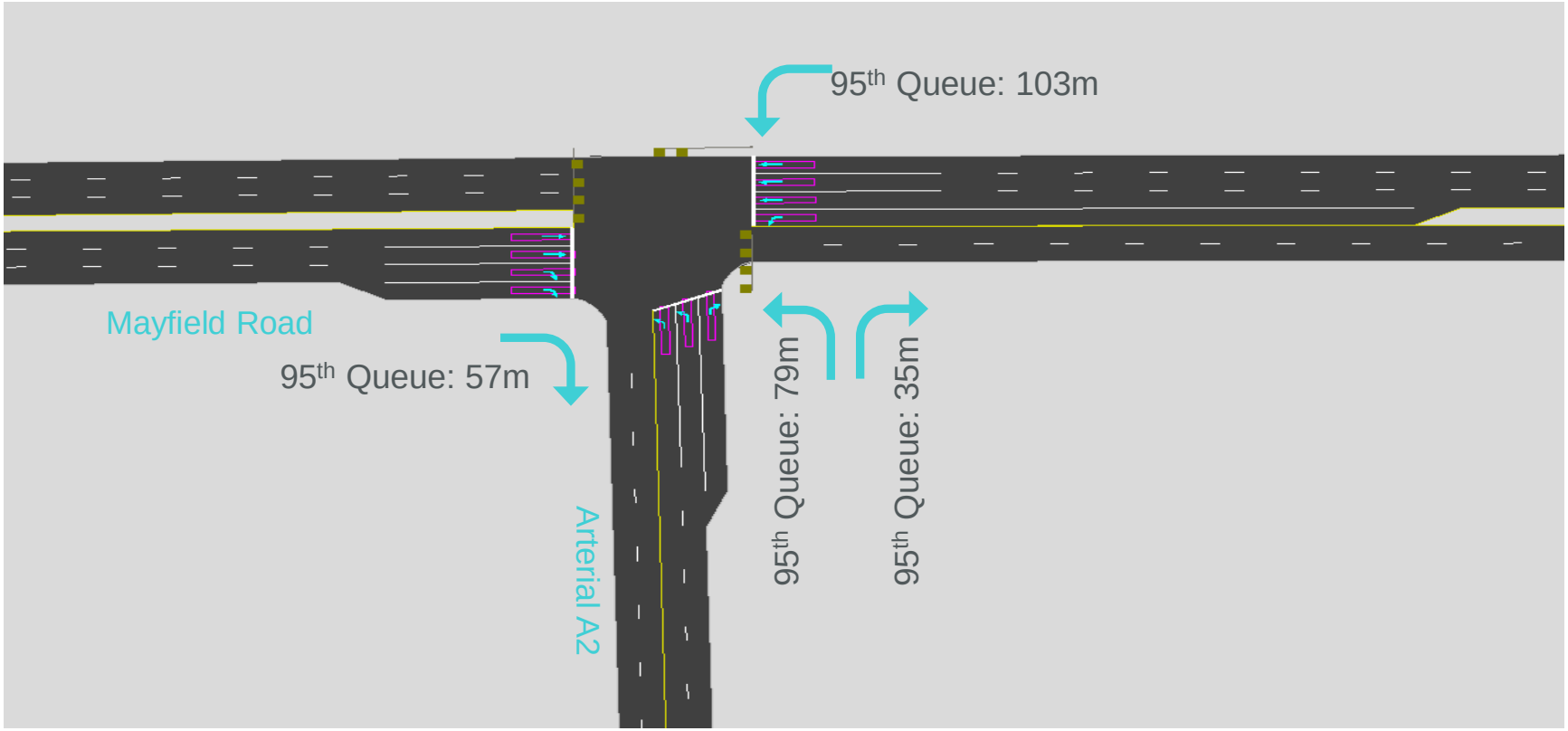




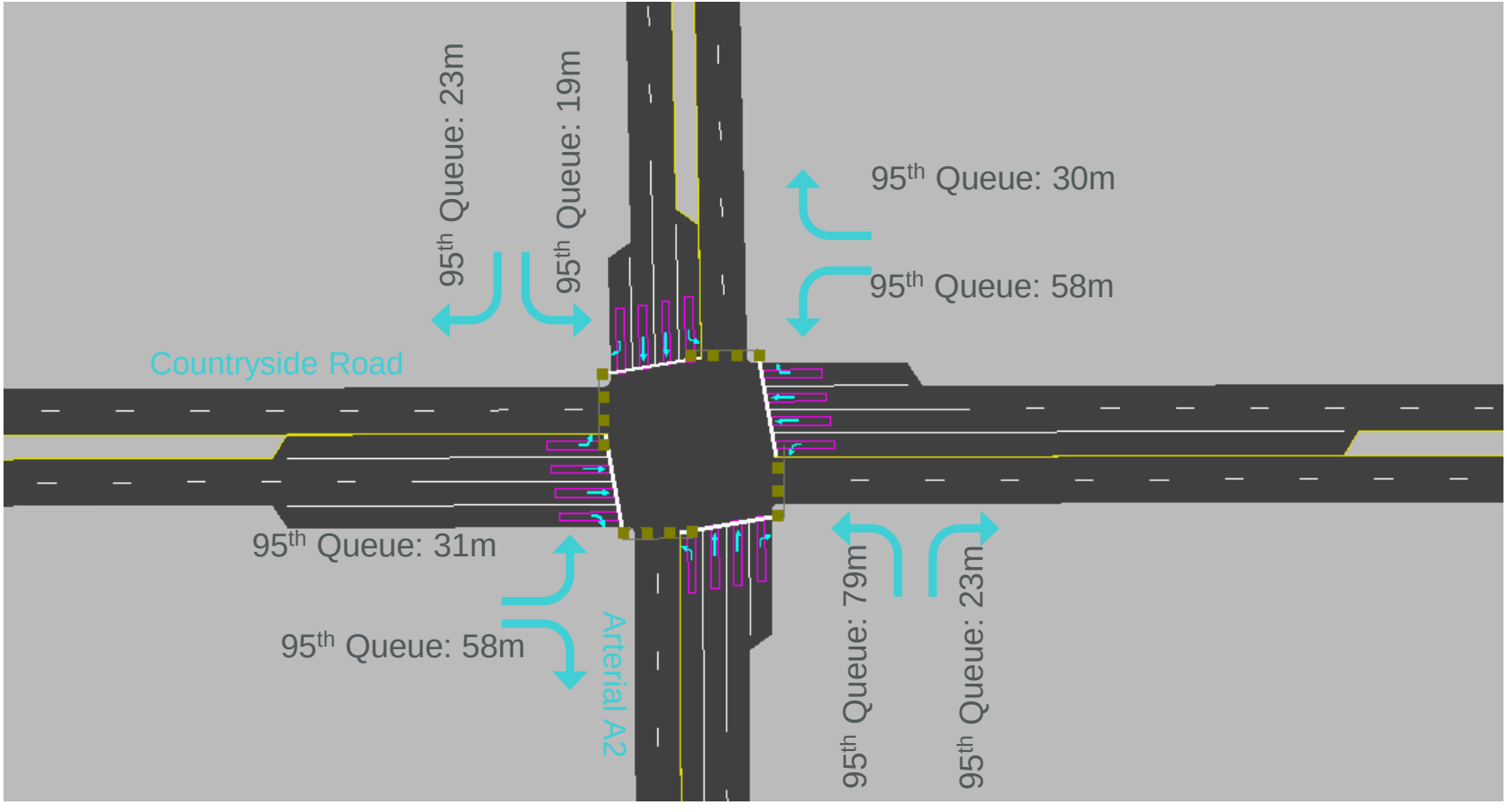
Traffic Volumes at A2 and Countryside



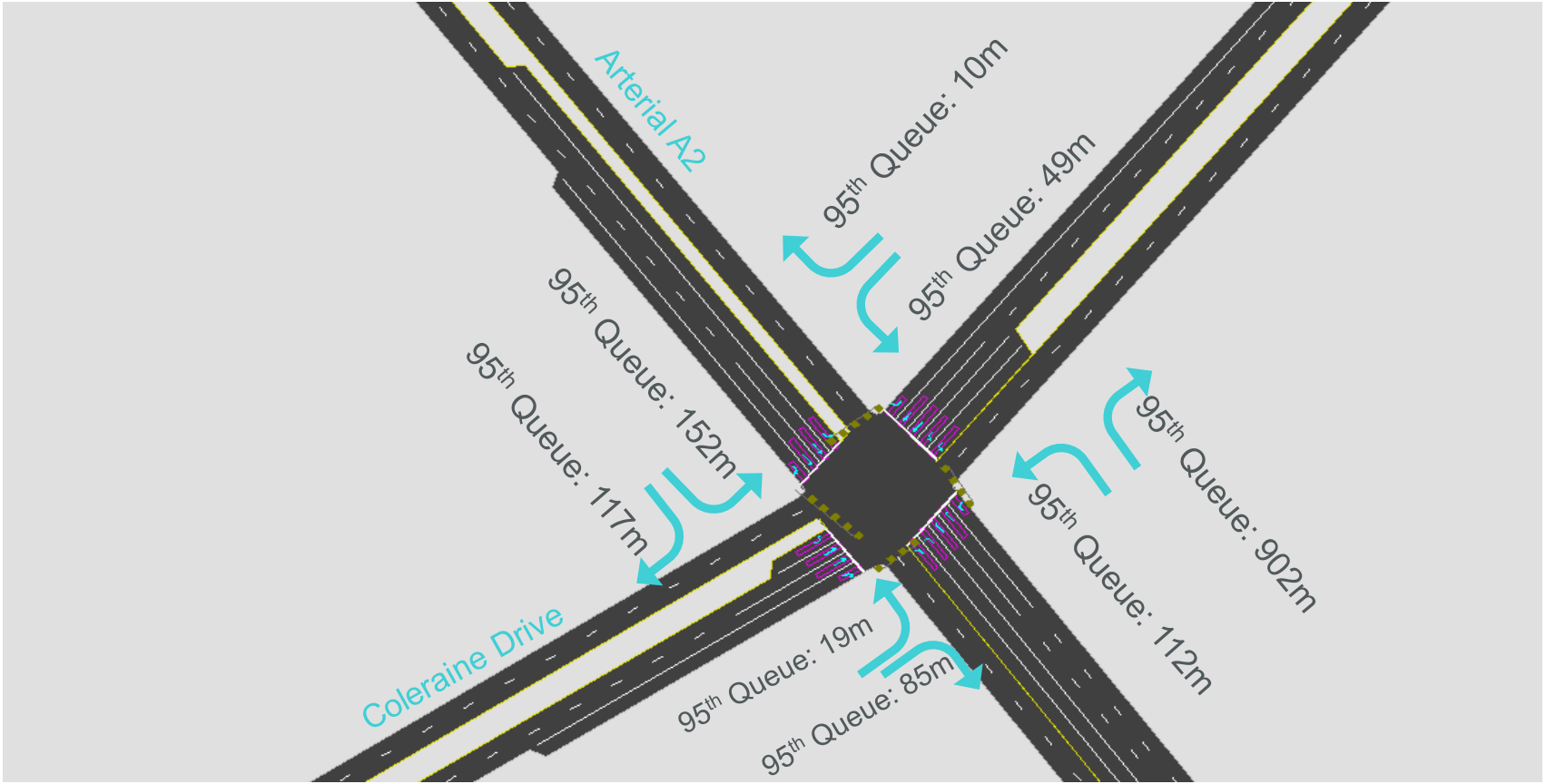
Queues at A2 and Mayfield



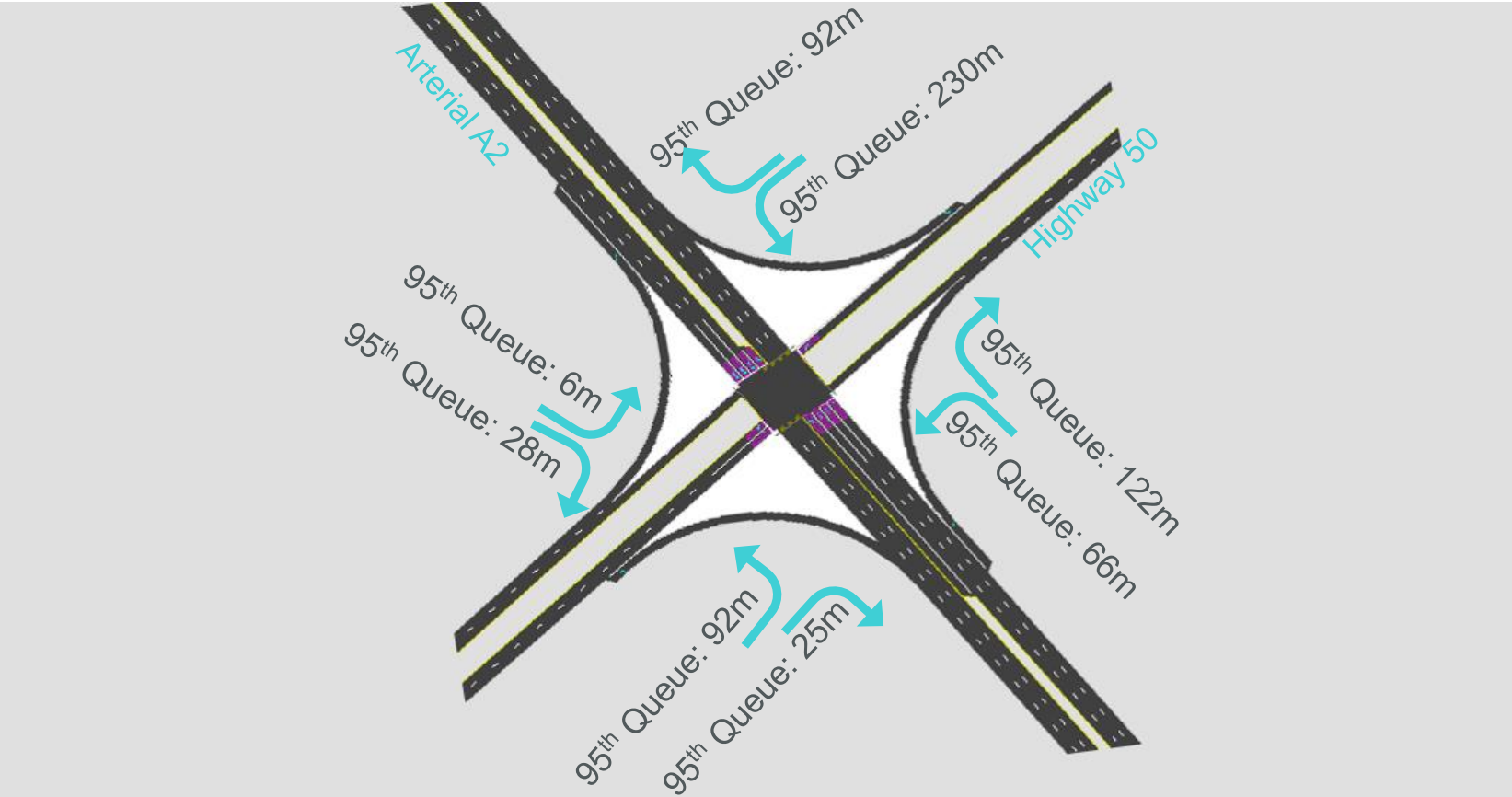
Queues at A2 and Countryside



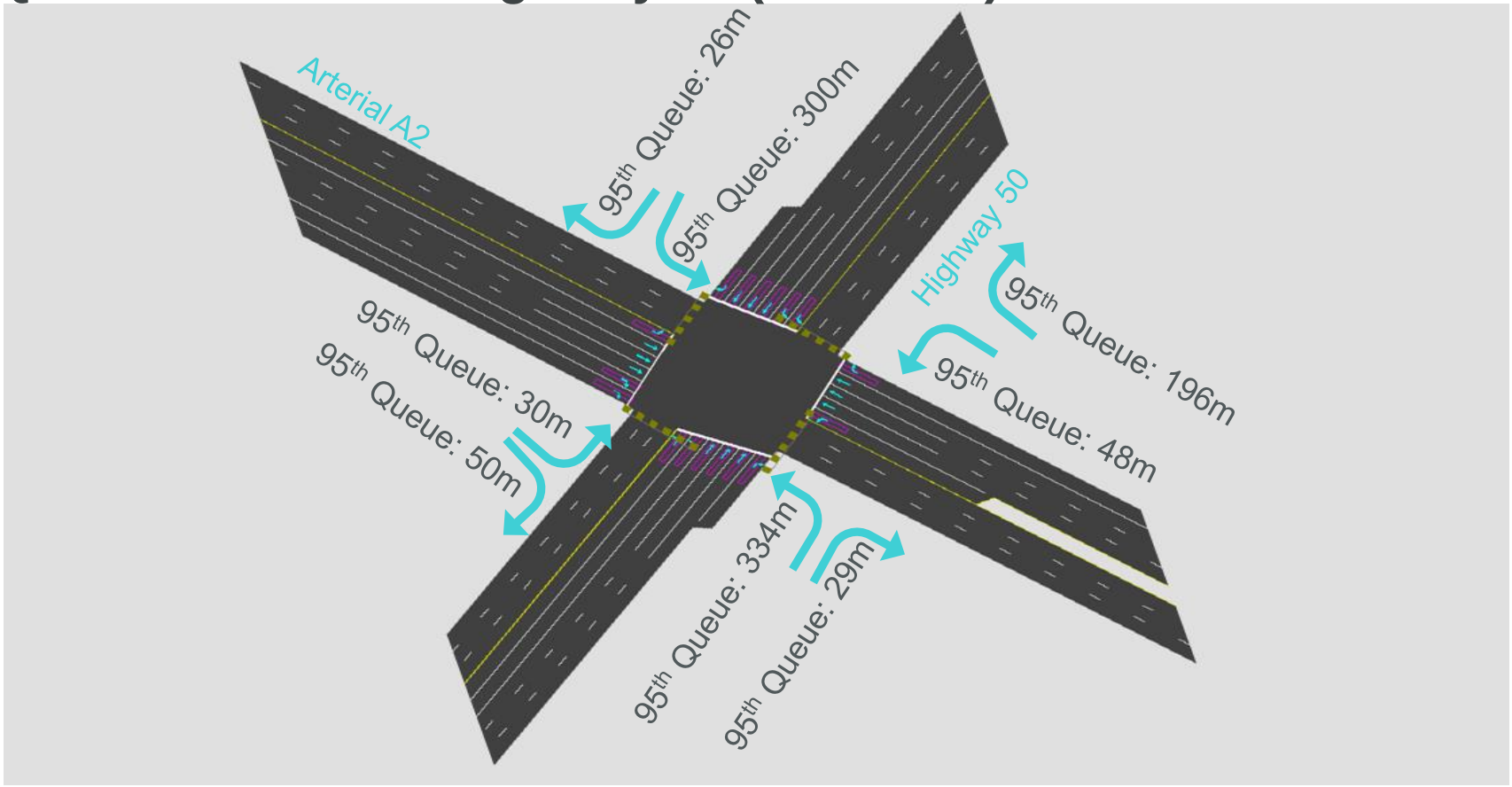
Queues at A2 and Coleraine



Queues at A2 and Highway 50 (SPUI)



Queues at A2 and Highway 50 (At Grade)



Appendix I - Microsimulation Traffic Analysis - Horizon 2041 Short-listed Alternatives

City of Brampton

Microsimulation Traffic Analysis - Horizon 2041 Short-listed Alternatives

Environmental Assessment Study of Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)

May, 2018

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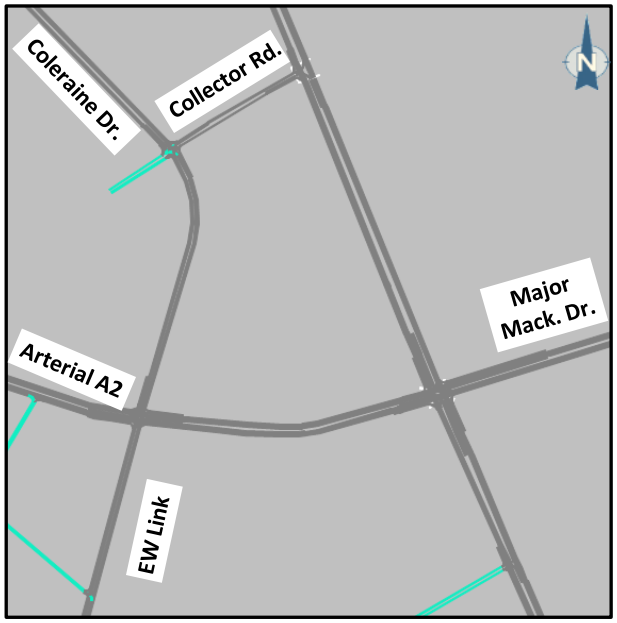
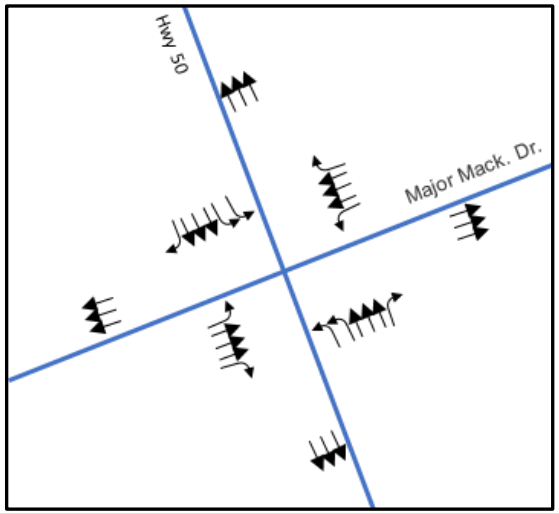
Outline

- Background
- Scenario Analysis and Results
- Alternative Comparison and Conclusion

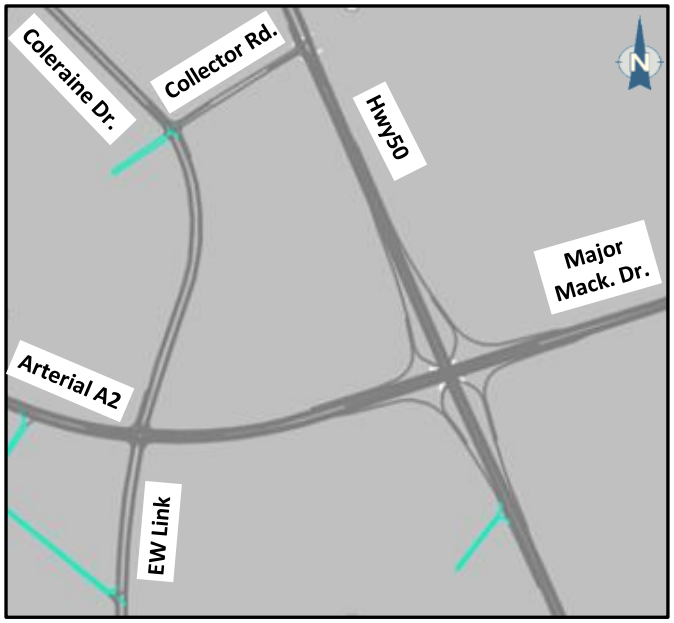
Background

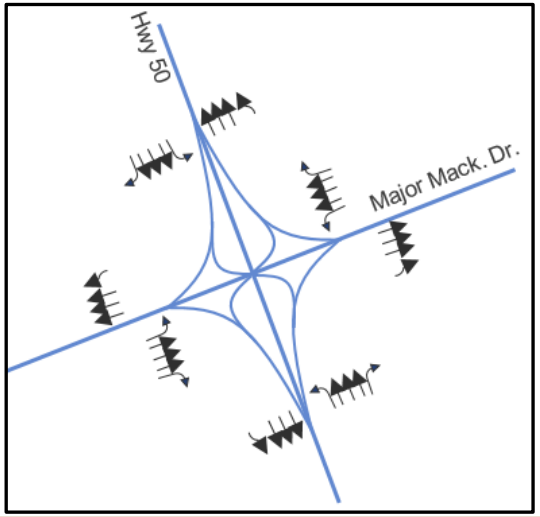
At-Grade Coleraine Dr. Realignment



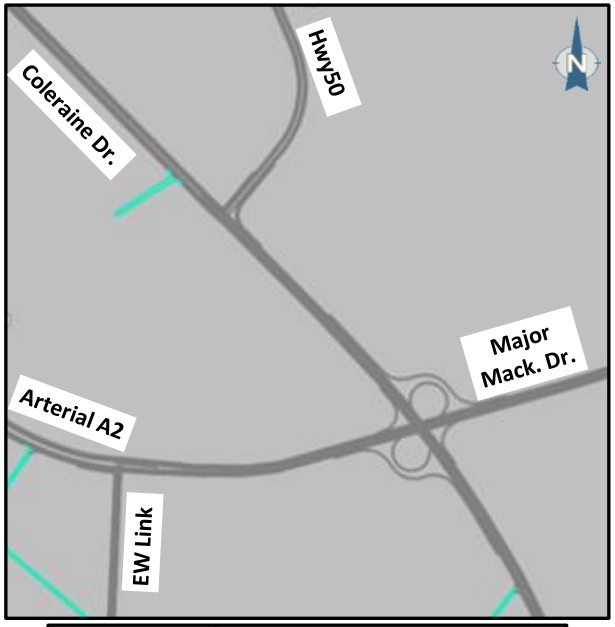


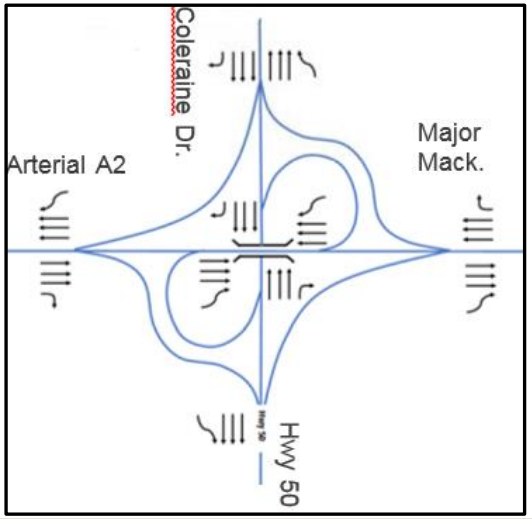
Single Point Diamond Interchange Design





Parclo A-type Interchange

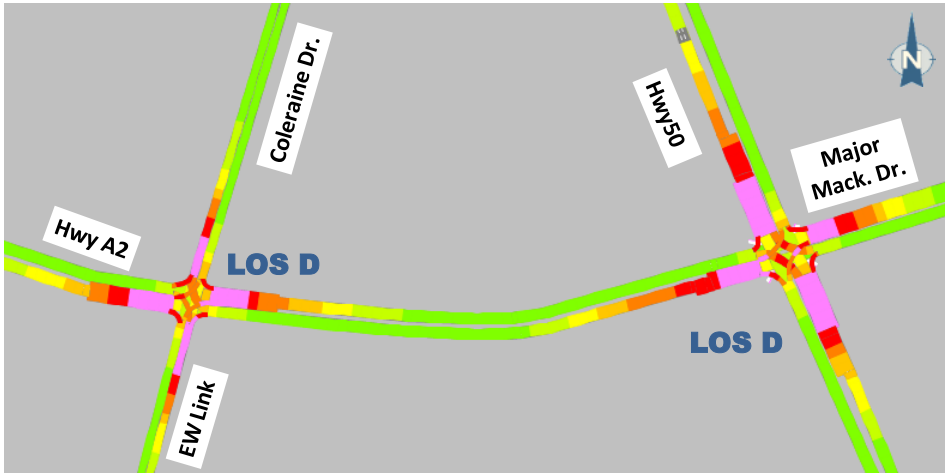


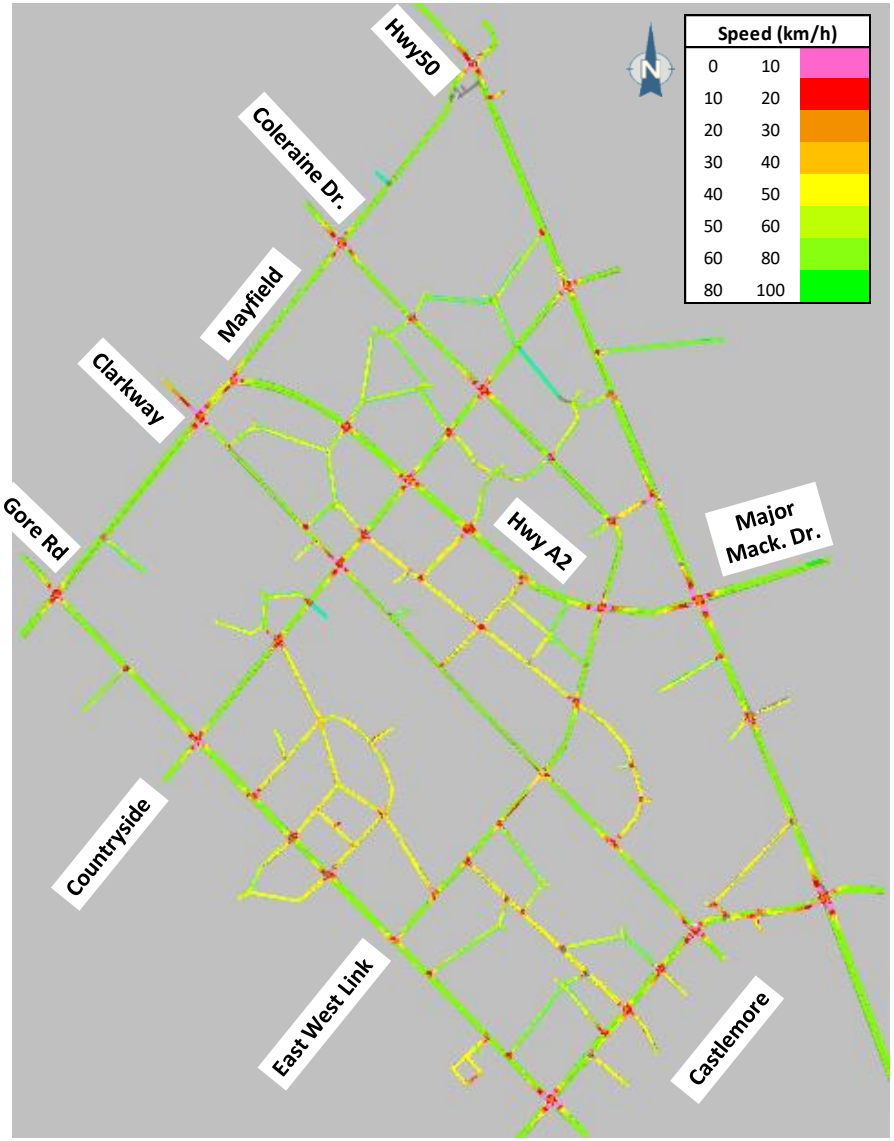


Scenario

At-Grade Coleraine Dr. Realignment

At-Grade Coleraine Dr. Realignment – 2041 AM Peak Speed Profiles





At-Grade Coleraine Dr. Realignment – 2041 AM Peak MOEs

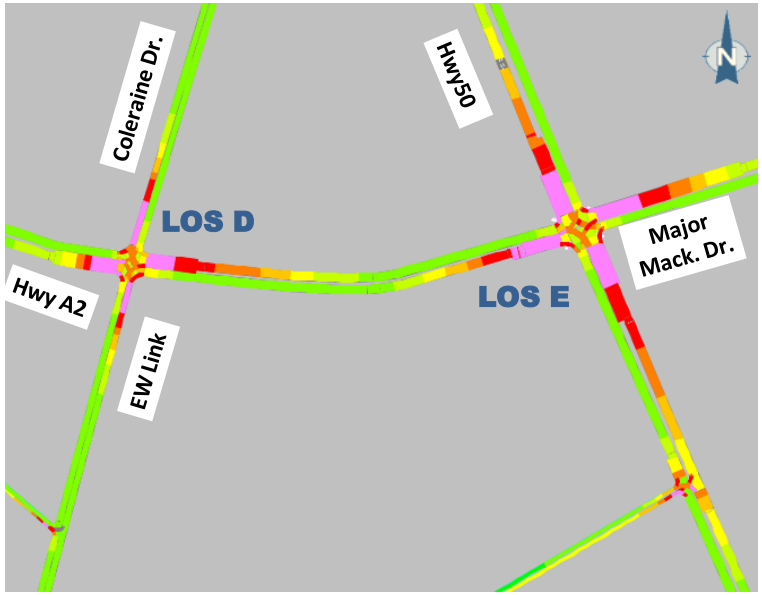
Highway 50 and Major Mack. Dr. Signal

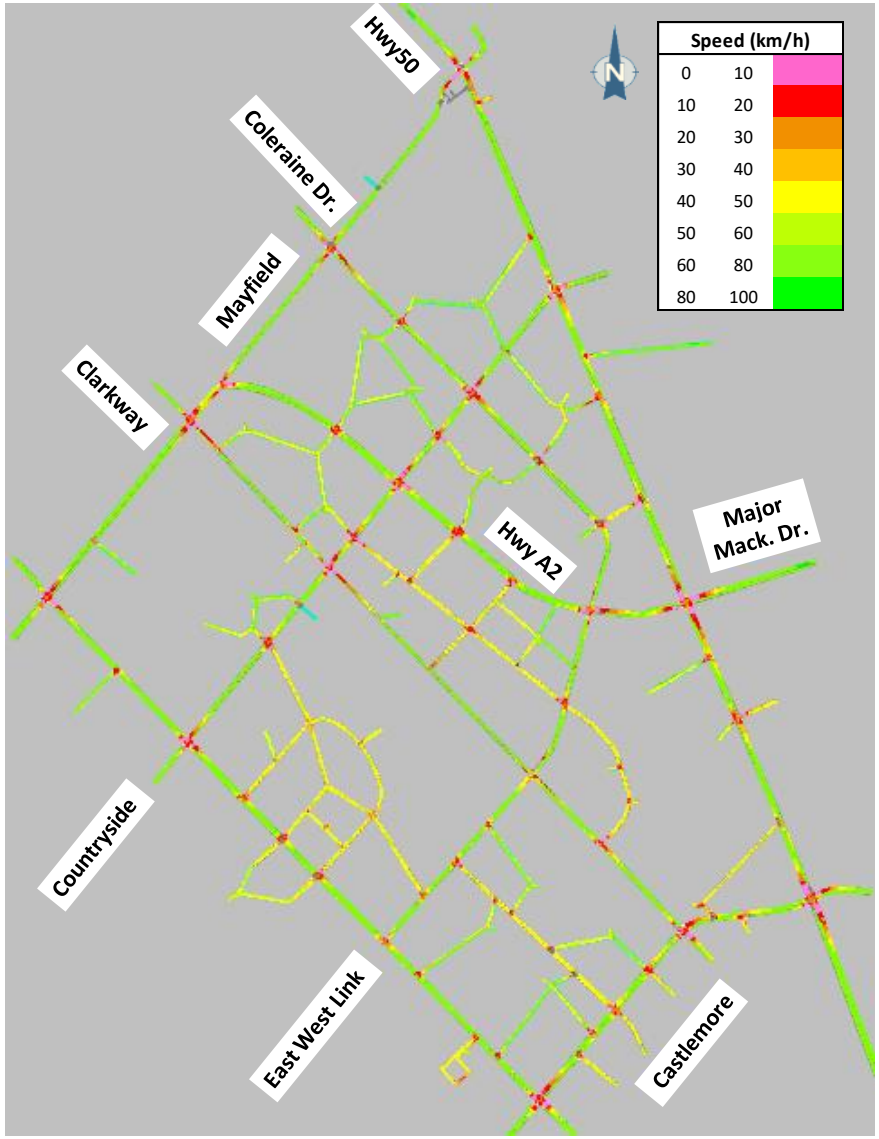
Movement	Volume	Avg. Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	84	14	58	149	B
NBT	712	65	53	143	E
NBL	430	104	53	143	F
EBR	661	30	51	233	C
EBT	1,177	42	46	225	D
EBL	76	43	46	225	D
SBR	40	18	70	297	B
SBT	1,353	37	72	293	D
SBL	777	70	72	293	E
WBR	650	9	29	112	A
WBT	1,294	31	25	105	C
WBL	62	30	25	105	C
Overall	**7,315**	**43**	**50**	**317**	**D**

Coleraine Dr./ EW Link and Arterial A2 Signal

Movement	Volume	Avg. Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	380	41	42	135	D
NBT	322	50	34	124	D
NBL	56	47	34	124	D
EBR	27	10	40	159	A
EBT	1,073	41	35	149	D
EBL	219	64	35	149	E
SBR	3	47	32	128	D
SBT	42	39	25	116	D
SBL	499	50	25	116	D
WBR	869	15	30	128	B
WBT	600	33	27	120	C
WBL	284	53	27	120	D
Overall	**4,374**	**38**	**33**	**175**	**D**

At-Grade Coleraine Dr. Realignment – 2041 PM Peak Speed Profiles





At-Grade Coleraine Dr. Realignment – 2041 PM Peak MOEs

Highway 50 and Major Mack. Dr. Signal

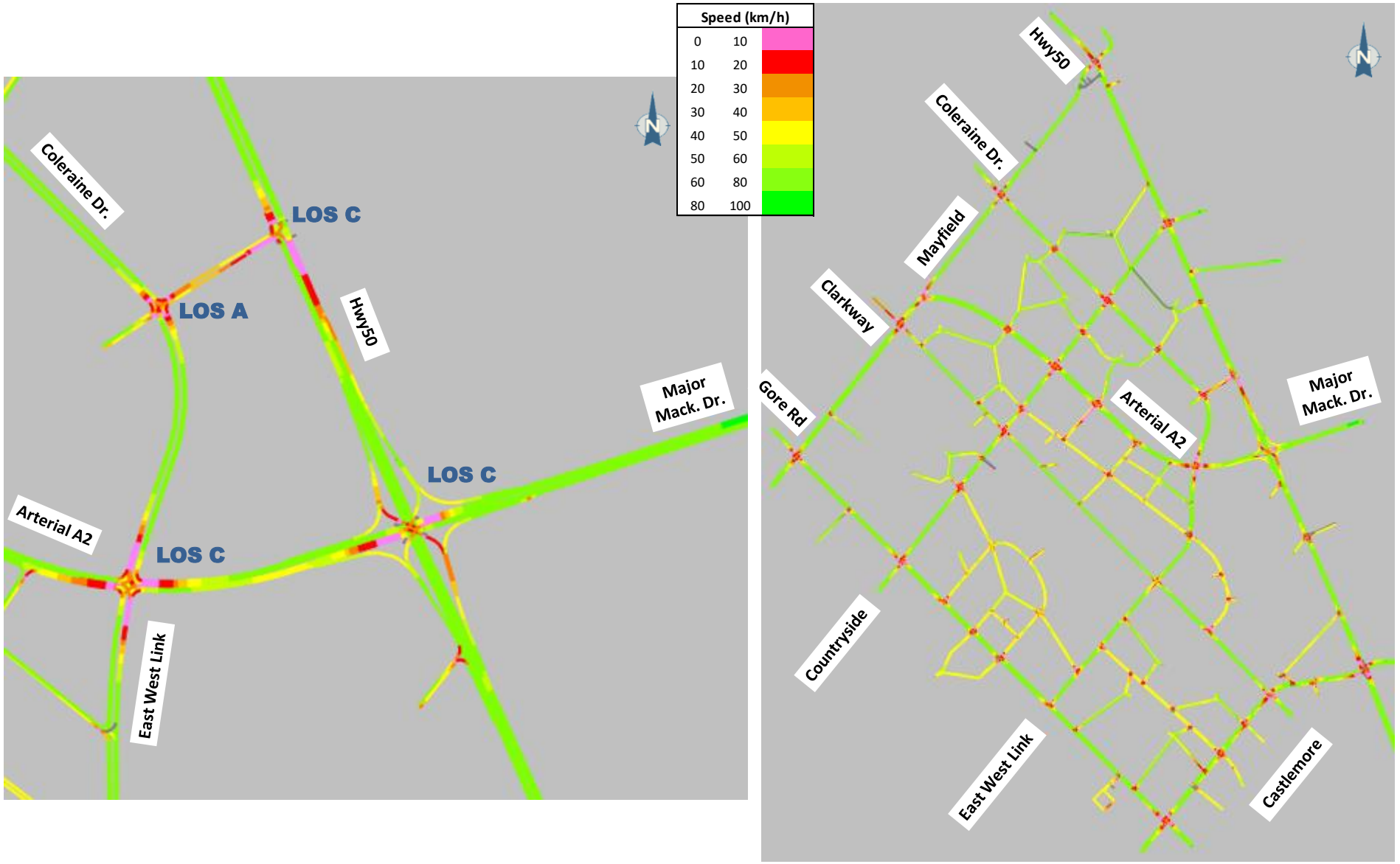
Movement	Volume	Avg. Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	35	40	112	363	D
NBT	1,814	55	108	357	E
NBL	682	68	108	357	E
EBR	428	25	61	205	C
EBT	890	76	55	197	E
EBL	41	148	55	197	F
SBR	55	9	105	395	A
SBT	798	30	106	392	C
SBL	766	95	106	392	F
WBR	540	17	71	201	B
WBT	1,642	59	64	193	E
WBL	80	43	64	193	D
Overall	**7,773**	**56**	**85**	**424**	**E**

Coleraine Dr./ EW Link and Arterial A2 Signal

Movement	Volume	Avg. Delay (s)	Avg. Queue (m)	Max. Queue (m)	LOS
NBR	179	38	32	111	D
NBT	343	49	25	100	D
NBL	26	50	25	100	D
EBR	69	6	25	78	A
EBT	673	39	20	68	D
EBL	130	66	20	68	E
SBR	15	56	47	138	E
SBT	183	48	40	127	D
SBL	546	59	40	127	E
WBR	1,066	26	45	245	C
WBT	912	43	43	236	D
WBL	388	48	43	236	D
Overall	**4,531**	**42**	**35**	**245**	**D**

Single Point Diamond Design

Single Point Diamond Design – 2041 AM Peak Speed Profiles



Single Point Diamond Design – 2041 AM Peak MOEs

Highway 50 and Major Mack. Dr. Signal

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
NBL*	820	31	36	272	C
SBL*	558	23	15	138	C
EBT	1,354	46	37	161	D
EBL	1	2	37	161	A
WBT	903	28	15	73	C
WBL	72	32	15	73	C
Overall	**3,708**	**27**	**26**	**272**	**C**

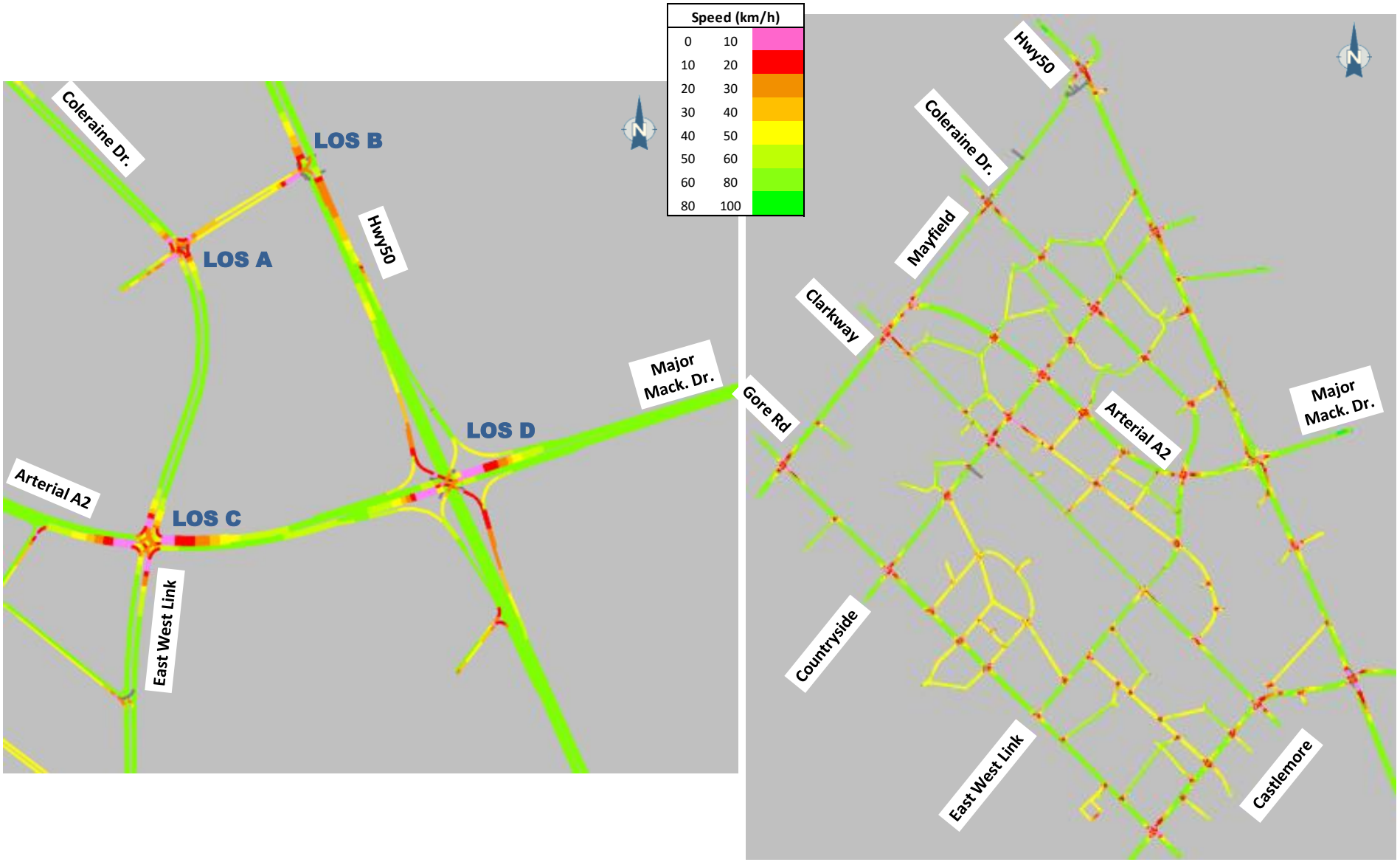
*** It is recommended that the NBL and SBL to be converted to dual left turns, which is expected to improve the performance of the left turns as well as the signal overall**

Coleraine Dr./ EW Link and Arterial A2 Signal

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
EBL	184	26	30	183	C
EBT	1,581	29	30	183	C
EBR	42	23	0	29	C
WBL	401	43	34	117	D
WBT	747	25	34	117	C
WBR*	593	22	39	129	C
NBL	26	71	31	129	E
NBT	182	64	31	129	E
NBR	344	46	27	149	D
SBL**	441	78	35	118	E
SBT	19	54	35	118	D
SBR	2	5	30	112	A
Overall	**4,562**	**35**	**28**	**183**	**C**

*** Channelized WBR is considered at Coleraine Dr./ Arterial A2 to accommodate the high demand**
**** Dual SBL is considered at Coleraine Dr./ Arterial A2 to achieve an acceptable LOS**

Single Point Diamond Design – 2041 PM Peak Speed Profiles



Single Point Diamond Design – 2041 PM Peak MOEs

Highway 50 and Major Mack. Dr. Signal

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
NBL*	945	39	69	358	D
SBL*	783	33	37	283	C
EBT	891	42	23	80	D
EBL	5	58	23	80	E
WBT	1,586	37	36	130	D
WBL	77	33	36	130	C
Overall	**4,287**	**40**	**37**	**358**	**D**

*** It is recommended that the NBL and SBL to be converted to dual left turns, which is expected to improve the performance of the left turns as well as the signal overall**

Coleraine Dr./ EW Link and Arterial A2 Signal

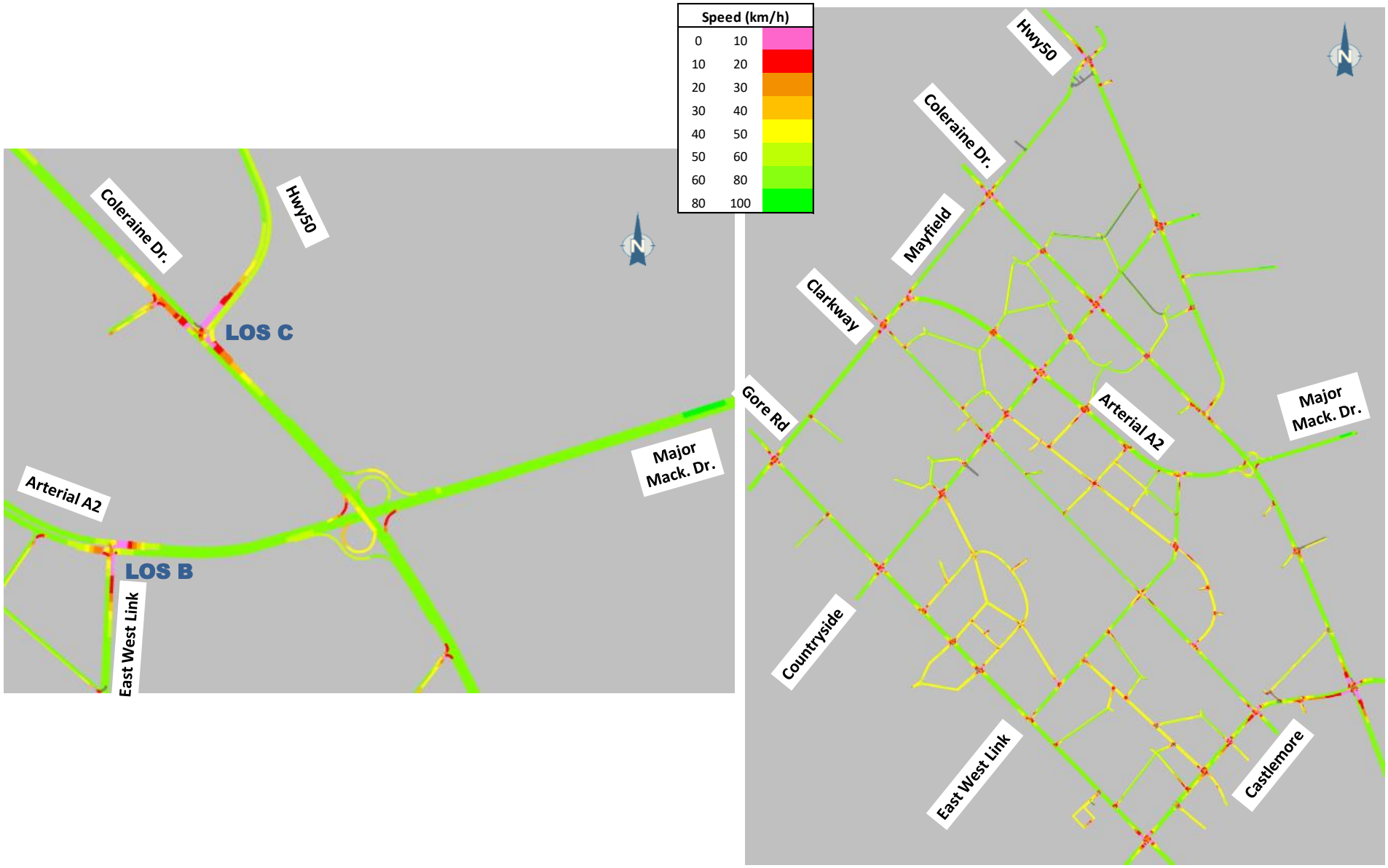
Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
EBL	57	43	28	109	D
EBT	1,101	40	28	109	D
EBR	54	30	6	118	C
WBL	531	63	46	132	E
WBT	1,208	18	46	132	B
WBR*	816	14	37	120	B
NBL	20	29	12	70	C
NBT	109	44	12	70	D
NBR	213	28	4	64	C
SBL**	184	43	10	37	D
SBT	89	36	10	37	D
SBR	22	9	5	31	A
Overall	**4,404**	**31**	**18**	**132**	**C**

*** Channelized WBR is considered at Coleraine Dr./ Arterial A2 to accommodate the high demand**

**** Dual SBL is considered at Coleraine Dr./ Arterial A2 to achieve an acceptable LOS**

Parclo A-type Design

Parclo A-type Design – 2041 AM Peak Speed Profiles



Parclo A-type Design – 2041 AM Peak MOEs

Coleraine Dr. and Highway 50 Signal

(Coleraine Dr.: NB/SB, Highway 50: EB/WB)

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
WBL	842	49	41	167	D
WBR	0	0	0	0	A
NBR	949	14	11	134	B
NBT	1,153	32	28	167	C
SBL	326	39	26	127	D
SBT	1,893	10	26	127	A
Overall	**5,163**	**24**	**30**	**171**	**C**

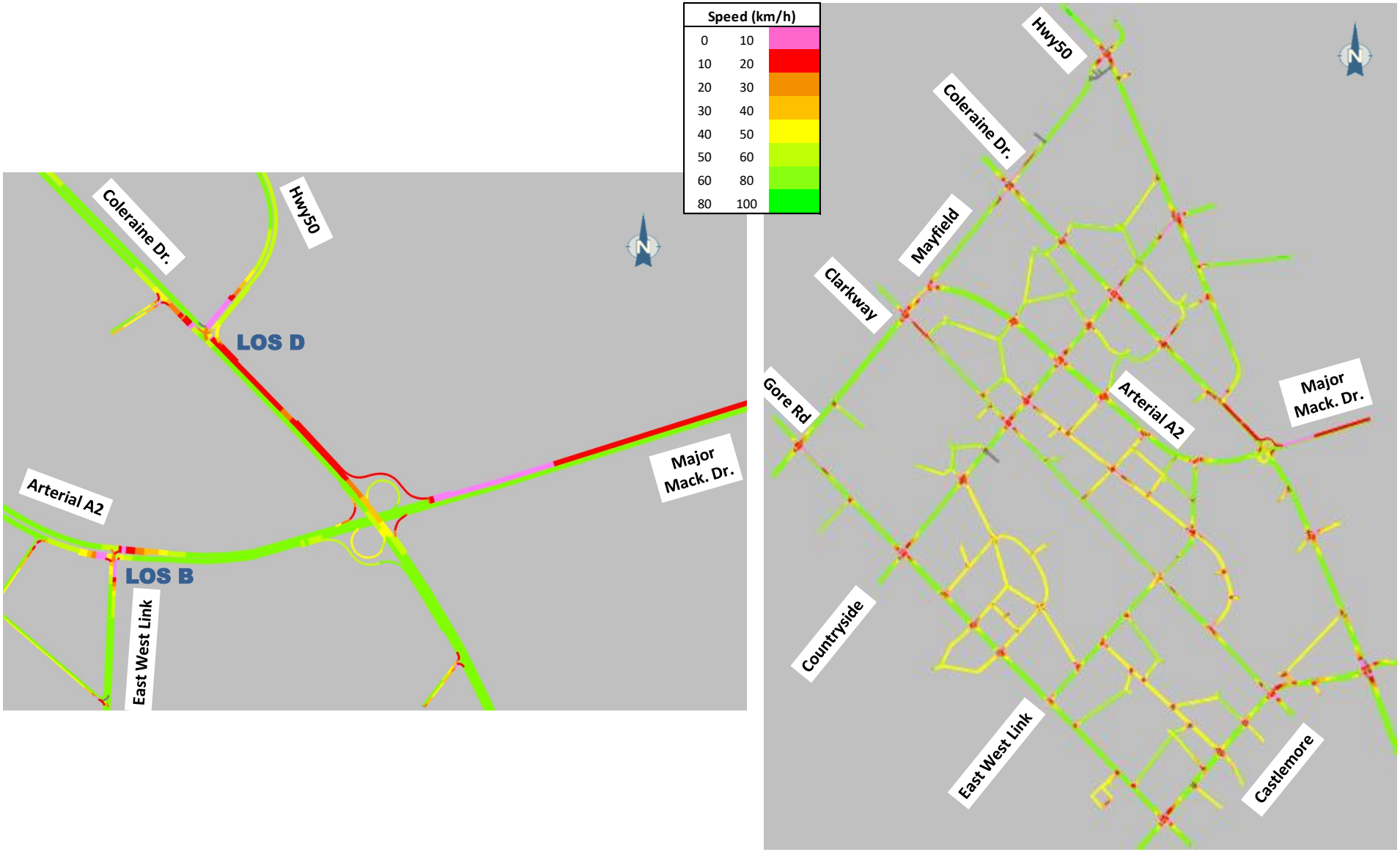
Arterial A2 and EW Link

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
EBT	1,180	6	4	68	A
EBR	32	3	1	55	A
WBL	450	39	21	91	D
WBT	617	6	21	91	A
NBL	209	45	37	140	D
NBR	606	32	43	148	C
Overall	**3,094**	**19**	**21**	**148**	**B**

Coleraine Dr. and Major Mack. Dr. Interchange (E-N Ramp)

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
WBR	1,122	4	0	12	A
WBT	887	0	0	12	A

Parclo A-type Design – 2041 PM Peak Speed Profiles



Parclo A-type Design – 2041 PM Peak MOEs

Coleraine Dr. and Highway 50 Signal

(Coleraine Dr.: NB/SB, Highway 50: EB/WB)

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
WBL	712	67	48	156	E
WBR	0	0	0	0	A
NBR	1,516	66	248	510	E
NBT	1,604	72	274	510	E
SBL	208	54	19	124	D
SBT	1,469	11	19	124	B
Overall	**5,509**	**53**	**128**	**510**	**D**

Arterial A2 and EW Link

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
EBT	812	17	7	66	B
EBR	65	3	3	53	A
WBL	588	24	17	152	C
WBT	761	9	17	152	A
NBL	197	53	18	68	D
NBR	222	10	24	76	B
Overall	**2,645**	**18**	**14**	**152**	**B**

Coleraine Dr. and Major Mack. Dr. Interchange (E-N Ramp)

Movement	Volume	Avg. Delay (sec)	Avg. Q len (m)	Max Q len (m)	LOS
WBR	917	301	556	> 900	F
WBT	893	90	350	> 700	F

Significant weaving happening at NB direction between Major Mack. off-ramp and Highway 50/ Coleraine Dr. intersection, which results in high traffic congestion and long queue spillback at Major Mack. WB.

Network Performance – Alternative Comparison

Scenario	AM							
	Avg. Delay (s)	Avg. Speed (km/h)	Total Distance Travelled (km)	Total Travel Time (hr)	Total Delay (hr)	Total Vehicles Served	Total Delay to Enter the Network (hr)	Total Vehicles NOT Served
At-grade Coleraine Dr. Realignment with East-West Link	121	43	87,475	2,041	770	22,810	0.3	1
Single Point Diamond Interchange Design	118	43	87,806	2,024	746	22,801	0.4	0
Parclo A-type Interchange Design	119	43	89,641	2,071	753	22,851	0.3	0

Scenario	PM							
	Avg. Delay (s)	Avg. Speed (km/h)	Total Distance Travelled (km)	Total Travel Time (hr)	Total Delay (hr)	Total Vehicles Served	Total Delay to Enter the Network (hr)	Total Vehicles NOT Served
At-grade Coleraine Dr. Realignment with East-West Link	140	41	95,334	2,314	936	24,143	0.2	1
Single Point Diamond Interchange Design	126	43	95,922	2,232	843	24,168	0.2	0
Parclo A-type Interchange Design	168	38	94,786	2,510	1,117	23,891	90.6	259

Thank you!

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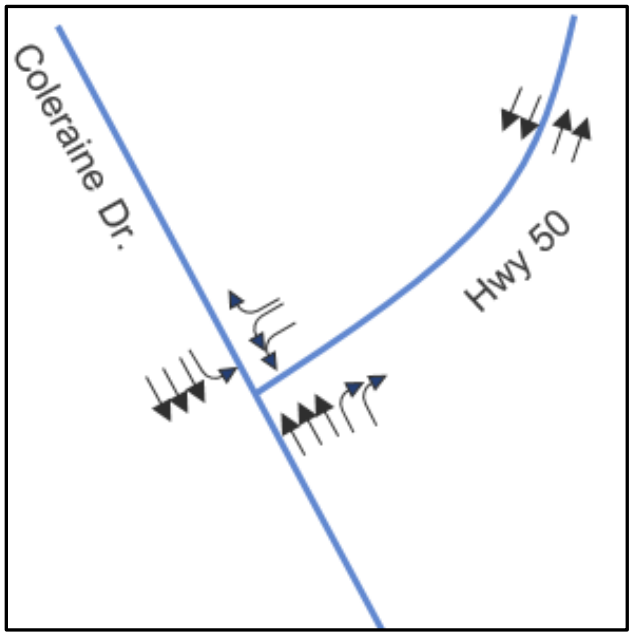
Parclo A-type Design



Mid-block Volume

Single Point Diamond Interchange Design – 2041		
Location	PM	
	Direction	Volume
Hwy 50 - north of the interchange	NB	2,500
	SB	1,800
Hwy 50 - south of the interchange	NB	2,907
	SB	1,680
Major Mac - east of the interchange	EB	1,707
	WB	2,271

Parclo A-type Interchange Design – 2041		
Location	PM	
	Direction	Volume
Hwy 50 - south of the interchange	NB	2,569
	SB	1,365
Major Mac - east of the interchange	EB	1,702
	WB	2,010

J

Appendix J - SP 47 EA Highway 50 Traffic Operations Analysis with Proposed Bus Facility

Memo

To: Mr. Mario Goolsarran, P.Eng., PMP

From: Rudy Sooklall (Wood), Thanushan Rajeswaran (Wood)

Date: September 23, 2020

File: TP115086

cc: John McGill (Wood)

Re: SP 47 EA Highway 50 Traffic Operations Analysis with Proposed Bus Facility

1.0 INTRODUCTION

Wood Environment & Infrastructure Solutions ("Wood") was retained by the City of Brampton (the "City") to provide engineering services to assess 2041 operations along Highway 50 segment from Major Mackenzie Drive to Fastfrate Entrance with a proposed Bus Maintenance and Storage Facility to be located south of Cadetta Road and a SPUI configuration at the intersection with Major Mackenzie Drive. A Vissim microsimulation model was developed to assess operations of the study corridor to identify any operational constraints and propose mitigation measures if required.

This memorandum documents the analysis methodology and findings of the Vissim microsimulation operations analysis.

2.0 STUDY APPROACH

The study corridor located in the City of Brampton spans approximately 1.0 km. A Vissim microsimulation corridor model was developed to determine operations on Highway 50 with the proposed Bus Facility, SPUI at Major Mackenzie Drive and adjacent background developments with accesses at Cadetta Road and the Bus Facility Driveway. The adjacent background developments comprise of office and logistics/warehouse land uses located north of Cadetta Road in the Triangle Lands, and logistics/warehouse land use south of the Bus Facility. The study corridor is shown in **Figure 1** with the three study intersections:

- Highway 50 and Major Mackenzie/Arterial A2 (SPUI configuration)
- Highway 50 and Cadetta Road (signalized)
- Highway 50 and Fastfrate Entrance/Bus Facility Entrance (signalized)

Figure 1: Study Corridor and Intersections

The 2041 future conditions were assessed during weekday AM and PM peak hour operations with:

- SPUI configuration at the intersection of Highway 50 and Major Mackenzie/Arterial A2
- Transit Facility site traffic
- Triangle Lands site traffic
- Site traffic from logistics/warehouse land use south of the Bus Facility

The focus of the traffic operations analysis was:

- Evaluate operations of the three study intersections
- Traffic operations along the Highway 50 segment from Major Mackenzie Drive to Fastfrate Entrance including potential queuing of vehicles between the closely spaced study intersections
- Potential southbound weave on Highway 50 between Major Mackenzie Drive/Arterial A2 and Cadetta Road

A Vissim microsimulation model was chosen to assess traffic operations along the study corridor based on the following rationale:

- Synchro is not reliable to address queuing between closely spaced intersections
- SPUI operations are better modelled in Vissim compared to Synchro
- Transit routes can be explicitly modelled in Vissim

The analysis methodology is described in detail in the following subsections.

2.1 Vissim Model Development

Microsimulation models for the weekday AM and PM peak hour periods were developed using the Vissim 10 software. A 90-minute period was modelled for each peak which consists of a 30-minute warm-up period followed by the peak hour. Traffic operations for the 2041 horizon

were assessed for the study corridor with the intersection of Highway 50 and Major Mackenzie Drive having a SPUI configuration using two demand scenarios forecasted by CIMA+ for the SP 47 overall study area:

- Demand with an at-grade intersection at Highway 50 and Major Mackenzie Drive (At-Grade Forecasted Demand)
- Demand with a SPUI configuration at Highway 50 and Major Mackenzie Drive (SPUI Forecasted Demand)

2.1.1 Vissim Network

The Vissim network was coded using a scaled background image from the AutoCAD design of the Highway 50 study segment to ensure correct dimensions of the SPUI and distances between closely spaced intersections were used in the model development. The mainline sections of Highway 50, Major Mackenzie Drive, Arterial A2, Cadetta Road, Fastfrate Entrance and Bus Facility Entrance were coded in the model and the following vehicle types were used:

- Cars
- Single-Unit Trucks
- Articulated Trucks
- Buses

Transit routes were coded into the model based on the forecasted bus facility site trips provided by IBI Group. A The speed limit of 70 km/h was used for Highway 50, 60 km/h for Major Mackenzie Drive and Arterial A2, and 50 km/h for Cadetta Road, Fastfrate Entrance and Bus Facility Entrance. A 130-second cycle length was used for the SPUI (Highway 50 and Major Mackenzie Drive/Arterial A2) with the AM peak hour At-Grade demand scenario and a 120-second cycle length all other times. The Highway 50 and Cadetta Road and Highway 50 and Fastfrate Entrance/Bus Facility Entrance intersections operated with a 100-second cycle length and these two intersections were coordinated. The Vissim network developed for the 2041 future conditions is shown in **Figure 2**.

Figure 2: 2041 Vissim Network

2.2 2041 Forecasted Demand

The 2041 forecasted demand used in this analysis was developed based on the following:

- Forecasted demand at the intersection of Highway 50 and Major Mackenzie Drive/Arterial A2 with At-Grade and SPUI configurations provided by CIMA+
- Forecasted Bus Facility site trips (bus and auto) provided by IBI Group
- Forecasted Triangle Lands site trips generated using estimated number of jobs for the Office Node and Logistics/Warehouse Land Uses provided by the City of Brampton
- Forecasted site trips generated using estimated number of jobs for the Logistics/Warehouse Land Use provided by the City of Brampton for the lands south of the Bus Facility

The development of the 2041 forecasted demand is described in detail in the following subsections.

2.2.1 Demand with At-Grade and SPUI Configuration at Major Mackenzie Drive

The 2041 forecasted demand volumes at the intersection of Highway 50 and Major Mackenzie Drive/Arterial A2 provided by CIMA+ with an At-Grade and SPUI configurations are shown in **Figure 3** and **Figure 4,** respectively.

The existing turning movements at the Cadetta Road and Fastfrate Entrance/Bus Facility Entrance intersections with Highway 50 are also shown and the through movements at these two intersections were carried from the Highway 50 and through with the Major Mackenzie Drive/Arterial A2 intersection.

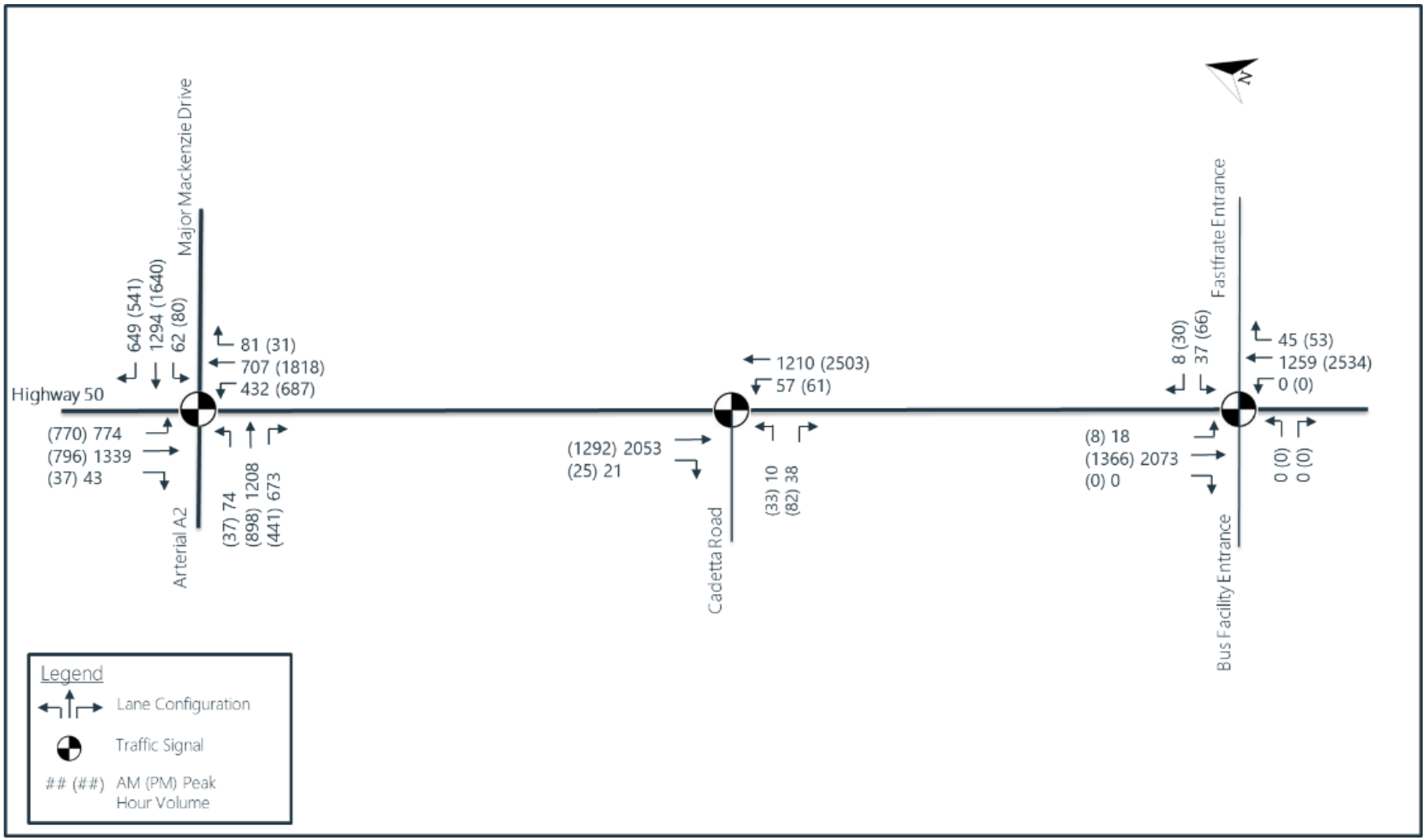


Figure 3: 2041 SPUI Traffic Volumes (At-Grade Forecasted Demand)

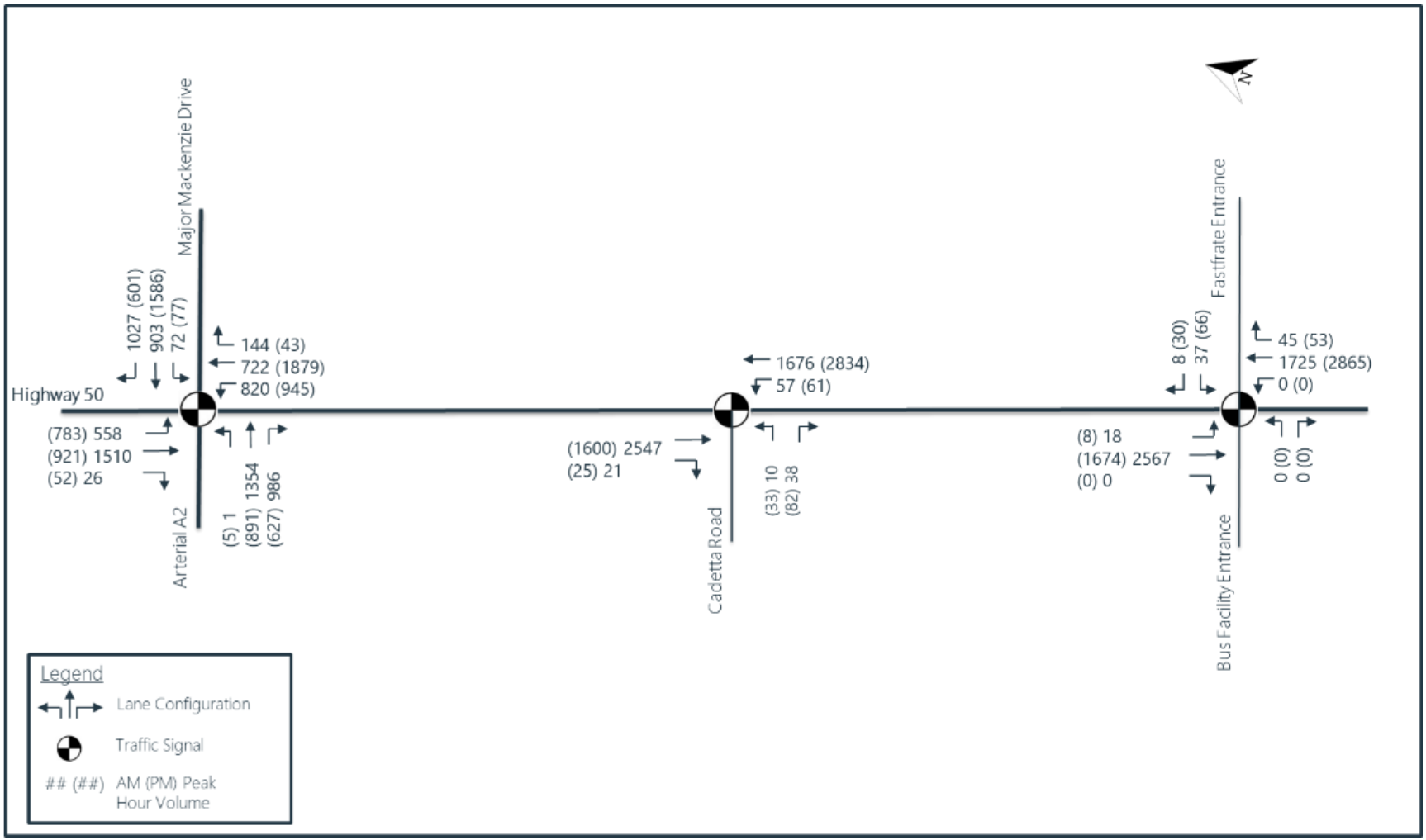


Figure 4: 2041 SPUI Traffic Volumes (SPUI Forecasted Demand)

2.2.2 Bus Facility Site Traffic

The 2041 forecasted bus facility demand site traffic provided by IBI Group consists of buses and autos and are shown in **Figure 5** and **Figure 6,** respectively.

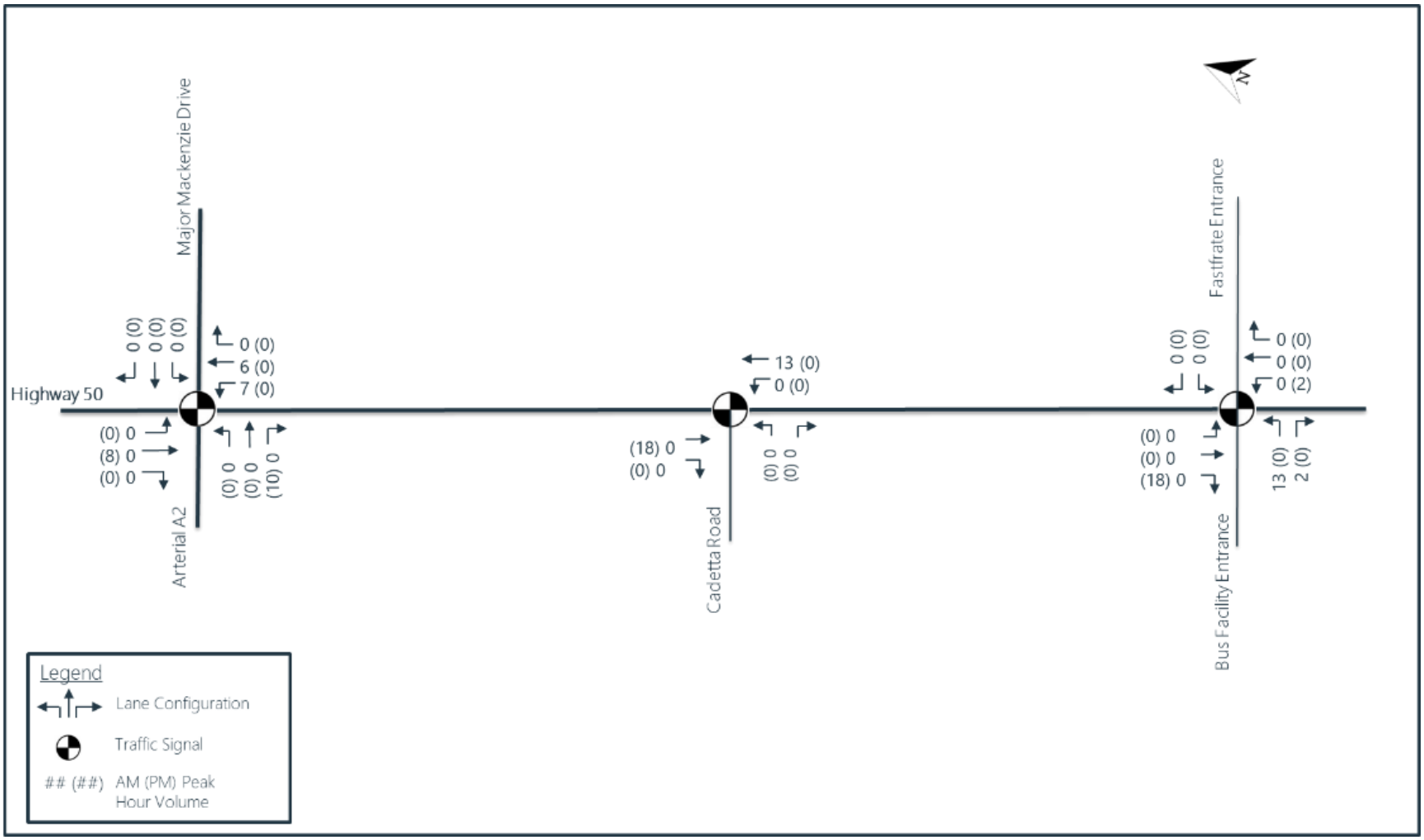


Figure 5: 2041 Bus Facility Site Trips (Buses)

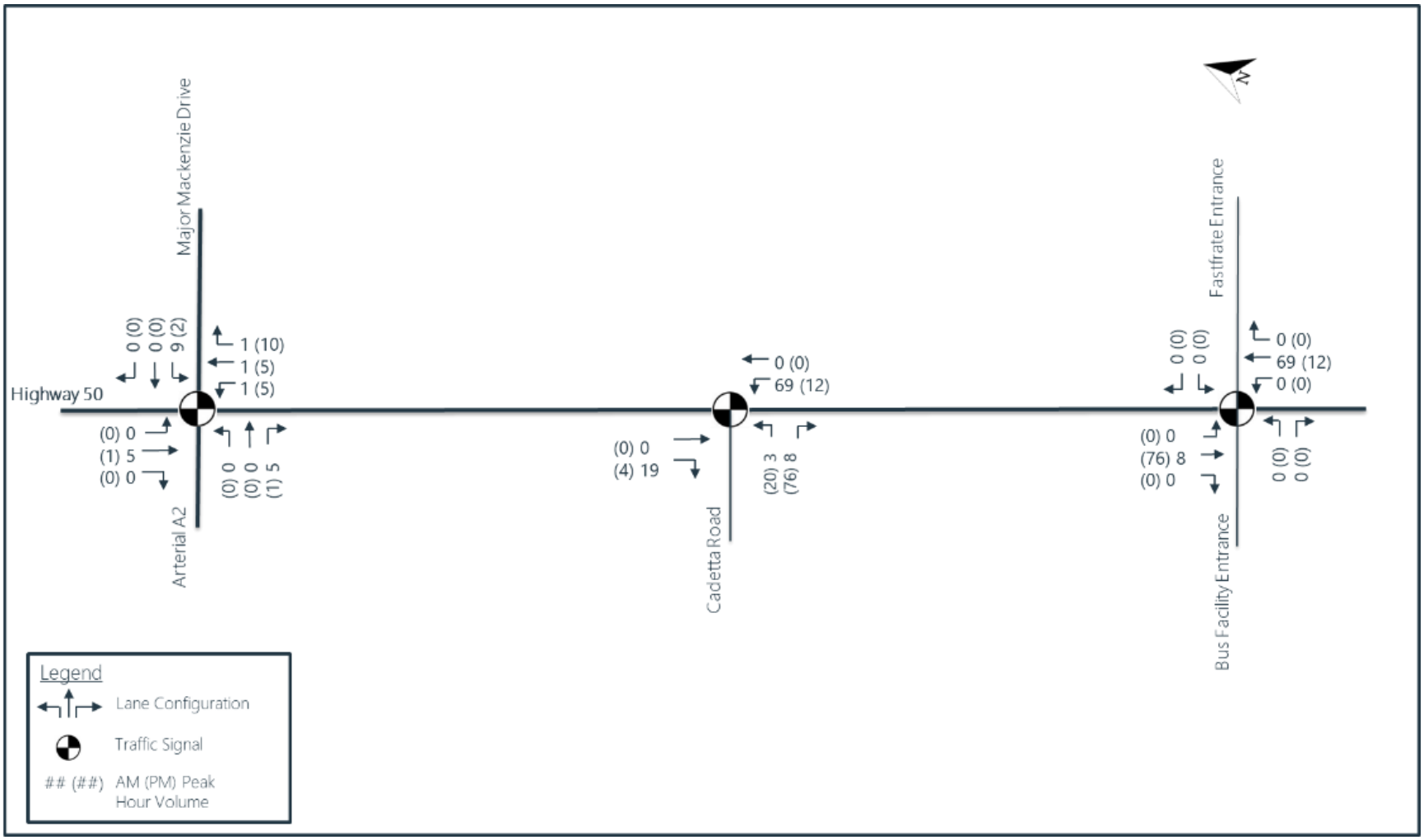


Figure 6: 2041 Bus Facility Site Trips (Autos)

2.2.3 Triangle Lands Site Trips

The 2041 forecasted Triangle Lands site trips comprise of trips generated by an Office Node and Logistics/Warehouse land use. Assumptions made in generating site trips to the Office Node are:

- 50% of 598 jobs forecast by the City (299 jobs)
- Non-auto mode split of 20% (239 peak period site trips)
- 70% of peak period site trips made during peak hour (167 site trips)
- Single-unit trucks and Articulated Truck percentages based on existing conditions

Assumptions made in generating Logistics/Warehouse site trips are:

- 5% of 2,584 jobs based on area of Triangle Lands compared to total lands for this land use
- 2 shifts assumed for this land use (65 jobs per shift)
- Non-auto mode split of 20% (52 peak period site trips)
- Single-unit trucks and Articulated Truck percentages based on existing conditions

Table 1 provides a summary of the Triangle Lands generated site trips validated against trips generated using trips rates from the ITE Trip Generation Manual. The results show that the site trips generated using the City's forecast for the SP 47 area are generally in line with the trips forecasted using the ITE Trip Generation Manual.

Table 1: Triangle Lands Site Trips

Triangle Lands Site Trips					
Peak Hour	**Land Use Designation**	**Area (hectares)**	**Trips using City's Forecast**	**ITE Trip Generation**	**Difference**
AM	Office Node	1.8	209	209	0
	Logistics, Warehouse & Transportation	4.2	65	79	-14
PM	Office Node	1.8	209	288	-79
	Logistics, Warehouse & Transportation	4.2	65	82	-17

The 2041 forecasted office and warehouse site trips for Triangle Lands used in this analysis are shown in **Figure 7** and **Figure 8**, respectively. Access to the Triangle Lands is via Cadetta Road.

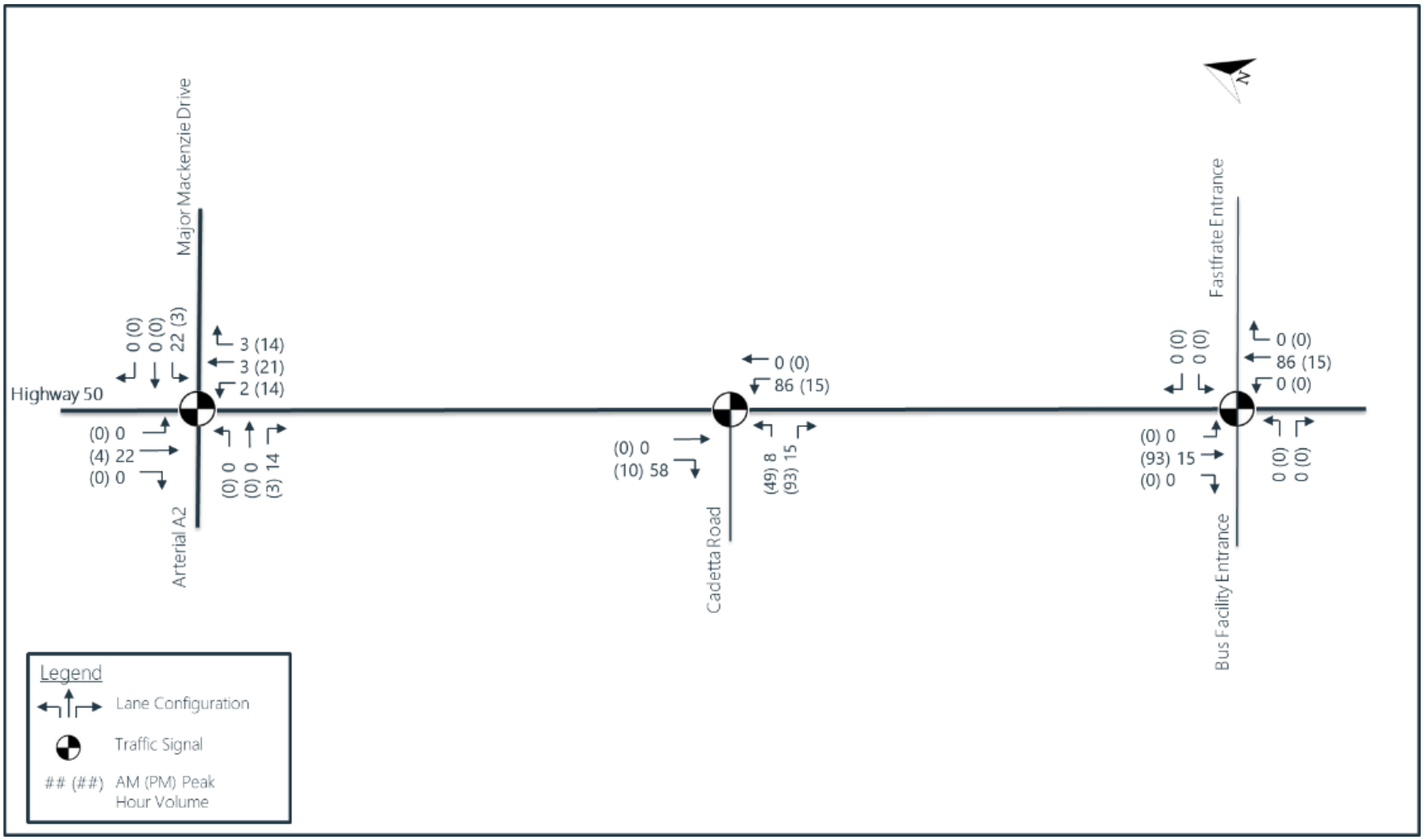


Figure 7: 2041 Office Site Trips (Triangle Lands)

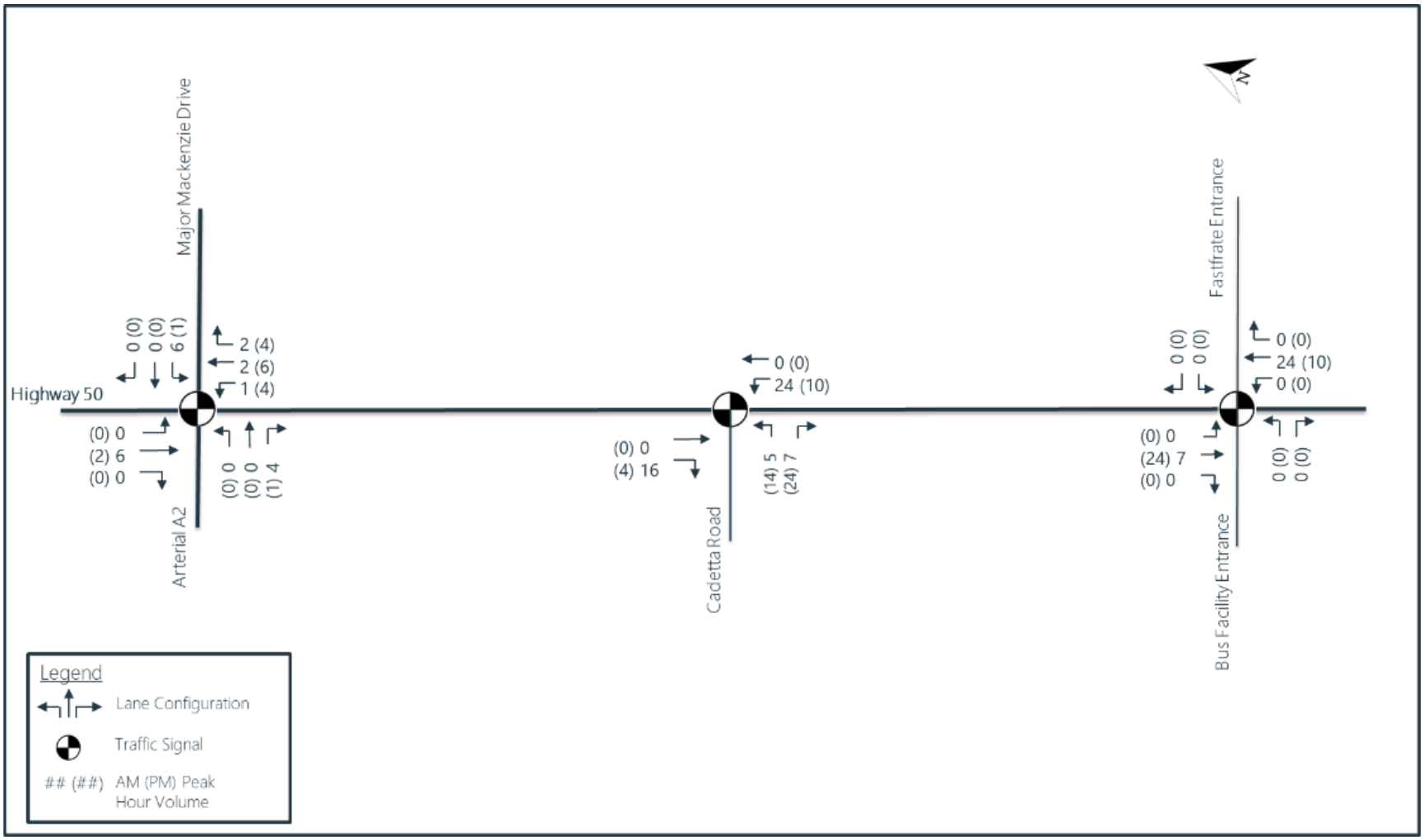


Figure 8: 2041 Warehouse Site Trips (Triangle Lands)

2.2.4 Logistics/Warehouse Site Trips

Lands located south of the proposed Bus Facility are designated as Logistics/Warehouse land use and it is expected that 50% of trips generated from these lands will use the Bus Facility Entrance. Assumptions made in generating Logistics/Warehouse site trips which will use the Bus Facility Entrance are:

- 7% of 2,584 jobs based on area of the lands compared to total lands for this land use
- 2 shifts assumed for this land use (91 jobs per shift)
- Non-auto mode split of 20% (73 peak period site trips)
- Single-unit trucks and Articulated Truck percentages based on existing conditions
- 50% of trips will use the Bus Facility Entrance

Table 2 provides a summary of the Logistics/Warehouse generated site trips validated against trips generated using trips rates from the ITE Trip Generation Manual. The results show that the site trips generated using the City's forecast for the SP 47 area are in line with the trips forecasted using the ITE Trip Generation Manual.

Table 2: Logistics Warehouse Site Trips

Logistics Warehouse Site Trips					
Peak Hour	**Land Use Designation**	**Area (hectares)**	**Forecasted Trips**	**ITE Trip Generation**	**Difference**
AM	Logistics, Warehouse & Transportation	5.2	91	92	-1
PM	Logistics, Warehouse & Transportation	5.2	91	95	-4

The 2041 forecasted warehouse site trips used in this analysis are shown in **Figure 9**.

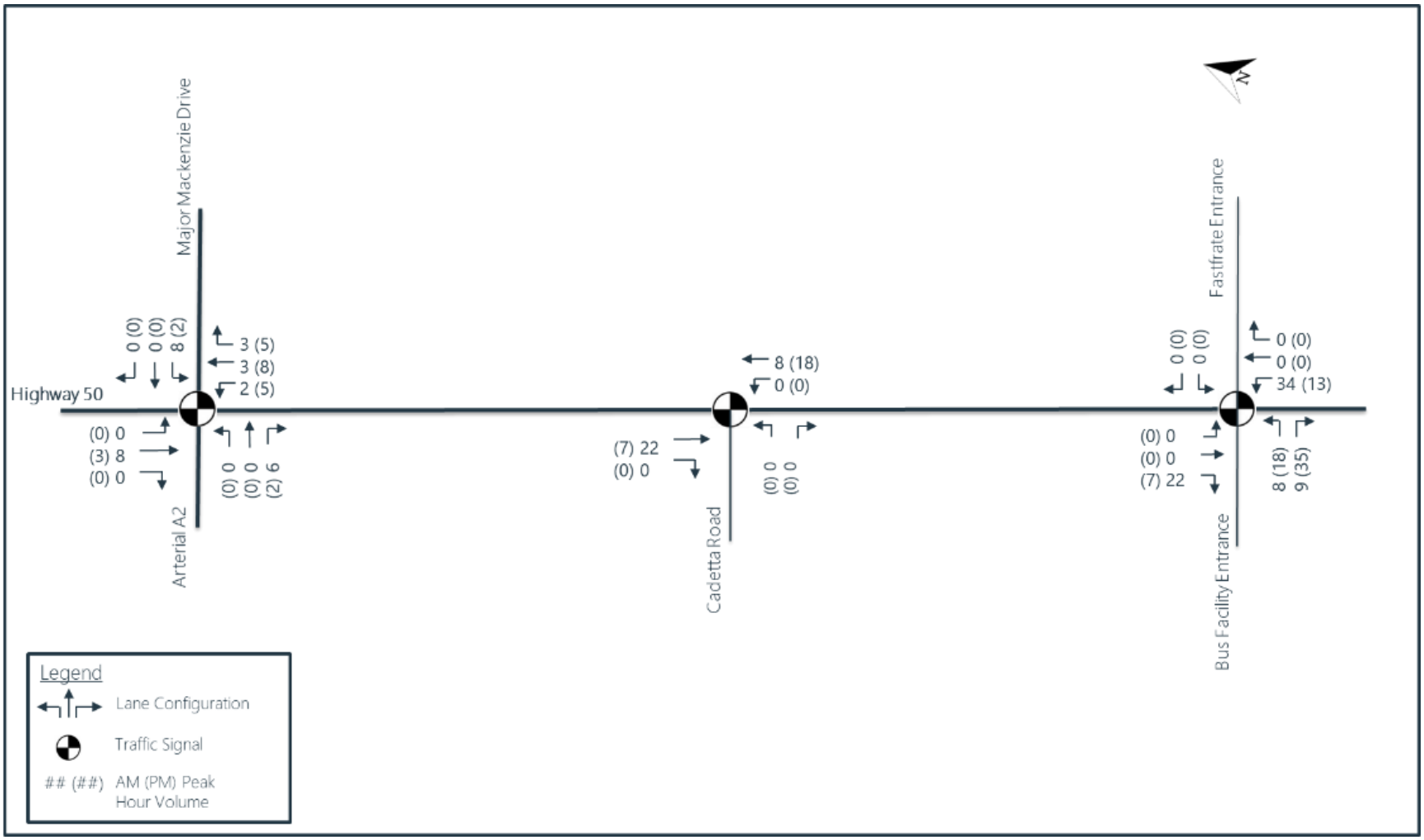


Figure 9: 2041 Warehouse Site Trips (Bus Facility Entrance)

2.2.5 2041 Total Demand with At-Grade and SPUI Configuration at Major Mackenzie Drive

The resulting 2041 total demand for the study corridor are shown in **Figure 10** and **Figure 11** with Major Mackenzie Drive having At-Grade and SPUI configurations, respectively.

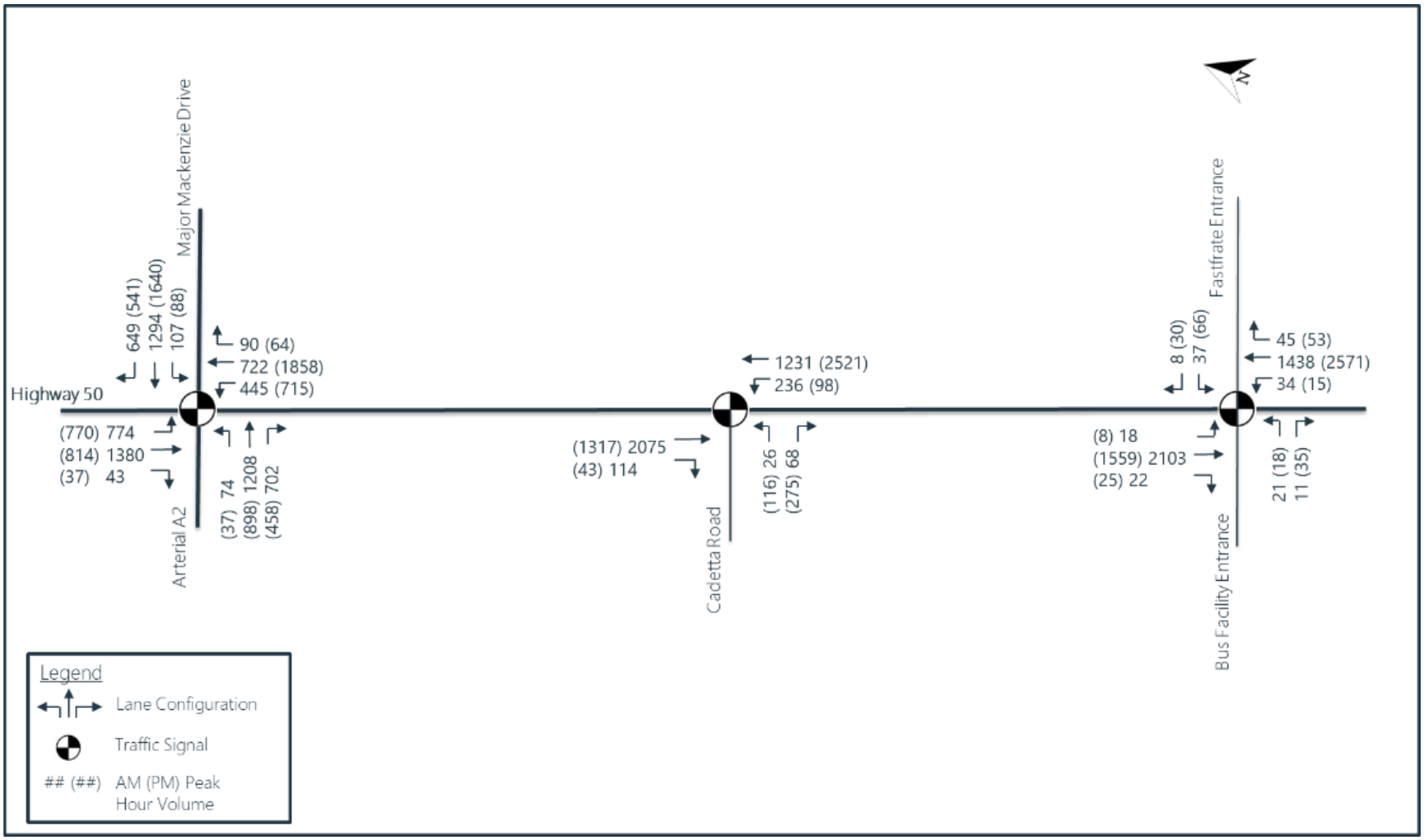


Figure 10: 2041 SPUI Total Traffic Volumes (At-Grade Forecasted Demand)

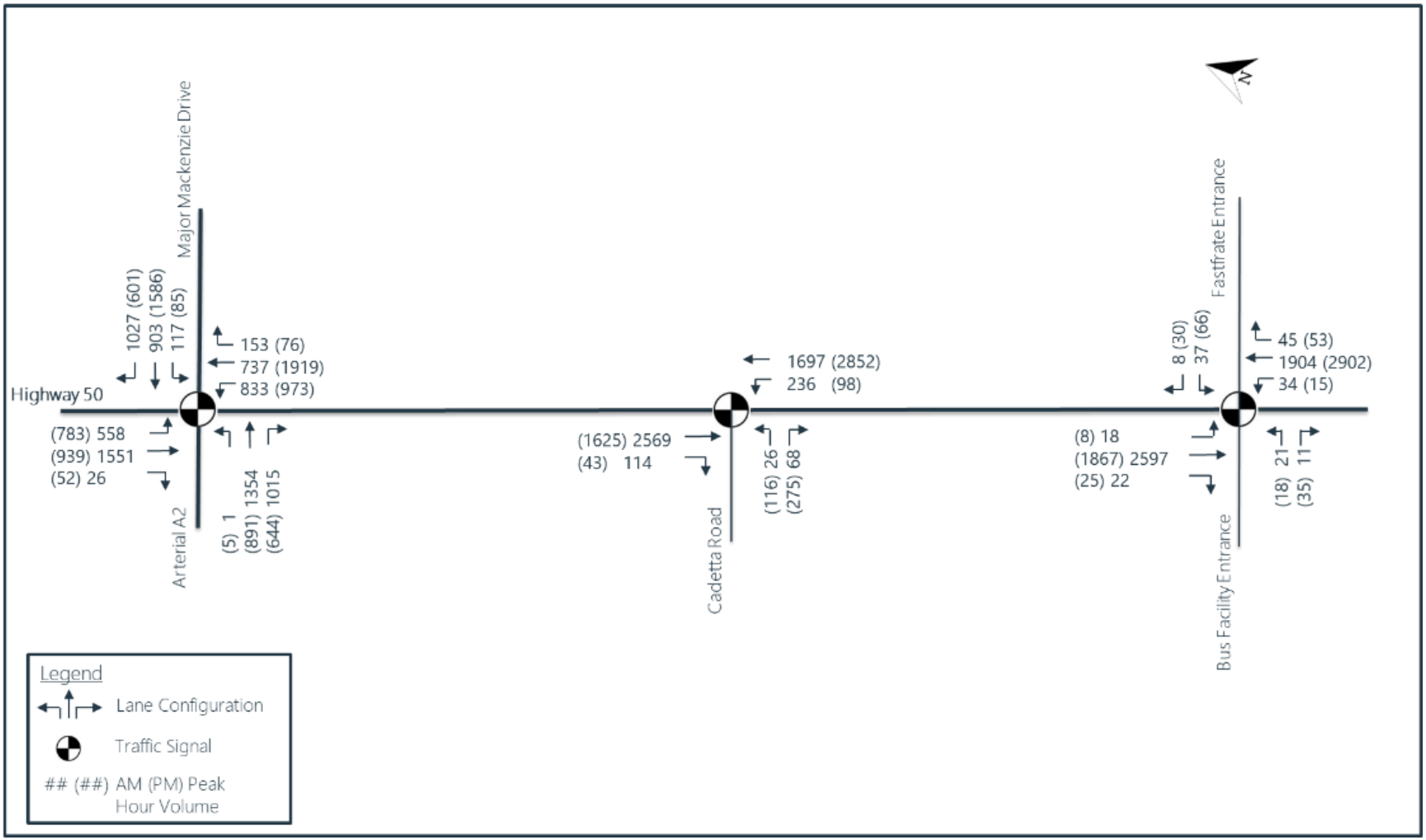


Figure 11: 2041 SPUI Total Traffic Volumes (SPUI Forecasted Demand)

3.0 MODELLING RESULTS

Two demand scenarios were modelled for the Highway 50 study corridor with a SPUI at Major Mackenzie Drive/Arterial A2:

- AM and PM Peak Hours with At-Grade Forecasted Demand
- AM and PM Peak Hours with SPUI Forecasted Demand

The analysis assessed operations for all movements at study intersections and the measures of effectiveness (MOEs) used are queues, delays, and level of service (LOS). The following subsections summarize the intersection operations results for the weekday AM and PM peak hours. The reported results are based on an average of 10 simulation runs.

3.1 Scenario 1: At-Grade Demand with SPUI Configuration

The LOS, delay and maximum queue lengths for turning movements at Highway 50 and Major Mackenzie/Arterial A2 intersection during the weekday AM and PM peak hours are summarized in **Table 3**.

Table 3: Highway 50 and Major Mackenzie Drive/Arterial A2 Results (At-Grade Demand)

Highway 50 and Major Mackenzie Drive/Arterial A2 (At-Grade Demand)					
Turning Movement	**LOS (Delay [sec])**		**Maximum Queue Length (m)**		
	AM	**PM**	**AM**	**PM**	**Storage Length**
SBL	C (34.7)	C (34.2)	**342**	**301**	**280**
SBT (to Highway 50)	A (0.0)	A (0.0)	-	-	**-**
SBT (to Cadetta)	**E (60.7)**	**E (57.9)**	36	18	**260**
SBR	A (0.4)	A (0.4)	0	0	**310**
NBL	C (32.7)	C (29.9)	73	97	**350**
NBT	A (0.0)	A (0.1)	-	-	**-**
NBR	A (0.9)	A (2.0)	0	0	**375**
EBL	**E (67.4)**	**E (59.7)**	28	17	**190**
EBT	D (43.5)	D (35.6)	114	71	**300+**
EBR	A (1.5)	A (0.8)	0	0	**285**
WBL	**E (62.8)**	D (54.5)	45	42	**135**
WBT	D (48.8)	D (45.1)	187	231	**300+**
WBR	A (3.4)	A (2.9)	38	16	**285**
Overall	**C (23.8)**	**C (20.9)**	**-**	**-**	**-**

The results show that the EB left turn for both peak hours are expected to operate with a LOS 'E' under 2041 conditions with the forecasted At-Grade demand. The WB left is expected to operate with LOS 'E' during the AM peak hour. This is due to competing demand for green time at the

SPUI and that the EB and WB left turns are fully protected for safety reasons. However, queues for the EB and WB left turns can be accomodated in the available storage without impeding traffic flow.

Operational issues are expected for the SB left turn during both peak hours due to very high turning volumes with queues expected to occasionally spillback Highway 50 mainline. Due to the high demand for the SB left turn, SB through traffic to Cadetta Road are impeded by the SB left queue as shown in **Figure 12** (solid red line is SB left queue and dashed line is through movement).

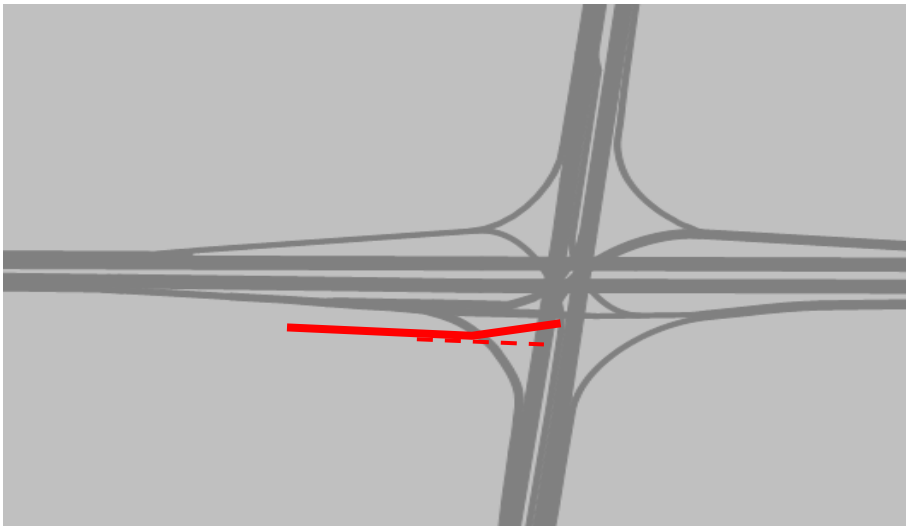


Figure 12: SB Left Queue Blocking Access to the Through Movement

The LOS, delay and maximum queue lengths for turning movements at Highway 50 intersections at Cadetta Road Fastfrate Entrance/Bus Facility Entrance during the weekday AM and PM peak hours are summarized in **Table 4** and **Table 5**, respectively.

Table 4: Highway 50 and Cadetta Road Results (At-Grade Demand)

Highway 50 and Cadetta Road (At-Grade Demand)					
Turning Movement	**LOS (Delay [sec])**		**Maximum Queue Length (m)**		
	AM	**PM**	**AM**	**PM**	**Storage Length**
SBT (to Cadetta)	A (7.2)	A (5.7)	103	58	**295**
SBT (to Highway 50)	A (5.7)	A (4.7)	49	27	**350+**
SBR	A (3.1)	A (2.2)	19	9	**295**
NBL	C (23.8)	A (7.5)	44	9	**105**
NBT	A (2.0)	A (4.1)	28	63	**330**
EBL	D (46.8)	D (44.0)	21	35	**75**
EBR	A (7.0)	A (7.5)	19	30	**75**
Overall	**A (6.2)**	**A (5.6)**	-	-	-

Table 5: Highway 50 and Fastfrate Entrance/Bus Facility Entrance Results (At-Grade Demand)

Highway 50 and Fastfrate Entrance/Bus Facility Entrance (At-Grade Demand)					
Turning Movement	LOS (Delay (sec))		Maximum Queue Length (m)		
	AM	PM	AM	PM	Storage Length
SBL	B (15.7)	D (35.7)	4	2	**95**
SBT	A (5.8)	A (4.3)	-	-	**-**
SBR	A (8.4)	A (5.9)	-	-	**-**
NBL	B (11.5)	A (9.4)	5	3	**120**
NBT	A (4.4)	A (7.1)	-	-	**-**
NBR	A (2.2)	A (3.1)	-	-	**-**
EBL	D (44.1)	D (39.3)	-	-	**-**
EBR	B (13.6)	B (10.5)	-	-	**-**
WBL	D (41.3)	D (40.2)	-	-	**-**
WBR	B (12.7)	B (18.4)	-	-	**-**
SBTR	-	-	80	42	**335**
NBTR	-	-	61	232	**500+**
WBLR	-	-	29	22	**100**
EBLR	-	-	45	16	**60**
Overall	**A (5.9)**	**A (6.9)**	**-**	**-**	**-**

The results show that turning movements at the Highway 50 intersections at Cadetta Road and Fastfrate Entrance/Bus Facility Entrance are expected to operate with a LOS 'D' or better for both AM and PM peak hours with the forecasted At-Grade demand. No queuing issues were observed on Highway 50 between Major Mackenzie Drive and Fastfrate Entrance/Bus Facility Entrance. Furthermore, no weaving issues were observed on SB Highway 50 between Major Mackenzie Drive and Cadetta Road. All queues are expected to be accomadated within the available storage lengths at these two intersections.

3.2 Scenario 2: SPUI Demand with SPUI Configuration

The LOS, delay and maximum queue lengths for turning movements at Highway 50 and Major Mackenzie/Arterial A2 during the weekday AM and PM peak hours are summarized in **Table 6**.

The results show that the EB and WB left turns for both peak hours are expected to operate with a LOS 'E' under 2041 conditions with the forecasted SPUI demand. Similar to the scenario with the At-Grade demand this is due to competing demand for green time at the SPUI and that the EB and WB left turns are fully protected for safety reasons. The SB left queue is expected to very occasionally spillback to Highway 50 mainline.

Table 6: Highway 50 and Major Mackenzie Drive/Arterial A2 Results (SPUI Demand)

Highway 50 and Major Mackenzie Drive/Arterial A2 (SPUI Demand)					
Turning Movement	LOS (Delay (sec))		Maximum Queue Length (m)		
	AM	PM	AM	PM	Storage Length
SBL	C (27.4)	C (33.3)	139	**300**	**280**
SBT (to Highway 50)	A (0.0)	A (0.0)	-	-	**-**
SBT (to Cadetta)	**E (57.8)**	D (56.2)	39	16	**260**
SBR	A (0.2)	A (0.4)	0	0	**310**
NBL	D (39.9)	C (32.3)	153	131	**350**
NBT	A (0.0)	A (0.1)	-	-	**-**
NBR	A (8.4)	A (5.8)	0	0	**375**
EBL	**E (60.4)**	**E (69.7)**	2	4	**190**
EBT	D (45.3)	D (36.4)	138	71	**300+**
EBR	A (2.4)	A (1.0)	0	0	**285**
WBL	**E (56.5)**	**E (57.0)**	47	37	**135**
WBT	C (25.4)	C (32.8)	90	156	**300+**
WBR	A (3.2)	A (2.3)	5	2	**285**
Overall	**B (18.3)**	**B (17.8)**	**-**	**-**	**-**

The LOS, delay and maximum queue lengths for turning movements at Highway 50 intersections at Cadetta Road Fastfrate Entrance/Bus Facility Entrance during the weekday AM and PM peak hours are summarized in **Table 7** and **Table 8**, respectively.

Table 7: Highway 50 and Cadetta Road Results (SPUI Demand)

Highway 50 and Cadetta Road (SPUI Demand)					
Turning Movement	LOS (Delay (sec))		Maximum Queue Length (m)		
	AM	PM	AM	PM	Storage Length
SBT (to Cadetta)	A (9.5)	A (6.2)	148	73	**295**
SBT (to Highway 50)	A (6.4)	A (4.7)	62	32	**350+**
SBR	A (4.2)	A (2.3)	28	9	**295**
NBL	C (33.9)	B (11.3)	54	12	**105**
NBT	A (2.1)	A (3.9)	34	77	**330**
EBL	D (51.0)	D (43.9)	21	35	**75**
EBR	A (7.1)	A (7.5)	19	30	**75**
Overall	**A (7.1)**	**A (5.6)**	**-**	**-**	**-**

Table 8: Highway 50 and Fastfrate Entrance/Bus Facility Entrance SPUI Demand

Highway 50 and Fastfrate Entrance/Bus Facility Entrance (SPUI Demand)					
Turning Movement	LOS (Delay (sec))		Maximum Queue Length (m)		
	AM	PM	AM	PM	Storage Length
SBL	C (22.9)	D (49.6)	3	4	**95**
SBT	A (6.3)	A (4.8)	-	-	**-**
SBR	A (9.2)	A (7.4)	-	-	**-**
NBL	B (16.1)	B (11.7)	7	4	**120**
NBT	A (5.2)	A (8.7)	-	-	**-**
NBR	A (2.1)	A (3.7)	-	-	**-**
EBL	D (44.6)	D (37.0)	-	-	**-**
EBR	B (13.3)	B (10.3)	-	-	**-**
WBL	D (40.6)	D (39.9)	-	-	**-**
WBR	B (18.1)	C (21.9)	-	-	**-**
SBTR	-	-	147	54	**335**
NBTR	-	-	117	506	**500+**
WBLR	-	-	29	22	**100**
EBLR	-	-	45	16	**60**
Overall	**A (6.5)**	**A (7.9)**	**-**	**-**	**-**

The results show that turning movements at the Highway 50 intersections at Cadetta Road and Fastfrate Entrance/Bus Facility Entrance are expected to operate with a LOS 'D' or better for both AM and PM peak hours with the forecasted SPUI demand. No queuing issues were observed on Highway 50 between Major Mackenzie Drive and Fastfrate Entrance/Bus Facility Entrance. Furthermore, no weaving issues were observed on SB Highway 50 between Major Mackenzie Drive and Cadetta Road. All queues are expected to be accomadated within the available storage lengths at these two intersections.

4.3 Summary of Results

The results from the analysis show that the main operational issue along the Highway 50 study corridor is expected at the SB left turn at the SPUI, especially during the AM peak hour with the At-Grade forecasted demand where the queue from this movement is expected to spillback to the Highway 50 mainline. However, no queuing issues are expected during the AM peak hour with the SPUI forecasted demand and it is expected that operations will be closer to the SPUI demand than the At-Grade demand. This is illustrated in **Figure 13** and **Figure 14** for the AM and PM peak hours, respectively. It can be seen that the PM queues may occasionally extend beyond the available storage but this is not expected to be a major concern.

The proposed Bus Facility site trips are not expected to negatively impact the Major Mackenzie Drive/Arterial A2 SPUI operations based on the modelling results.

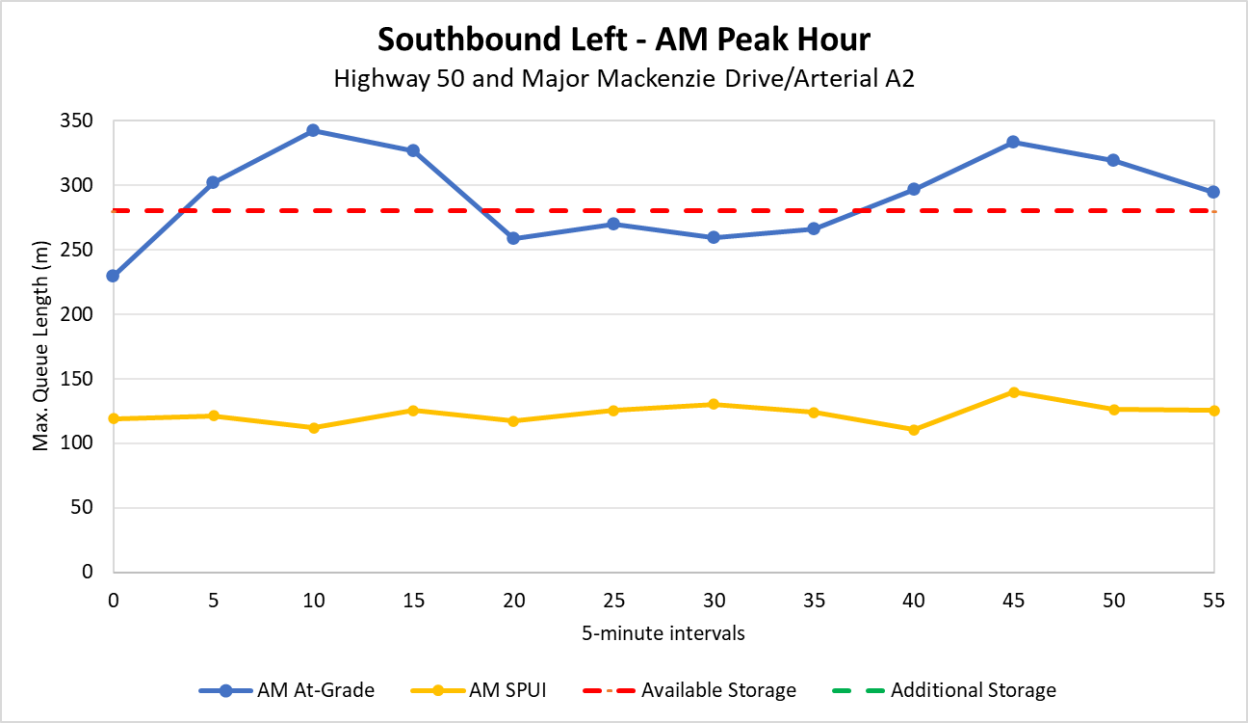


Figure 13: SB Left at SPUI (AM Peak Hour)

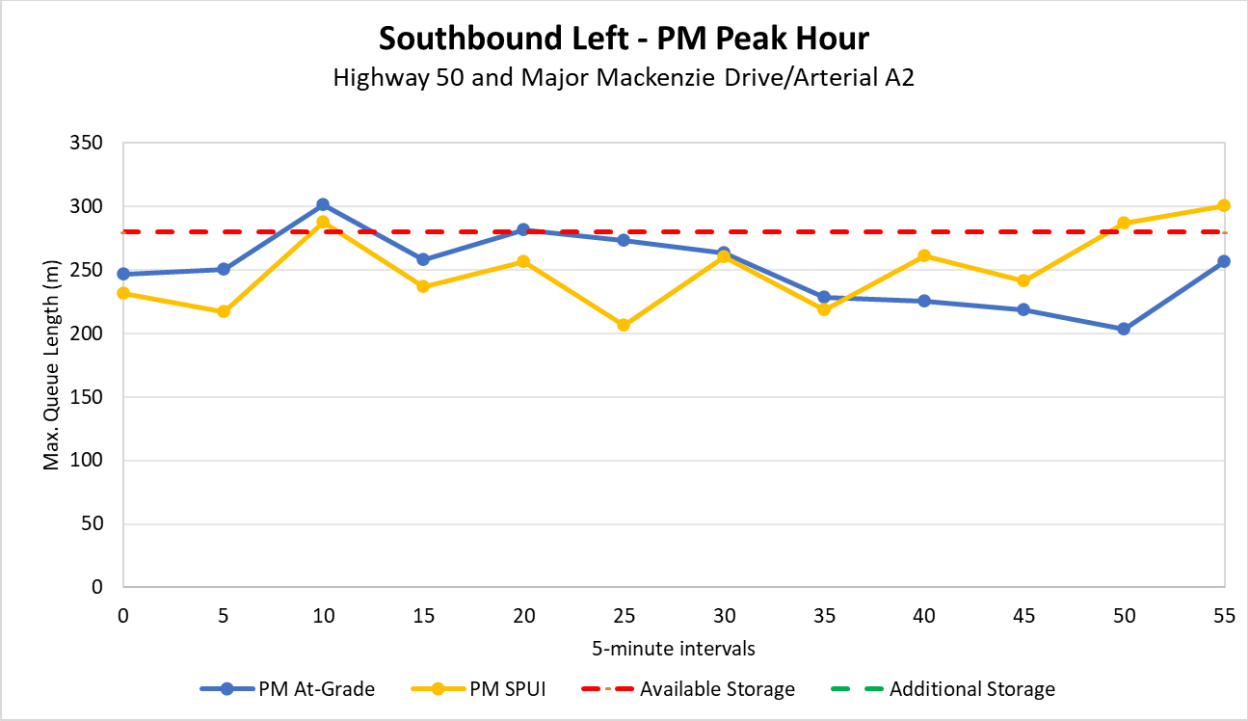


Figure 14: SB Left at SPUI (PM Peak Hour)

4.0 CONCLUSIONS

Results from the Vissim model developed to assess operations along the Highway 50 study corridor from Major Mackenzie Drive/Arterial A2 to Fastfrate Entrance/Bus Facility Entrance show that no major operational issues are expected under 2041 conditions with the SPUI forecasted demand.

The SB left at the SPUI is expected to experience queue spillback to Highway 50 under 2041 conditions with the At-Grade demand during the AM peak hour. However, no queuing issues are expected during the AM peak hour with the SPUI forecasted demand and it is expected that operations will be closer to the SPUI demand than the At-Grade demand.

No queuing issues were observed from the modelling along Highway 50 between Major Mackenzie Drive/Arterial A2 to Fastfrate Entrance/Bus Facility Entrance. Furthermore, no weaving issues were observed on SB Highway 50 between Major Mackenzie Drive and Cadetta Road. The proposed Bus Facility site trips are not expected to negatively impact the Major Mackenzie Drive/Arterial A2 SPUI operations.

The EB and WB left turns at the SPUI are fully protected due to safety reasons and this combined with competing demand for green time at the SPUI resulted in these two left turns expected to operate with a LOS 'E' for both peak hours. However, no queuing issues are expected for these two left turns.

K

Appendix K - Evaluation of Grade Separation Alternatives at the Intersection of Regional Road 50 and Major Mackenzie Drive (Arterial A2)

Technical Memorandum

To:	Soheil Nejatian, Sonya Bubas
From:	John McGill, P.Eng.,
Date:	March 22, 2021
File:	TP115086 Highway 427 Industrial Secondary Plan Area 47 – MCEA for Arterial Roads
cc:	David Sinke, P.Eng., Stephen Keen, P.Eng.
Re:	Evaluation of Grade Separation Alternatives at the Intersection of Regional Road 50 and Major Mackenzie Drive (Arterial A2)

1. Introduction

The following document provides a detailed evaluation of the short-listed intersection alternatives being considered to address anticipated operational issues at the future intersection of Regional Road 50 and Arterial A2/Major Mackenzie Drive.

During completion of the SP47 Transportation Master Plan (SP47 TMP), this area was identified as a special policy area requiring additional study due to significant environmental, transportation and development concerns, uncertainty regarding extension of Highway 427 and GTA West, as well as realignment of Rainbow Creek. During completion of the Vissim traffic modelling for this area, the intersection of Regional Road 50 and Arterial A2/ Major Mackenzie Drive was identified as having an overall level-of-service of E during the p.m. peak in 2041, with some turning movements operating at a level-of-service F). While an overall LOS E during the p.m. peak is not uncommon at major arterial to arterial intersections, at the EA stage of the planning process, it is prudent to examine opportunities to address means of mitigating the anticipated travel time delays, increased risk of collision, and additional CO_2 emissions associated with the anticipated congestion. The following report provides details related to the alternatives considered, as well as the evaluation process used to arrive at a recommended solution for this intersection.

1.1. Update to Detailed Qualitative Assessment of Alternatives

An update was made to this assessment of alternatives based on the information presented at the May 2018 Workshop with the City of Brampton and Region of Peel. Wood recognizes that use of congestion costing in the decision-making process is still not universally accepted, and as such, some sensitivity analysis has been completed. The results of this analysis are presented at the end of Table 16.

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Registered in Canada No. 773289-9; GST: 899879050 RT0008; DUNS: 25-362-6642

1.2. Existing Conditions

Special Policy Area 2 currently consists primarily of open agricultural land, with existing residential properties along Clarkway Drive and Coleraine Drive, and existing industrial/commercial along Coleraine Drive and south of the Trans-Canada Pipeline. The only existing roadway within the special study area is Coleraine Drive, which is currently a two-lane rural residential roadway that intersects Regional Road 50 at a 20 degree skew (TAC recommended minimum is 70 degrees). Existing Rainbow Creek approximately bisects the area from north to south through a wide, poorly defined, floodplain. Flow in the vicinity of SPA2 is intermittent.

1.3. Future Conditions

1.3.1. Transportation and Traffic

When developed, SPA2 will include two new arterial roadways: a six-lane north-south extension of Major Mackenzie Drive known as Arterial A2, and a four-lane east-west arterial linking Arterial A2 to The Gore Road. As identified within both the *Region of Peel Highway 427 Extension Area Transportation Master Plan* (2009) and the *Highway 427 Industrial Secondary Plan Area 47 Transportation Master Plan (2014)*, Arterial A2 is to act as an east-west arterial linking Major Mackenzie Drive to Mayfield Road until such time as Highway 427 is extended further to the north and Arterial A2 is extended into Bolton. Coleraine Drive will also be realigned to correct the issues with its alignment at the existing intersection with Regional Road 50. The alignments contemplated for these three roadways during the SP47 TMP are illustrated in Figure 1. It should be noted that the SP47 TMP study states that intersection operations documented in the TMP study report were preliminary in nature. As such, the traffic study completed as part of the TMP was not sufficient to recommend intersection configurations. For the same and other reasons, the TMP study recommended a special policy area around the intersection of Coleraine Drive and Arterial A2 restricting developments until road alignments are finalized through the current EA process.

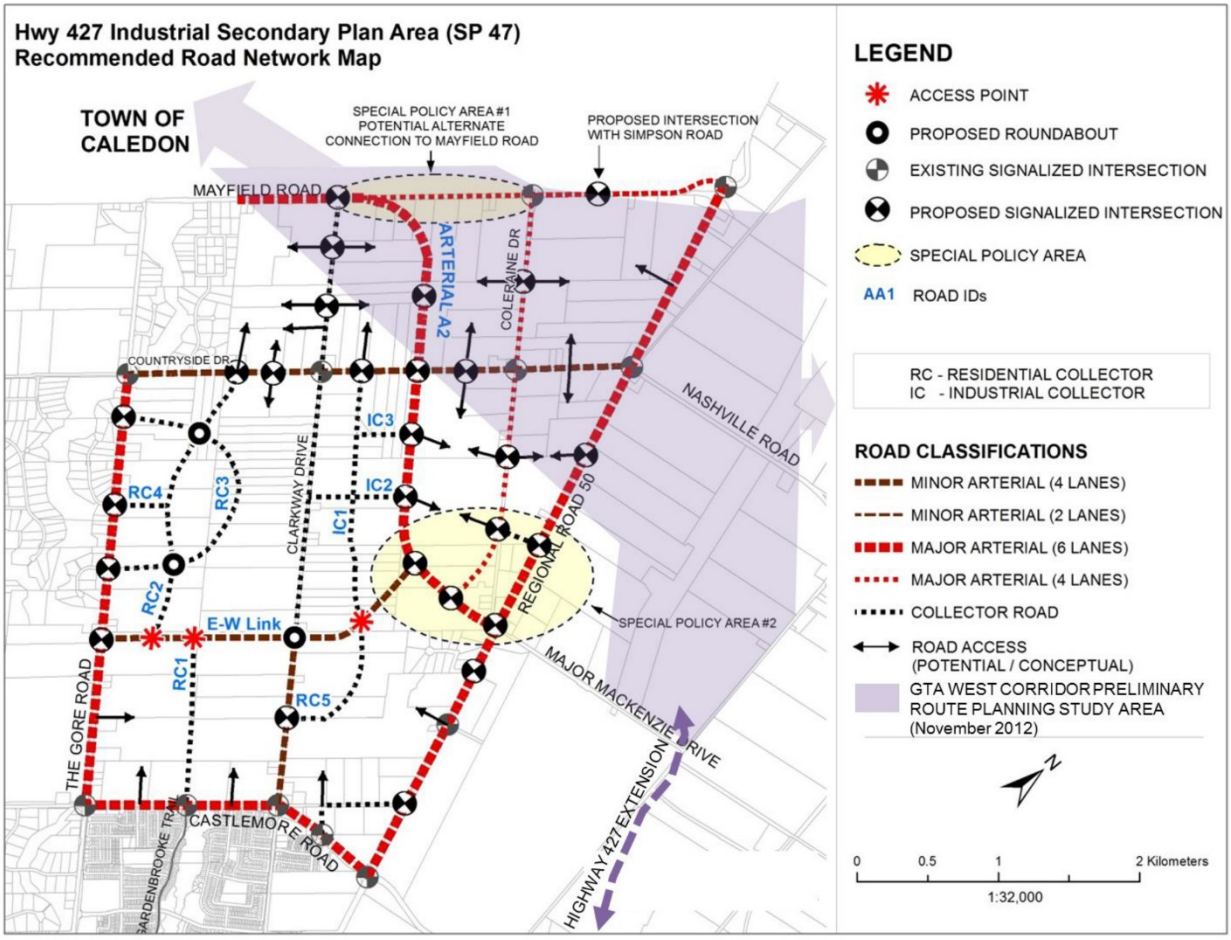

Figure 1: SP47 TMP-Recommended Road Network.

Traffic analysis completed by the City of Brampton (updated City-wide EMME model) and CIMA+ (as part of the current EA study) indicate significant issues with queuing of vehicles extending from the intersection of Arterial A2 at Regional Road 50 back through the SP47 TMP-proposed intersection with Coleraine Drive. For this reason, alignment and intersection configurations that increase the spacing between the intersection of Arterial A2 and each of Regional Road 50 and Coleraine Drive have been contemplated as part of the current study.

1.3.2. Development

The lands within Special Policy Area 2 will primarily be built out as commercial and industrial, with limited residential and office space also provided. Commercial Block 47-3 will be located west of Arterial A2 and north of East-West Arterial. The area east of Arterial A2 will be large scale industrial/warehousing, with some smaller scale office complexes provided adjacent to the Arterial A2/Regional Road 50 intersection. Residential development is planned for south of East-West Arterial and Arterial A2. A mosaic of the most recently-provided development plans for SPA2 is provided as Figure 2.

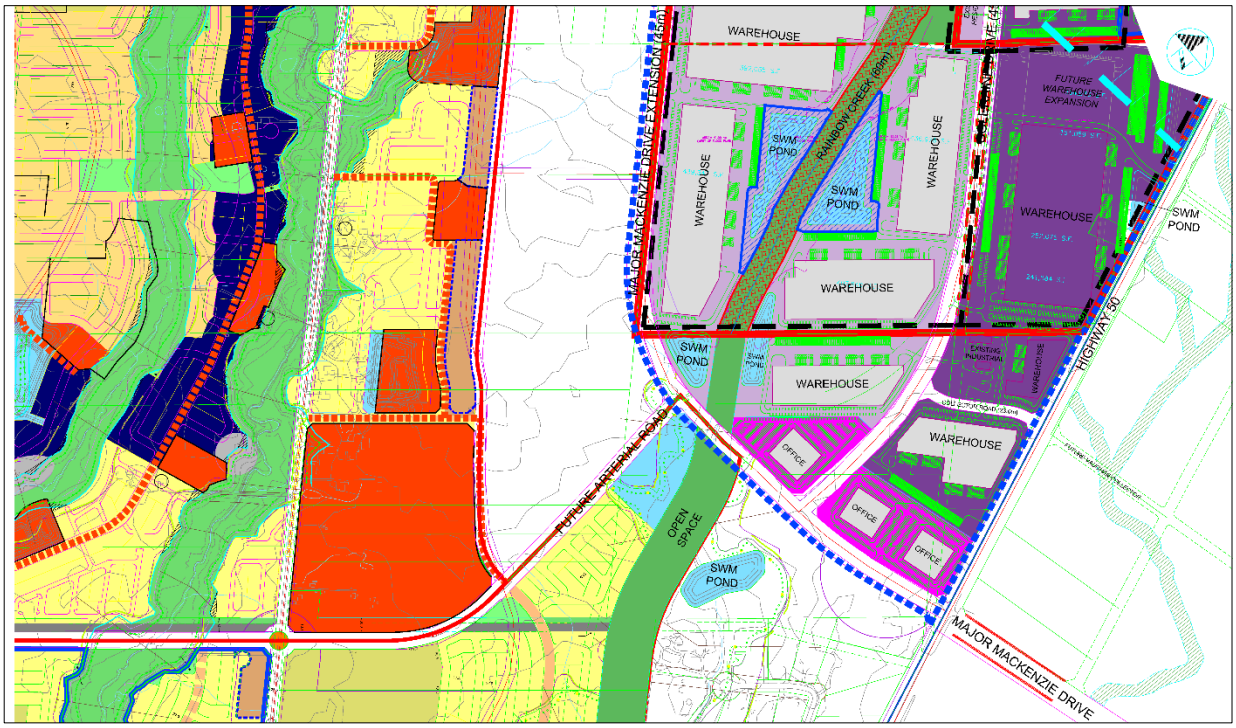

Figure 2: Current Development Plans Within Special Policy Area 2.

1.3.3. Rainbow Creek

A plan to restore and enhance Rainbow Creek was proposed as an addendum to the Master Environmental Servicing Plan (MESP) developed for SP47. The plan was developed in consultation with the City of Brampton, TRCA and adjacent development groups, and aims to provide a balanced approach to economic, social and environmental planning objectives. The Rainbow Creek Restoration/Enhancement Plan will reconfigure/reduce the width of the existing floodplain, improve the stormwater drainage system, and improve the existing ecological conditions and function of Rainbow Creek's Natural Heritage System.

2. Short-Listed Intersection Design Options – Regional Road 50 at Major Mackenzie Drive

The following sections provide a brief introduction to the three short-listed alternatives selected for further evaluation to address traffic issues at Regional Road 50 and Arterial A2/Major Mackenzie Drive. For the purpose of assessment, the boundaries for more detailed analysis have been set as follows:

- Arterial A2, from 60 m south of the SP47 TMP intersection with the East-West Arterial to 200 m east of Regional Road 50;
- East-West Arterial, from 600 m southwest of Arterial A2 to Arterial A2;
- Coleraine Drive, from 1 km south of Countryside Drive to its south terminus; and
- Regional Road 50 from 850 m north of Major Mackenzie Drive to Cadetta Road.

These boundaries include the future intersections of Arterial A2 and East-West Arterial, the future intersection of Coleraine Drive with either Regional Road 50 or Arterial A2, and the existing intersection of Regional Road 50 with Major Mackenzie Drive.

2.1. At-Grade Intersection Design

Alternative intersection configuration 1 consists of an at-grade design, which would include three through lanes and single right turn lanes in all directions, with single left turn lanes in both directions on Major Mackenzie Drive/Arterial A2 and double left turn lanes in the northbound and southbound directions along Highway 50.

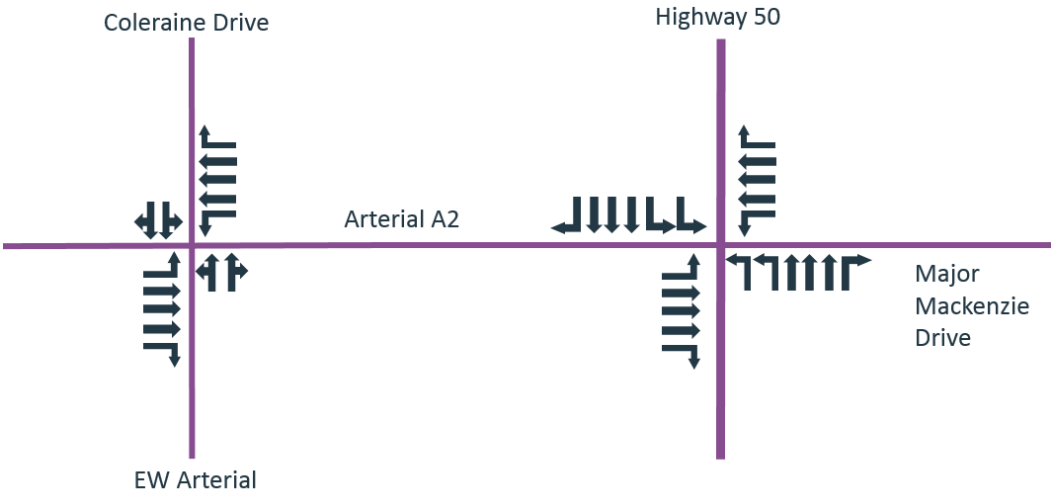

Figure 3: At Grade Intersection Lane Configuration

2.2. Single Point Urban Interchange (SPUI)

Alternative intersection configuration 2 consists of a single point urban interchange (SPUI), with the signalized intersection of Major Mackenzie Drive and Arterial A2 at-grade, and the through lanes of Regional Road 50 located on an overpass structure. Consideration was also provided to locating the intersection on a structure and leaving Regional Road 50 at-grade, however the structural and retaining wall costs would be significantly increased. Left and right turn movements off of Regional Road 50 would be accommodated via at-grade slip around lanes which would split on approach to the signalized intersection. East and westbound left turn lanes would be merged with the right turn lane from the opposing direction before ultimately merging onto Regional Road 50. The evaluated configuration consisted of single right and left turn lanes, although operations at the intersection could be improved through provision of dual lefts, particularly in the north and southbound directions.

Examples of SPUI interchanges exist within the province today, including structures at Fourth Avenue at Highway 406 in St. Catharines and Hunt Club Road at Airport Parkway in Ottawa. SPUIs are also used extensively through the U.S.

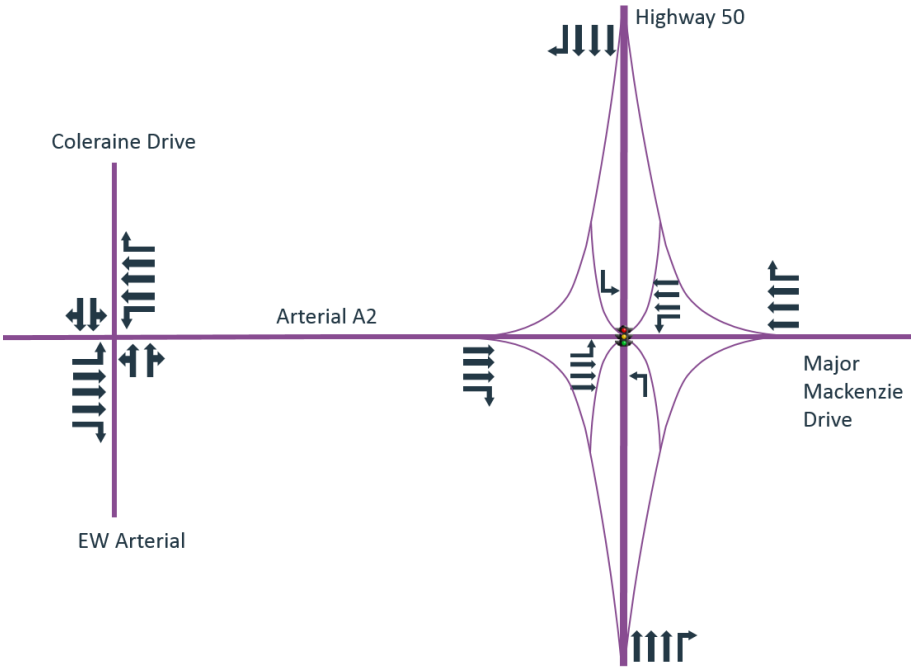

Figure 4: SPUI Interchange Lane Configuration

2.3. Modified Parclo 'A'-Type Interchange

The modified Parclo 'A'-Type Interchange would be created by diverting Highway 50 to meet Coleraine Drive at a T-intersection approximately 560 m north of Major Mackenzie Drive. Coleraine Drive would continue south under Major Mackenzie Drive at the future Parclo interchange. The lane configurations for both intersections can be seen in Figure 5.

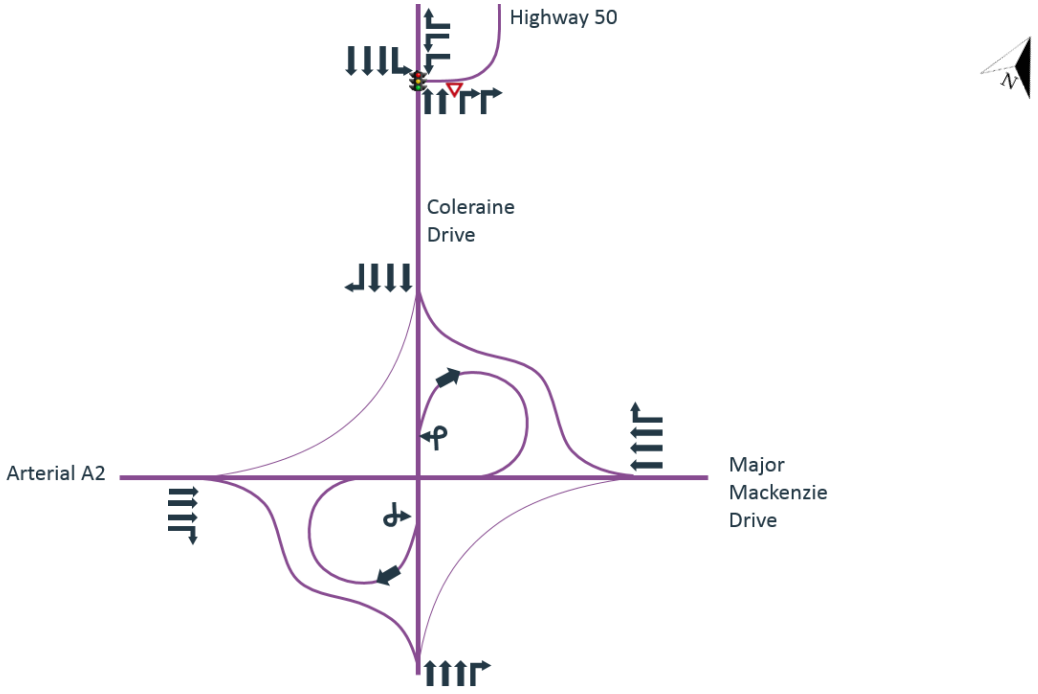

Figure 5: Modified Parclo A-Type Interchange New Lane Configuration

The interchange would restrict both westbound and eastbound left turns, forcing westbound drivers to take a left at the Arterial A2 and East-West Arterial intersection and eastbound drivers to travel through the network to the Countryside Drive and Coleraine Drive intersection.

3. Future Traffic Conditions (2041)

The following sections provide a summary of the anticipated p.m. peak traffic volume and delays for the key intersections associated with each alternative. The 2041 horizon years is used as it represents the limit of full build-out of the SP47 study area.

3.1. At-Grade Intersection Design

Critical intersections for the at-grade design include both the four-leg intersection of Arterial A2 / East-West Arterial and Coleraine Drive, and the future intersection of Regional Road 50/Arterial A2/Major Mackenzie Drive. Figure 6 (right) illustrates the anticipated travel speeds within the network during the p.m. peak. Green indicates near free-flow conditions, while pink represents speeds in the 0-10 km/h range. As previously discussed, there are obvious capacity issues at both critical intersections under this scenario. A summary of model outputs for the various approaches to the two at-grade intersections within the selected study area are provided in

Table 1 and

Table 2.

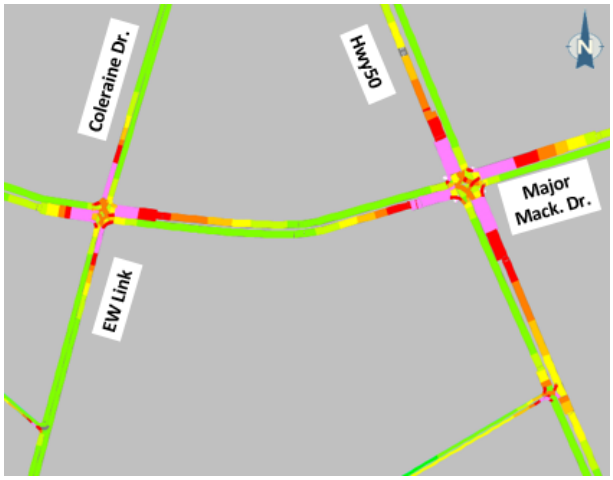

Figure 6: 2041 p.m. Peak Speed Plots for the At-Grade Intersection.

Table 1: Regional Road 50 and Major Mackenzie Drive Signal

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS
NBR	35	40	112	363	D
NBT	1,814	55	108	357	E
NBL	682	68	108	357	E
EBR	428	25	61	205	C
EBT	890	76	55	197	E
EBL	41	148	55	197	F
SBR	55	9	105	395	A
SBT	798	30	106	392	C
SBL	766	95	106	392	F
WBR	540	17	71	201	B
WBT	1,642	59	64	193	E
WBL	80	43	64	193	D
Overall	7,773	56	85	424	E

Table 2: Coleraine Drive / East-West Arterial and Arterial A2 Signal

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS
NBR	179	38	32	111	D
NBT	343	49	25	100	D
NBL	26	50	25	100	D
EBR	69	6	25	78	A
EBT	673	39	20	68	D
EBL	130	66	20	68	E
SBR	15	56	47	138	E
SBT	183	48	40	127	D
SBL	546	59	40	127	E
WBR	1,066	26	45	245	C
WBT	912	43	43	236	D
WBL	388	48	43	236	D
Overall	4,531	42	35	245	D

3.2. Single Point Urban Interchange (SPUI)

Critical intersections for the SPUI design include both the four-leg intersection of Arterial A2 / East-West Arterial and Coleraine Drive, and the future grade-separated intersection of Regional Road 50/Arterial A2/Major Mackenzie Drive. Figure 7 (right) illustrates the anticipated travel speeds within the network during the p.m. peak. Green indicates near free-flow conditions, while pink represents speeds in the 0-10 km/h range. In comparison to the at-grade alternative, there are improved levels of service for both critical intersections, but left turn volumes continue to cause issues at the interchange. A potential solution would include provision of dual left-turn ramps off of Regional Road 50. A summary of model outputs for the various approaches to the two at-grade intersections within the selected study area are provided in Table 3 and Table 4.

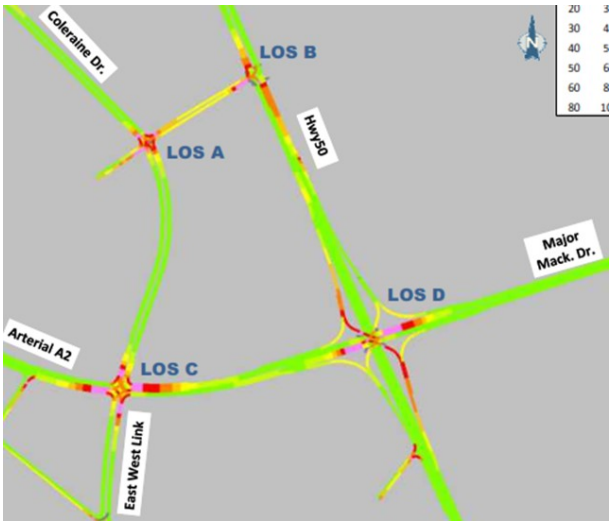

Figure 7: 2041 p.m. Peak Speed Plots for the SPUI Grade-Separation.

Table 3: Highway 50 and Major Mackenzie Drive Signal

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS
NBL	945	39	69	358	D
SBL	783	33	37	283	C
EBT	891	42	23	80	D
EBL	5	58	23	80	E

WBT	1,586	37	36	130	D
WBL	77	33	36	130	C
Overall	4,287	40	37	358	D

Table 4: Coleraine Dr / EW Link and Arterial A2 Signal

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS
EBL	57	43	28	109	D
EBT	1,101	40	28	109	D
EBR	54	30	6	118	C
WBL	531	63	46	132	E
WBT	1,208	18	46	132	B
WBR*	816	14	37	120	B
NBL	20	29	12	70	C
NBT	109	44	12	70	D
NBR	213	28	4	64	C
SBL**	184	43	10	37	D
SBT	89	36	10	37	D
SBR	22	9	5	31	A
Overall	4,404	31	18	132	C

3.3. Modified Parclo 'A'-Type Interchange

Critical intersections for the Modified Parclo 'A' design include T- intersection of Arterial A2 / East-West, the future intersection of Coleraine Drive / Regional Road 50 and the future grade-separated intersection of Regional Road 50/Arterial A2/Major Mackenzie Drive. Figure 8 (right) illustrates the anticipated travel speeds within the network during the p.m. peak. In comparison to the at-grade alternative, there are improved levels of service for the intersection of Arterial A2/East-West Arterial, however issues related to volume and weaving cause issues at the Coleraine Drive / Regional Road 50 intersection which impact westbound Major Mackenzie Drive. A potential solution would include relocation of the Coleraine Drive/Regional Road 50 intersection, although this would have implications to planned industrial development and anticipated traffic volumes on Countryside Drive. Note that this alternative considers a 6-lane cross-section on Coleraine Drive and the southerly portion of Regional Road 50. A summary of model outputs for the various approaches to the two at-grade intersections within the selected study area are provided in Table 5, Table 6, and Table 7.

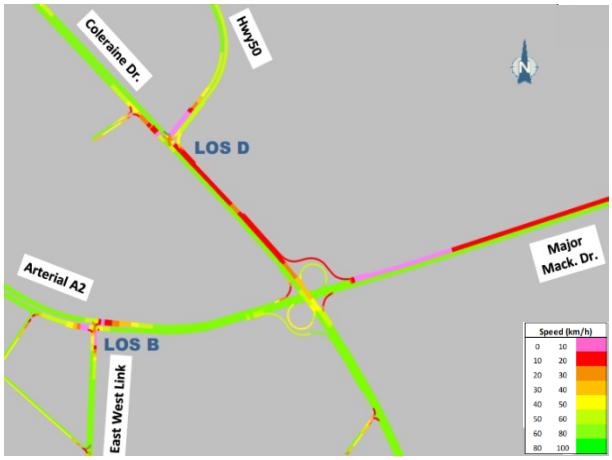

Figure 8: 2041 p.m. Peak Speed Plots for the Modified Parclo 'A' Interchange.

Table 5: Coleraine Dr. and Highway 50 Signal (p.m. Peak)

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS

WBL	712	67	48	156	E
WBR	0	0	0	0	A
NBR	1,516	66	248	510	E
NBT	1,604	72	274	510	E
SBL	208	54	19	124	D
SBT	1,469	11	19	124	B
Overall	**5,509**	**53**	**128**	**510**	**D**

Table 6: East-West Arterial and Arterial A2 Signal (p.m. peak)

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS
WBL	712	67	48	156	E
WBR	0	0	0	0	A
NBR	1,516	66	248	510	E
NBT	1,604	72	274	510	E
SBL	208	54	19	124	D
SBT	1,469	11	19	124	B
Overall	**5,509**	**53**	**128**	**510**	**D**

Table 7: Parclo Interchange Ramp (p.m. peak)

Movement	Volume	Ave. Delay (sec)	Ave. Q Len (m)	95th % Q (m)	LOS
WBR	917	301	556	> 900	F
WBT	893	90	350	> 700	F

4. Detailed Evaluation of Intersection Alternatives

In order to identify a preferred alternative to address the anticipated capacity issues at the intersection of Regional Road 50 and Arterial A2/Major Mackenzie Drive, a detailed assessment is required. This assessment must not only qualitatively examine the overall impacts of each alternative, but also quantitatively assess the costs and benefits associated with each. The cost associated with any grade-separation alternative is significant, not only in terms of structural requirements, but also the increase property impacts. This additional cost must be outweighed by the net benefit in terms of reduce travel times, reduced collision risk, and reduced CO_2 emissions.

The following sections provide an overview of: the process used to determine congestion costing for each alternative; the anticipated net-present-value of each alternative considering construction, maintenance, operations, and congestion costs; as well as the overall qualitative assessment for each.

4.1. Congestion Costing Methodology

The estimated cost of traffic congestion is based on a number of factors, including: increased fuel consumption and vehicular maintenance costs, loss of productivity, negative environmental impact and increased chance of collisions. Discussion regarding how these impacts can be converted to an equivalent monetary value is provided in the following sections.

4.1.1. Travel Time Index

In order to determine the amount of time lost to congestion, it is first imperative to estimate the Travel Time Index (TTI), which is simply calculated as the ratio between peak period and free-flow travel times. Or in the case where a decisions is being made with respect to implementing infrastructure improvements, the TTI would be the ratio of travel times with and without road improvements.

In the current analysis, we are looking to use the cost of congestion to provide an indication of anticipated financial benefit of implementing an interchange at the intersection of Arterial A2 and Highway 50. As such, we are not so much interested in the 'congested' versus 'free-flow' condition, as much as the 'without interchange' versus 'with interchange' condition. To this end, no elimination of the base traffic volumes was completed, as these same bases would occur in the network leading up to the intersection regardless of the intersection treatment.

4.1.2. Average Cost of Driving

The average cost (AC) of driving is a function not only of the monetary costs, but also the opportunity cost of time lost to driving in congested conditions (productivity). The amount of excess time spent in traffic can be determined based on the estimated congested velocity. Congested velocity can be estimated based on the V/C ratio of the roadway using the following formula:

$$v_{congested} = \frac{v_{freeflow}}{[1 + 0.05VC^{10}]}$$ [1]

The congested velocity can be converted to an average cost of driving based on the following equation:

$$AC = c + \frac{b}{v_{congested}}$$ [$CAD/km]

Where c is base monetary cost
b is the value of time
$v_{congested}$ is the congested velocity

Using the U.S. Department of Transportation methodology, the value of time, b, is based on the average hourly wage rate for the area in which the site is located. The base hourly value of time is then estimated at 50% of the average hourly wage for all periods other than during the a.m. peak, when employment start times are less flexible. During the a.m. peak, the average hourly value of time is estimated at 125% of the average hourly wage. For the GTA, the mean hourly wage for 2006 was $21.62, resulting in a base value of time of $10.80, and an a.m. peak period value of time of $27.02. Assuming an average annual inflation rate of 1.6%[2] between 2006 and 2016, these rates would equate to a base value of time of $12.67 and an a.m. peak period value of time of $31.66.

The base monetary cost of driving is based on estimated costs for fuel, maintenance, and insurance, and was estimate by Metrolinx[3] to be $0.201/vehicle-km in 2008. Applying the average annual inflation rate of 1.6%, this equates to a 2016 value of $0.228/vehicle-km.

The total hourly social cost of driving can therefore be estimated using the average cost (AC) and multiplying that value by the total volume of travelers (Q) over a particular distance (d) in km.

$$TC = AC \times Q \times d$$ [$CAD/hr]

[1] Based on the U.S. Bureau of Public Roads speed-flow relationship curves.
[2] Based on Bank of Canada: Inflation Calculator for the years 2006-2016. Data accessed March 20, 2017.
[3] HDR (2008). Metrolinx – Costs of Road Congestion in the Greater Toronto and Hamilton Area.

4.1.3. Emissions Costs

Vehicle emissions are higher per km for slow moving vehicles, particularly when moving through acceleration/deceleration cycles. Based on Transport Canada's "*Towards Estimating the Social and Environmental Costs of Transportation in Canada*" (2004), the average cost of auto emissions in 2002 was estimated to be $0.01082/vehicle-km. As a result of inflation, this value can be estimated as follows for 2016:
The hourly cost of emissions over a study portion of roadway can then be estimated as follows:

0.01082	$CAD/vehicle-km (2002)
x 1.29920	Change between 2002-2016 (%/100)
0.01406	$CAD/vehicle-km (2016)

Where EC is emissions costs
Q is hourly estimated volumes (veh/hr -km)
d is distance over which the volumes were measured. (km)

$$EC = 0.01406 \times Q \times d \text{ [\$CAD/hr]}$$

4.1.4. Collision Costs

Collision rates increase as traffic volumes increase, partly due to the higher likelihood that a collision will occur with the increase in volume, and partly due to the congestion itself. The cost of collisions can be estimated as follows, based on Small & Verhoef's "*The Economics of Urban Transportation*" (2007):

0.10537	$CAD/vehicle-km (2005)
x 1.20420	Change between 2005-2016 (%/100)
0.12688	$CAD/vehicle-km (2016)

Where CC is collision costs
Q is estimated volumes (veh/hr -km)
d is distance over which the volumes were measured. (km)

$$CC = 0.12688 \times Q \times d \text{ [\$CAD/hr]}$$

4.1.5. Logistical Costs

Although a large proportion of traffic moving through the Arterial A2/Highway 50 intersection will be associated with the industrial developments along Coleraine Drive, the specific logistical costs associated with congestion will not be considered as part of this evaluation. It should be noted, however, that increased congestion can have negative impacts on trucking through reduced reliability, increased fuel and wage costs, reduced desirability for warehouse locations, and need to employ drivers for less desirable shifts.

4.1.6. Determination of Total Congestion Cost

To determine the total cost of delay, one needs to apply the cost factors to the total anticipated delay for each individual impacted, as well as the vehicle-km costs for the volume of traffic impacted. For simplicity, this is calculated on an hourly basis and then extrapolated to an annualized cost.

$$Hourly\ Cost\ of\ Congestion\ (2016) = Q \cdot d \cdot\ [AC + (0.01406 + 0.12688)]$$

Note that Q and AC vary with time.

4.1.7. Conversion of Peak Hour Cost to 24 hour Costs

Conversion of the peak hourly cost of congestion is accomplished through use of standard hourly volume profiles for a particular roadway type and day of the week. For simplicity sake, the volume profile for a typical

Wednesday urban arterial condition will be used to approximate volumes within Special Policy Area 2. Wednesday was selected as its volume profile is equivalent to the average of all days combined (including both weekday and weekends). The hourly profiles for a typical Wednesday are provided in Table 8 and Figure 9 below, taken from NCHRP Project 03-110.

Table 8: Hourly Proportion of AADT for Major Urban Arterial Roadways.

Hour Starting	Urban Principal Arterial	Hour Starting	Urban Principal Arterial
12:00 AM	1.0%	12:00 PM	5.3%
1:00 AM	0.6%	1:00 PM	5.4%
2:00 AM	0.5%	2:00 PM	6.3%
3:00 AM	0.5%	3:00 PM	6.9%
4:00 AM	0.9%	4:00 PM	7.2%
5:00 AM	3.0%	5:00 PM	7.7%
6:00 AM	5.4%	6:00 PM	6.2%
7:00 AM	7.1%	7:00 PM	4.4%
8:00 AM	5.8%	8:00 PM	3.5%
9:00 AM	4.7%	9:00 PM	3.3%
10:00 AM	4.6%	10:00 PM	2.6%
11:00 AM	5.0%	11:00 PM	2.1%

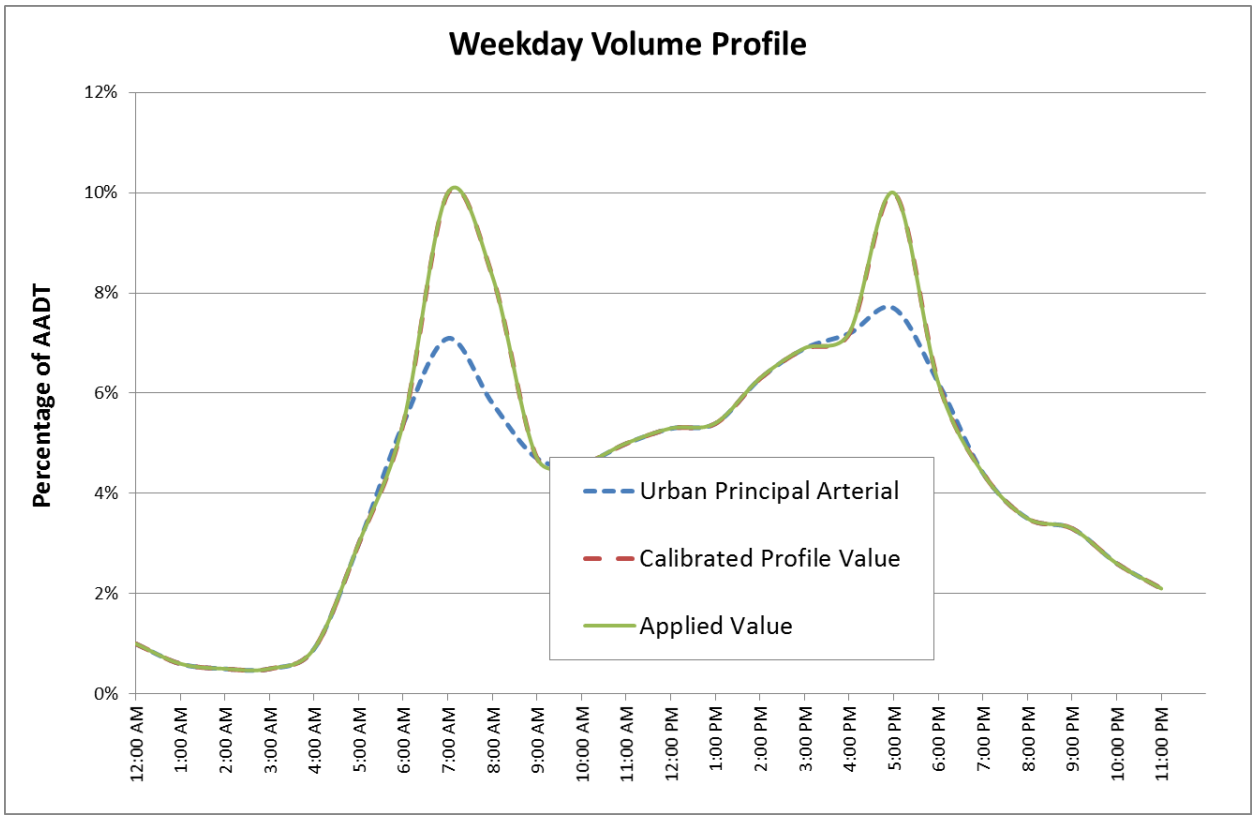

Figure 9: Weekday Vehicular Volume Profile for Urban Major Arterial Roadways.

4.1.8. Conversion of 24 Hour Costs to Annualized Costs

To convert the average daily cost into an average annual value, a similar monthly profile can be applied to the 24 hour values. However, for the sake of simplicity and as traffic patterns do not change significantly over the course of a year for developments such as that planned within SP47, the daily costs will simply be multiplied by 365 days to arrive at an annual total.

4.1.9. Analysis of Intersection Alternatives Within SP47 Special Policy Area 2

The following sections provide an overview of the high level congestion costing analysis completed for the intersection alternatives within Special Policy Area 2. For the purpose of analysis, the p.m. peak congestion costs were calculated and converted to an annual average daily total using a peaking factor of 0.077, based on the values in Table 8 .

Estimates of Hourly Congestion Costing

Travel time estimates were estimated using posted speeds for the mid-block segments between major intersections. Travel times through the intersections were estimated based on LOS for a particular intersection approach. All posted speed limits were assumed to be 70 km/h (free flow velocities). The 2041 p.m. peak period congestion costing for both mid-block and the intersections are provided in Table 9 to Table 14, below.

Table 9: P.M. Peak Period Mid-Block Congestion Cost Analysis for Alternative 1.

Mid-Block Road Segment	Segment Limits	Segment Length	Alternative 1 At-Grade Intersection							
		(km)	v (km/h)	Travel Time (hr)	Average Social Cost per Vehicle ($/veh.)	Peak Hour Volume in Segment (veh/hr)	Total Peak Hour Social Cost for Road Segment ($)	Total Anticipated Collision Costs	Total Anticipated Emissions Costs	Total Anticipated Costs Per Segment
Arterial A2	North Limit to East-West Arterial/Coleraine Drive	0.10	70	0.0014	$ 0.37	3,738	$ 1,369.22	$ 0.97	$ 0.11	$ 1,370.29
Arterial A2	Coleraine Drive to Reg. Road 50	0.58	70	0.0083	$ 0.50	3,953	$ 1,958.69	$ 5.92	$ 0.66	$ 1,965.26
East-West Arterial	West Limit to Arterial A2	0.56	70	0.0080	$ 0.49	3,837	$ 1,880.55	$ 5.55	$ 0.62	$ 1,886.72
Coleraine Drive,	North Limit to Arterial A2	0.70	70	0.0100	$ 0.53	4,014	$ 2,118.56	$ 7.26	$ 0.81	$ 2,126.62
Regional Road 50	North Limit to Major Mackenzie Drive	0.82	70	0.0117	$ 0.56	2,283	$ 1,278.69	$ 4.83	$ 0.54	$ 1,284.06
Regional Road 50	Major Mackenzie Drive to Cadetta Road	0.33	70	0.0047	$ 0.43	1,188	$ 508.71	$ 1.01	$ 0.11	$ 509.83
Major Mackenzie Drive	Reg. Road 50 to East Limit	0.20	70	0.0029	$ 0.39	3,764	$ 1,480.05	$ 1.94	$ 0.22	$ 1,482.21
TOTALS							$ 10,594.47	$ 27.48	$ 3.05	$ 10,625.00

Table 10: P.M. Peak Period Mid-Block Congestion Cost Analysis for Alternative 2.

Mid-Block Road Segment	Segment Limits	Segment Length	Alternative 2 Single Point Urban Interchange							
		(km)	v (km/h)	Travel Time (hr)	Average Social Cost per Vehicle ($/veh.)	Peak Hour Volume in Segment (veh/hr)	Total Peak Hour Social Cost for Road Segment ($)	Total Anticipated Collision Costs	Total Anticipated Emissions Costs	Total Anticipated Costs Per Segment
Arterial A2	North Limit to East-West Arterial/Coleraine Drive	0.0014	70	0.0014	$ 0.37	2,462	$ 901.82	$ 0.64	$ 0.07	$ 902.53
Arterial A2	Coleraine Drive to Interchange	0.0083	70	0.0083	$ 0.50	4,053	$ 2,008.23	$ 6.07	$ 0.67	$ 2,014.98
East-West Arterial	West Limit to Arterial A2	0.0080	70	0.0080	$ 0.49	1,016	$ 497.95	$ 1.47	$ 0.16	$ 499.58
Coleraine Drive	North Limit to Arterial A2	0.0100	70	0.0100	$ 0.53	1,277	$ 673.99	$ 2.31	$ 0.26	$ 676.56
Regional Road 50	North Limit to Interchange	0.0117	70	0.0117	$ 0.56	4,300	$ 2,408.39	$ 9.11	$ 1.01	$ 2,418.51
Regional Road 50	Interchange to Cadetta Road	0.0047	70	0.0047	$ 0.43	4,587	$ 1,964.17	$ 3.91	$ 0.43	$ 1,968.51
Major Mackenzie Drive	Interchange to East Limit	0.0029	70	0.0029	$ 0.39	3,978	$ 1,564.20	$ 2.05	$ 0.23	$ 1,566.49
TOTALS							$ 10,018.77	$ 25.55	$ 2.84	$ 10,047.16

Table 11: P.M. Peak Period Mid-Block Congestion Cost Analysis for Alternative 3.

Mid-Block Road Segment	Segment Limits	Segment Length	Alternative 3 Modified Parclo							
		(km)	v (km/h)	Travel Time (hr)	Average Social Cost per Vehicle ($/veh.)	Peak Hour Volume in Segment (veh/hr)	Total Peak Hour Social Cost for Road Segment ($)	Total Anticipated Collision Costs	Total Anticipated Emissions Costs	Total Anticipated Costs Per Segment
Arterial A2	North Limit to East-West Arterial	0.05	70	0.0007	$ 0.35	1,835	$ 647.46	$ 0.24	$ 0.03	$ 647.72
Arterial A2	East-West Arterial to Interchange	0.64	70	0.0091	$ 0.51	2,383	$ 1,219.24	$ 3.94	$ 0.44	$ 1,223.62

East-West Arterial	West Limit to Arterial A2	0.53	70	0.0076	$ 0.48	1,072	$ 516.74	$ 1.47	$ 0.16	$ 518.37
Coleraine Drive	North Limit to Regional Road 50	0.24	70	0.0034	$ 0.40	3,281	$ 1,325.46	$ 2.03	$ 0.23	$ 1,327.72
Coleraine Drive	Regional Road 50 to Interchange	0.53	70	0.0076	$ 0.48	3,993	$ 1,924.77	$ 5.46	$ 0.61	$ 1,930.84
Regional Road 50	North Limit to Coleraine Drive	0.42	70	0.0060	$ 0.45	2,436	$ 1,102.11	$ 2.64	$ 0.29	$ 1,105.05
Regional Road 50	Interchange to Cadetta Road	0.38	70	0.0054	$ 0.44	3934	$ 1,737.50	$ 3.86	$ 0.43	$ 1,741.79
TOTALS							$ 9,992.84	$ 22.14	$ 2.46	$ 10,017.44

Table 12: 2041 P.M. Peak Congestion Costing for Intersections Associated with Alternative 1.

Intersection Location	Approach and Movement	Approach LOS	Alternative 1 At-Grade Intersection			
			Estimated Delay per Vehicle (sec.)	Average Social Cost per Vehicle ($/veh.)	Peak Hour Volume on Approach (veh/hr)	Total Peak Hour Social Cost for Road Segment ($)
Arterial A2 / Coleraine Drive / East-West Arterial	Eastbound Through	D	40	$ 0.55	35	$ 19.20
	Eastbound Left	E	55	$ 0.63	1,814	$ 1,139.33
	Eastbound Right	E	68	$ 0.70	682	$ 474.29
	Southbound Through	C	25	$ 0.47	428	$ 201.99
	Southbound Left	E	76	$ 0.74	890	$ 656.76
	Southbound Right	F	148	$ 1.12	41	$ 45.74
	Westbound Through	A	9	$ 0.39	55	$ 21.23
	Westbound Left	C	30	$ 0.49	798	$ 394.12
	Westbound Right	F	95	$ 0.84	766	$ 641.33
	Northbound Through	B	17	$ 0.43	540	$ 230.23
	Northbound Left	E	59	$ 0.65	1,642	$ 1,060.65
	Northbound Right	D	43	$ 0.56	80	$ 45.17
Arterial A2 / Regional Road 50 / Major Mackenzie Drive	Eastbound Through	D	38	$ 0.54	179	$ 96.54
	Eastbound Left	D	49	$ 0.60	343	$ 204.93
	Eastbound Right	D	50	$ 0.60	26	$ 15.61
	Southbound Through	A	6	$ 0.37	69	$ 25.65
	Southbound Left	D	39	$ 0.54	673	$ 366.16
	Southbound Right	E	66	$ 0.68	130	$ 89.03
	Westbound Through	E	56	$ 0.63	15	$ 9.45
	Westbound Left	D	48	$ 0.59	183	$ 107.92
	Westbound Right	E	59	$ 0.65	546	$ 352.72
	Northbound Through	C	26	$ 0.48	1,066	$ 507.79
	Northbound Left	D	43	$ 0.57	912	$ 516.22
	Northbound Right	D	48	$ 0.59	388	$ 229.56
TOTALS						**$ 7,451.63**

Table 13: 2041 P.M. Peak Congestion Costing for Intersections Associated with Alternative 2.

Intersection Location	Approach and Movement	Approach LOS	Alternative 2 Single Point Urban Interchange			
			Estimated Delay per Vehicle (sec.)	Average Social Cost per Vehicle	Peak Hour Volume on Approach	Total Peak Hour Social Cost for Road Segment ($)

				($/veh.)	(veh/hr)	
Arterial A2 / Coleraine Drive / East-West Arterial	NBL	D	39	$ 0.54	945	$ 513.60
	SBL	C	33	$ 0.51	783	$ 400.97
	EBT	D	42	$ 0.56	891	$ 498.24
	EBL	E	58	$ 0.64	5	$ 3.21
	WBT	D	37	$ 0.53	1,586	$ 845.38
	WBL	C	33	$ 0.51	77	$ 39.43
Arterial A2 / Regional Road 50 / Major Mackenzie Drive (Interchange)	EBL	D	43	$ 0.56	57	$ 32.17
	EBT	D	40	$ 0.55	1,101	$ 604.15
	EBR	C	30	$ 0.50	54	$ 26.81
	WBL	E	63	$ 0.67	531	$ 355.29
	WBT	B	18	$ 0.43	1,208	$ 523.77
	WBR*	B	14	$ 0.41	816	$ 336.72
	NBL	C	29	$ 0.49	20	$ 9.82
	NBT	D	44	$ 0.57	109	$ 62.09
	NBR	C	28	$ 0.49	213	$ 103.50
	SBL**	D	43	$ 0.56	184	$ 103.85
	SBT	D	36	$ 0.53	89	$ 46.97
	SBR	A	9	$ 0.39	22	$ 8.50
TOTALS						**$ 4,514.50**

Table 14: 2041 P.M. Peak Congestion Costing for Intersections Associated with Alternative 3.

Intersection Location	Approach and Movement	Approach LOS	Alternative 3 Modified Parclo			
			Estimated Delay per Vehicle (sec.)	Average Social Cost per Vehicle ($/veh.)	Peak Hour Volume on Approach (veh/hr)	Total Peak Hour Social Cost for Road Segment ($)
Arterial A2 / East-West Arterial	EBT	B	17	$ 0.43	812	$ 348.69
	EBR	A	3	$ 0.36	65	$ 23.13
	WBL	C	24	$ 0.47	588	$ 274.14
	WBT	A	9	$ 0.39	761	$ 294.79
	NBL	D	53	$ 0.61	197	$ 121.15
	NBR	B	10	$ 0.39	222	$ 87.05
Regional Road 50 / Coleraine Drive	WBL	E	67	$ 0.69	712	$ 491.30
	WBR	A	0	$ 0.34	0	$ -
	NBR	E	66	$ 0.68	1,516	$ 1,038.16
	NBT	E	72	$ 0.72	1,604	$ 1,148.79
	SBL	D	54	$ 0.62	208	$ 129.38
	SBT	B	11	$ 0.40	1,469	$ 583.12
Coleraine Drive / Regional Road 50 / Major Mackenzie Drive (Interchange)=	WBR	F	301	$ 1.91	917	$ 1,755.45
	WBT	F	90	$ 0.81	893	$ 724.18
TOTALS						$ 7,019.34

Determination of Congestion Cost for the Analysis Period

In order to complete a lifecycle cost/benefit analysis for the implementation of an interchange at Highway 50, the costs of both congestion and construction over a reasonable analysis period must first be determined. Based on NCHRP Report 220, suitable analysis periods range between 20 and 40 years. Analysis periods of 20 years are most suitable for low cost intersection treatments, while 40 year analysis periods are more appropriate for complex intersection treatments (such as an interchange). Analysis beyond a 40 year planning horizon is not deemed useful due to levels of uncertainty with respect to traffic, available technologies, and relative costs.

Significant uncertainty is anticipated with completion of the cost/benefit analysis for a future interchange at Arterial A2/Highway 50; which, based on traffic analysis, is likely not warranted prior to the 2041 planning horizon (25 years beyond the current study's completion date). Additional, and significant, uncertainty results from the fact that the 2041 traffic warrant does not contemplate the likely further extension of Highway 427 north of Major Mackenzie Drive.

To determine baseline congestion and construction costing at the time of implementation of the interchange, inputs were forecast to 2041, assuming a continued average inflation rate of 1.6%. All other analysis discounted costs and benefits incurred over a 40 year analysis period to a 2041 value for direct comparison, assuming a continued 1.6% average annual inflation rate and a minimal baseline traffic growth rate of 1.2% (assumes full build-out of SP47 and surrounding areas by 2041). Construction cost of the interchange is assumed to be amortized over the assumed 40 year lifespan.

4.2. Construction and Net-Present-Value Analysis

Initial construction cost (including property acquisition), as well as the cyclical costs associated with annual operations, road resurfacing and full reconstruction must be considered as part of the overall cost-benefit analysis. For simplicity, the initial construction costs for each alternative has been estimated based on the following cost factors:

- Property acquisition;
- General preconstruction and agreement costs (assumed equivalent for all three options);
- Earth excavation and fill at the Regional Road 50 / Major Mackenzie Drive interchanges only;
- Asphalt, granular and concrete volumes associated with roadway and AT facility construction;
- Signalized intersections;
- Storm sewer and appurtenances; and
- Bridges and retaining walls.

Not included within the costing were the following factors which were assumed to be near equivalent between all three alternatives:

- Utility relocations;
- Lighting;
- Cut/fill at locations other than the interchanges;
- Construction of detour routes.

To account for inaccuracy in total estimated costing, a 30% contingency value was added to the overall construction cost (less property acquisition cost).

The overall costs for the various considered components of each alternative are summarized in Table 15 below, with more detail provided in Appendix A.

Table 15: Functional Construction Cost Estimates.

Cost Input	Alternative 1 At-Grade	Alternative 2 SPUI	Alternative 3 Parclo 'A'
General	$430,000	$430,000	$430,000
Roadwork	$7,780,000	$9,310,000	$9,090,000
Storm Sewer	$2,400,000	$2,400,000	$2,230,000
Traffic Signals	$600,000	$300,000	$600,000
Structural	$47,250,000	$57,680,000	$43,810,000
30% Contingency	$17,540,000	$21,040,000	$16,850,000
Property	$6,700,000	$6,700,000	$6,900,000
Total Initial Construction Cost	**$82,700,000**	**$97,860,000.00**	**$79,910,000.00**

4.3. Detailed Qualitative Assessment of Alternatives

The following section provides a detailed qualitative assessment of the three alternatives being considered. For simplicity, the net-present-value score has been weighted as 50% of the overall ranking, with all other factors considered equally.

Table 16: Detailed Assessment of Alternatives for the Intersection of Arterial A2, Regional Road 50 and Major Mackenzie Drive.

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
Engineering	Addresses Problem and Opportunity Statement	Provide enhanced inter-regional connectivity;	• Maintains east-west connectivity between Brampton and Vaughan. • Additional through and auxiliary lanes will provide improved levels of service through the Regional Road 50/Major Mackenzie Drive intersection, making it a more desirable option for drivers moving between the Regions of Peel and York until such time as congestion becomes intolerable.	• Maintains east-west connectivity between Brampton and Vaughan. • North-south traffic along Regional Road 50 would be unimpeded, making it a more desirable option for drivers moving along the border between the Regions of Peel and York. • Interchange will provide improved east-west traffic flow between the Regions of Peel and York. • Interchange structure provides a visual boundary between the Regions of Peel and York.	• Maintains east-west connectivity between Brampton and Vaughan. • East-west and north-south traffic unimpeded through interchange; • Restrictions in eastbound and westbound lefts will result in vehicles needing to take parallel routes north or south of the interchange in order to make these turns onto Regional Road 50 (approximately 130 vehicles/direction/ peak period) • Interchange structure provides a visual boundary between the Regions of Peel and York.
					
		Provide access to proposed development;	• Access between development blocks and major arterial roads is primarily restricted to intersections and limited, approved mid-block median breaks and right-in/right-out direct access points. • Some reconfiguration of the industrial development plan will be required to accommodate westerly shift in the Coleraine Drive/Arterial A2 (Major Mackenzie Drive Extension) intersection.	• Access between development blocks and major arterial roads is primarily restricted to intersections and limited, approved mid-block median breaks and right-in/right-out direct access points. • Planned collector roadway 440 m north of Major Mackenzie Drive would not be feasible due to conflict with the right-turn bypass lanes. If required, collector would need to be moved further to the north. • Some reconfiguration of the industrial development plan will be required to accommodate westerly shift in the Coleraine Drive/Arterial A2 (Major Mackenzie Drive Extension) intersection.	• Access between development blocks and major arterial roads is primarily restricted to intersections and limited, approved mid-block median breaks and right-in/right-out direct access points. • Significant traffic volumes and crossing distances on Coleraine Drive will limit desireability of mid-block access with this alternative. • Some additional internal road networks will be required for larger development areas. • Where access is provided directly to a major arterial road, it is limited to smaller developments or individual dwellings. It is also restricted to right-in/right-out only.
					
		Address anticipated capacity issues resulting from extension of Highway 427 to Major Mackenzie Drive, as well as development of the study area;	• Select movements at the Arterial A2 / Regional Road 50 / Major Mackenzie Drive intersection will reach levels of service that exceed what is deemed acceptable by the Region and City by 2041 (Eastbound left and southbound left at LOS F in the p.m. peak, Northbound left at LOS F in the a.m. peak). • Overall levels of service at major intersections will either be at, or better than, minimum acceptable levels of service for the 2041 plannining horizon (LOS D and E).	• All movements will either be at, or better than, minimum acceptable levels of service for the 2041 plannining horizon (LOS E or better). • Overall levels of service at major intersections will either be at, or better than, minimum acceptable levels of service for the 2041 plannining horizon (LOS C and D).	• All movements will either be at, or better than, minimum acceptable levels of service for the 2041 plannining horizon (LOS E or better). • Overall levels of service at major intersections will either be at, or better than, minimum acceptable levels of service for the 2041 plannining horizon (LOS B and C).
					
		Improve roadway geometrics to meet or exceed City and Regional standards;	• With a posted speed of 70 km/h, providing the desirable signalized intersection spacing of ~560 m could be accomplished by relocating the proposed collector 440 m north of Major Mackenzie Drive an additional 100 m to the north.	• With a posted speed of 70 km/h, providing the desirable signalized intersection spacing of ~560 m could be accomplished by relocating the proposed collector 440 m north of Major Mackenzie Drive an additional 100 m to the north.	• Design provides the recommended 560 m minimum spacing between Arterial Road intersections. • Design provides the recommended minimum spacing between Arterial Road intersections.

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
			• Roadway geoemetrics will meet City and Regional standards for at-grade intersections: – Six lane cross-section required on both Major Mackenzie Drive/Arterial A2 and Regional Road 50. – Double left turn lanes (not desirable) required on Regional Road 50, and single left turn lanes required on Major Mackenzie Drive/Arterial A2 to accommodate left turning vehicles. – Right turn lanes required in all directions.	• Roadway geoemetrics will meet TAC and MTO standards for interchange design: – Six lane cross-section required on both Major Mackenzie Drive/Arterial A2 and Regional Road 50. – Single left turn lanes provided on Reg. Road 50, Major Mackenzie Drive/Arterial A2 to accommodate left turning vehicles. – Right turn ramps will be provided in each direction.	• Roadway geoemetrics will meet TAC and MTO standards for interchange design: • Reduced four lane cross-section required on Regional Road 50 and Arterial A2. • Right turn ramps will require signalization or revision to current design (including the addition of merge lanes) to improve level of safety and traffic flow.
					
		Provide pedestrian and cycling facilities;	• Pedestrian and cycling facilities could be provided for all movements, in a similar fashion to all other at-grade signalized intersections with the City/Region.	• Pedestrian and cycling facilities could be provided for all through movements. • Right turns at the interchange would require travel along the outside of the right/left turning lanes, which would have a decreased travel distance but would not be intuitive. • Left turns at the interchange would require movements across an uncontrolled portion of the right turn lanes. • Potential to provide pedestrian-actuated signals at ramp locations should be investigated further.	• Pedestrian and cycling facilities could be provided for all through movements, but would require crossing at several uncontrolled locations. • Right turns at the interchange would require travel along the outside of the right/left turning lanes, which would have a decreased travel distance but would not be intuitive. • No ability to provide for left turning movements at the interchange.
					
		Improve traffic, pedestrian and cyclist safety;	• Controlled crossing in all four directions at all intersections. • Protected left turn phasing should be provided to minimize safetly implications associated with making left turns across three lanes of on-coming traffic, particularly off of Regional Road 50. • Requires significant pedestrian and cyclist crossing time due to total number of lanes (nine lanes total in north/south direction, eight lanes in total in east/west direction). • Potential vehicular and active transportation conflict points if channelized right turn lanes are provided. • Right-on-reed prohibitions can be used to partially mitigate conflicts with pedestrians and cyclists. • Most significant safety concerns are associated with congestion and significant crossing distances. • Mitigation techniques are available to the city/Region to address these concerns.	• North-south through movements would be unimpeded for vehicular traffic at the interchange. • East-west movements would be controlled in a similar fashion as an at-grade signalized intersection. • All left turn movements would be completed on a left-turn phase. • Conflict points at uncontrolled locations for pedestrians and cyclists include: – All through movements would require individuals to cross two right-turn ramps/lanes; and – Left turn movements would require crossing of up to two right turn ramps/lanes, as well as crossing through the at-grade intersection in two directions. • Potential to provide pedestrian-actuated signals for left turning cyclists and pedestrians should be investigated further. • Partial mitigation of risk can be provided through provision of enhanced lighting and clear zones, ladder (crosswalk) markings and clear signage indicating pedestrians and cyclists to yield to vehicles. • Most significant safety concerns are associated with congestion, significant crossing distances, and two uncontrolled pedestrian/cyclist crossing locations.	• All through movements would be unimpeded for vehicular traffic. • Left-turn ramps off of Regional Road 50 intersect Major Mackenzie Drive at a 25o angle, which would require signalization or provision of a merge lane. • Right-turn ramps off of Regional Road 50 would require longer merge lanes to improve safety. • All through movements would require active transportation facility users to cross three ramps/merge lanes at uncontrolled locations; and • No ability to provide pedestrians and cyclists with a means for making left turning movements at the interchange. • Routing for active transportation facilities would be significantly longer than with standard signalized intersection. • Limited ability to mitigate risk without signalizing the crossing locations (i.e. pedestrian activated signal), which is not considered financially or operationally feasible given the number of sites. • Most significant safety concerns are associated with weaving and merging at tamps and bypass lanes, as well as the number of uncontrolled pedestrian crossing

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
				• Mitigation techniques are available to the city/Region to address these concerns.	locations at right turn channels (Coleraine Drive at RR50) and at the ramps/bypass lanes at the interchange. • Mitigation techniques are available to the city/Region to address these concerns. • Limited ability to fully address issues associated with uncontrolled pedestrian/cyclist crossings.
					
		Improve watercourse crossings to enhance hydraulics, stream function and fisheries and wildlife passage;	• To maximize intersection spacing along Arterial A2 between Coleraine Drive and Regional Road 50, the intersection with Coleraine Drive will be moved west into the Rainbow Creek Natural Heritage System (NHS). • Potential significant impact to the function of the Rainbow Creek NHS if appropriately sized bridge openings are not provided. • All watercourse crossings will be developd to enhance hydraulics, stream function and both aquatic and terrestrial passage.	• To maximize intersection spacing along Arterial A2 between Coleraine Drive and Regional Road 50, the intersection with Coleraine Drive will be moved west into the Rainbow Creek Natural Heritage System (NHS). • Potential significant impact to the function of the Rainbow Creek NHS if appropriately sized bridge openings are not provided. • All watercourse crossings will be developd to enhance hydraulics, stream function and both aquatic and terrestrial passage.	• Due to elimination of the Regional Road 50 / Major Mackenzie Drive intersection, there are no concerns with intersection spacing to Coleraine Drive. • Four lane bridge structure will be required to cross Arterial A2 over the Rainbow Creek Natural Heritage System (NHS). • Moderate impacts to the function of the Rainbow Creek NHS. • All watercourse crossings will be developd to enhance hydraulics, stream function and both aquatic and terrestrial passage.
					
	Transportation Network Connectivity		• Network connectivity is provided per the recommendations of the SP47 TMP and earlier Peel Highway 427 Extension Area TMP. • Internal and inter-regional pedestrian and cyclist network connectivity can be provided. • Significant congestion at the Arterial A2 / Regional Road 50 / Major Mackenzie Drive intersection by 2041 will reduce inter-regional vehicular connectivity	• Network connectivity is provided per the recommendations of the SP47 TMP and earlier Peel Highway 427 Extension Area TMP. • Internal and inter-regional pedestrian and cyclist network connectivity can be provided. • No significant congestion at the Arterial A2 / Regional Road 50 / Major Mackenzie Drive junction by 2041.	• Network connectivity is modified in comparison to the recommendations of the SP47 TMP and earlier Peel Highway 427 Extension Area TMP. • Internal pedestrian and cyclist network connectivity can be provided. Inter-regional connectivity would be difficult to provide through the interchange, but would be maintained at intersections to the north. • Improved connectivity between the southern segment of Regional Road 50 and Emil Kolb Parkway (bypass for industrial traffic). Reduced connectivity along Reg. Rd. 50. • No congestion at the Coleraine Drive / Regional Road 50 / Major Mackenzie Drive junction by 2041.
					
	Transportation Network Capacity	Impacts on traffic on local roads and outside the study area. Transportation network improvement and accommodation of goods movement.	• Traffic volumes could be accommodated on the arterial road network, although the Arterial A2 / Regional Road 50 / Major Mackenzie Drive intersection will be congested by 2041. This will put additional stress on adjacent local roads and cause backup on Major Mackenzie (York Region). • Arterial A2 will provide provide additional north-south connectivity, including inter-municipal connectivity if extended further north towards Bolton.	• Traffic volumes could be accommodated on the arterial road network, with some congestion of the Arterial A2 / Regional Road 50 / Major Mackenzie Drive intersection by 2041. • Arterial A2 will provide provide additional north-south connectivity, including inter-municipal connectivity if extended further north towards Bolton.	• Traffic volumes can be accommodated on arterial roads, with with some congestion of the Coleraine Drive / Regional Road 50 intersection by 2041. • Network design provides enhanced connectivity to Emil Kolb Parkway (Bolton Bypass), which is an improvement for goods movement.

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
	Anticipated Impact to Traffic Operations	Indication of level-of-service for critical intersections.	• Regional Road 50 / Arterial A2 / Major Mackenzie Drive overall PM Peak Level of Service 'E'. • Individual movements with LOS E or F in PM peak: – Northbound through and left (E); – Eastbound through (E) and left (F); – Southbound left (F); and – Westbound through (E). • Coleraine Drive / Arterial A2 / East-West Arterial overall PM Peak level-of-service 'D'. • Individual movements with LOS E in PM Peak: – Eastbound left; and – Southbound right and left. • Total delay system-wide is 5,020hr/day	• Regional Road 50 / Arterial A2 / Major Mackenzie Drive overall PM peak Level of Service 'D'. • Individual movements with LOS E in PM peak: – Eastbound left (could be revised to dual left); • Coleraine Drive / Arterial A2 / East-West Arterial overall PM Peak level-of-service 'C'. • Individual movements with LOS E in PM Peak: – Westbound left (could be revised to dual left). • Total delay system-wide is 3,759hr/day	• Regional Road 50 / Coleraine Drive overall PM peak Level of Service 'C'. • Individual movements with LOS E in PM peak: – Southbound left (could be revised to dual left). • East-West Arterial at Arterial A2 overall PM peak Level-of-Service 'B'. • Individual movements with LOS E in PM peak: – Northbound left (could be revised to dual left). • No significant delay through the interchange. • Total delay system-wide is 3,526hr/day
	Wayfinding/ Human Factor Considerations for Vehicular Traffic	Indication of likely familiarity with proposed approach and clarity of routing for all travel directions.	• Familiar interchange configuration will be easy for drivers to navigate • Standard intersection signage required	• Most drivers will not be familiar with this interchange type and wayfinding signage will be required for left turn movements off of Regional Road 50. • As left turns from Highway 50 must occupy the rightmost lane along with right-turning vehicles, the use of proper advanced signage will be critical.	• Familiar interchange configuration. • Advanced signage will be required to alert vehicles that east and westbound left turns are not permitted at the interchange. • Signage will be required to differentiate Coleraine Drive and Regional Road 50 at their intersection point.
	Promotion of Active Transportation	Adheres to Region of Peel's Active Transportation Policies and Initiatives as Defined in the TTMP / ATMP	• Special Policy Area 47 Transportation Master Plan notes that the Major Mackenzie Drive / Regional Road 50 intersection should act as a potential active transportation "Trail Gateway" into the area. • Active transportation facilities could be provided on all impacted roadways. • All active transportation movements could be accommodated at both the Regional Road 50 and Coleraine/East-West arterial intersections with Arterial A2/Major Mackenzie Drive. • LOS for AT facilities anticipated to be equivalent to the vehicular LOS.	• Ability to use the intersection of Regional Road 50 at Major Mackenzie Drive at a 'Trail Gateway' into Special Policy Area 47 is compromised by the complex movements required for pedestrians and cyclists to move through the interchange. • Due to number of uncontrolled crossing locations and complex left turn movements, the LOS for AT facilities is not equivalent to the vehicular LOS.	• Ability to use the intersection of Regional Road 50 at Major Mackenzie Drive at a 'Trail Gateway' into Special Policy Area 47 is compromised by the complex movements required for pedestrians and cyclists to move through the interchange. • Due to lack of ability for pedestrians and cyclists to make left turn movements at the interchange, as well as the higher priority given to vehicular traffic, the LOS for AT facilities is not equivalent to the vehicular LOS.
		Wayfinding / Human Factor Considerations for pedestrians and cyclists.	• Typical intersection configuration, easy for pedestrians and cyclists to navigate.	• Intuitive for through-bound pedestrians and cyclists. • Advanced signage will be required for pedestrians and cyclists making right turns and north-southbound left turn movements at the interchange as wayfinding may not be intuitive.	• Intuitive for through-bound pedestrians and cyclists. • Trail maps will be required to assist pedestrians and cyclists with selecting alternative routes when their ultimate destinations would normally require left turns at the interchange.

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
					
	Transit Supportive Development	Potential adverse impact on transit service. Assessment of impact on planned transit service improvements.	• Limited impact to existing or future transit routes. • Secondary corridors outlined in Special Policy Area 47 Transportation Master Plan unaffected.	• Limited impact to existing or future transit routes. • Secondary corridor north/south to east/west connections at Regional Road 50 / Major Mackenzie Drive will need to be located outside of the interchange footprint.	• GO Bus Route 38 would be redirected to use new Regional Road 50 / Coleraine Drive intersection. Not expected to significantly impact travel time. • New routes would need to consider north and southbound left restrictions at the interchange. • Secondary corridor north/south to east/west connections at Regional Road 50 / Major Mackenzie Drive will need to be located outside of the interchange footprint.
					
	Structural Impacts	Need for additional bridge structures.	• Estimated area of bridge required over Rainbow Creek (assuming all roadway within the NHS is elevated) is 10,500 m^2.	• Approximate area of bridge deck required for the interchange is 2,100 m^2. • Approximate area of retaining walls requires is 160 m^2. • Estimated area of bridge required over Rainbow Creek (assuming all roadway within the NHS is elevated) is 10,500 m^2.	• Approximate area of bridge deck required for the interchange is 1,400 m^2. • Approximate area of retaining walls required is 320 m^2 (assumed along outside of loop ramps). • Estimated area of bridge required over Rainbow Creek (assuming all roadway within the NHS is elevated) is 8,300 m^2.
					
	Constructability	Ability to construct grade separation and/or expand intersections without significant impacts to existing roadways.	• Expansion of the intersection would require standard construction staging, including lane shifting.	• Construction of interchange can be deferred until warranted by traffic volumes. • Staging assumed to progress as follows: – Construct at-grade left and right turn lanes from Regional Road 50 to/from Arterial A2/Major Mackenzie Drive as required for the future interchange. – Detour Regional Road 50 traffic onto turn lanes (will require temporary signals). – Construct bridge abutments, retaining walls and new profile along current Regional Road 50 alignment. – Install bridge deck and permanent signals (potential for single weekend installation). – Reroute traffic to permanent configuration.	• No ability to delay construction to a later date. • Significant staging and throw-away detours would be required for construction. • Staging assumed to progress as follows; – Construct collector road between Coleraine Drive and existing Regional Road 50. Detour Coleraine traffic onto collector. – Construct bridge structure. – Construct realigned Regional Road 50 segments and widen Coleraine Drive (off line) – Detour Major Mackenzie Drive to connect to new Regional Road 50 alignment, south of future interchange fottprint. – Construct interchange – Reroute Major Mackenzie Drive along final alignment and decomission detour.
					

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
Financial	Utility Relocation	Ability to minimize effects on existing and proposed utilities.	• Impact to existing utilities would be limited to the future intersection footprint. • Anticipated utility impacts include: – Overhead hydro – Overhead and buried Bell – Gas – Watermain – Sanitary Sewer • Moderate utility impacts.	• Impact to existing utilities would be limited to the future interchange footprint. • Anticipated utility impacts include: – Overhead hydro – Overhead and buried Bell – Gas – Watermain – Sanitary Sewer • Moderate utility impacts.	• Utility impacts would include not only those within the footprint of the future interchange, • Anticipated utility impacts include: – Overhead hydro – Overhead and buried Bell – Gas – Watermain – Sanitary Sewer • Moderate utility impacts.
					
	Capital Costs	Function of total road length and width, AT facilities provided, intersection infrastructure, structural area required, and amount of utility relocation.	• Estimated functional construction cost (including property acquisition) is $109.19 M.	• Estimated functional construction cost (including property acquisition) is $127.55 M.	• Estimated functional construction cost (including property acquisition) is $118.48 M.
					
	Operating Costs	Function of road length, number of traffic signals, and area of bridge deck.	• Two signalized intersections required (Arterial A2 / Coleraine Drive / East-West Arterial and Regional Road 50 at Major Mackenzie Drive. Annual operating cost for these signals is approximately $14,000. • Estimated area of bridge required over Rainbow Creek (assuming all roadway within the NHS is elevated) is 10,500 m2. Annual maintenance cost for bridge structure is esimated at $470,000. • Total estimated length of individual lanes within the bounds of the area being evaluated is 28.4 km. At an approximate maintenance cost of $10,000/lane-km, the operational cost for the roadways would be $284,000/year. • Total anticipated annual operating cost of ~$768,000 /year.	• Two signalized intersections required (Arterial A2/ East-West Arterial and Regional Road 50 at Coleraine Drive. Annual operating cost for these signals is approximately $14,000. • Approximate area of bridge deck required for the interchange is 2,300 m2. Annual maintenance cost for bridge structure is $104,000. • Approximate area of retaining walls required is 160 m2 (assumed along outside of ramps). Estimated annual maintenance costs for these walls is $2,000. • Estimated area of bridge required over Rainbow Creek (assuming all roadway within the NHS is elevated) is 10,500 m2. Annual maintenance cost for bridge structure is $470, 000. • Total estimated length of individual lanes within the bounds of the area being evaluated is 28.7 km. At an approximate maintenance cost of $10,000/lane-km, the operational cost for the roadways would be $287,000/year. • Total anticipated annual operating cost of ~$877,000/year.	• Two signalized intersections required (Arterial A2/ East-West Arterial and Regional Road 50 at Coleraine Drive. Annual operating cost for these signals is approximately $14,000. • Approximate area of bridge deck required for the interchange is 1,400 m2. Annual maintenance cost for bridge structure is $66 k. • Approximate area of retaining walls required is 480 m2 (assumed along outside of ramps). Estimated annual maintenance costs for these walls is $4,000. • Estimated area of bridge required over Rainbow Creek (assuming all roadway within the NHS is elevated) is 8,300 m2. Annual maintenance cost for bridge structure is $380 k. • Total estimated length of individual lanes within the bounds of the area being evaluated is 25.6 km. At an approximate maintenance cost of $10,000/lane-km, the annual operational cost for the roadway would be $256,000/year • Total anticipated annual operating cost of ~$720 k/year.
					

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
	Property Acquisition	Estimated area and value of required property[4]	• Estimated property required to accommodate planned interchange and adjacent portions of Arterial A2, Coleraine Drive and East-West Arterial is 8.1 ha. • Estimated value of property to be acquired is $26.5 M.	• Estimated property required to accommodate planned interchange and adjacent portions of Arterial A2, Coleraine Drive and East-West Arterial is 8.8 ha. • Estimated value of property to be acquired is $28.5 M.	• Estimated property required to accommodate planned interchange and associated embankments, as well as the relocation of Regional Road 50, is 8.3 ha. • Estimated property to be made available through abandonment of existing Regional Road 50 right-of-way is 3.0 ha. Note that new collector road access from York will be required within the area southeast of the future Regional Road 50 / Coleraine Drive intersection, requiring property approximately equal to that being made available. • Estimated value of property to be acquired is $37.8 M.
					
	Congestion Cost	Estimate of annualized congestion cost based on CO_2 emissions and lost time.	• Estimated annual congestion cost for this scenario in 2021 is $19.9 M. • Estimated annual congestion cost for this scenario in 2041 is $35 M.	• Estimated annual congestion cost for this scenario in 2021 is $15 M. • Estimated annual congestion cost for this scenario in 2041 is $26.4 M.	• Estimated annual congestion cost for this scenario in 2021 is $22.8 M. • Estimated annual congestion cost for this scenario in 2041 is $40.2 M.
					
	Net Present Value Lifecycle Cost (incl. congestion)	Estimate of annualized lifecycle cost for each intersection alternative, assuming pavement lifecycle of 20 years and structural lifecycle of 50 years.	• Estimated lifecycle cost for this alternative over the 40 year assessment period is $1.7 B. • 25% increase relative to Alternative 2.	• Estimated lifecycle cost for this alternative over the 40 year assessment period is $1.37 B.	• Estimated lifecycle cost for this alternative over the 40 year assessment period is $1.94 B. • 42% increase relative to Alternative 2.
					
	Net Present Value Lifecycle Cost (Excl. congestion)	Estimate of annualized lifecycle cost for each intersection alternative, assuming pavement lifecycle of 20 years and structural lifecycle of 50 years.	• Estimated lifecycle cost for this alternative over the 40 year assessment period is $198.7 M.	• Estimated lifecycle cost for this alternative over the 40 year assessment period is $226.8 M. • 14% increase relative to Alternative 1.	• Estimated lifecycle cost for this alternative over the 40 year assessment period is $203.1 M. • 2% increase relative to Alternative 1.
					
Social / Cultural Environment	Conformance to Planning Objectives (Growth Plan, Official Plan, Secondary Plan, Area 47 TTMP)		• Interchange alternative is in line with recommendations of the various applicable planning documents. • Recommended westerly shift of the Arterial A2 / Coleraine Drive intersection does not conform to the recommendations made in the SP47 TMP or the SP47 MESP. Significant design coordination with TRCA will be required.	• Interchange alternative is in line with recommendations of the various applicable planning documents. • Recommended westerly shift of the Arterial A2 / Coleraine Drive intersection does not conform to the recommendations made in the SP47 TMP or the SP47 MESP. Significant design coordination with TRCA will be required.	• Realignment of Regional Road 50 and change in priority for Coleraine Drive are significantly different conditions than assumed during completion of the Special Policy Area 47 Transportation Master Plan or Secondary Plans. • Configuration has potentially significant impacts on remainder of the road network due to changes in routing beyond the limits of the SP47 study area.
					

[4] For all alternatives, property requirements and increases in impervious area have been estimated for portions of roadway that fall within the following limits: Arterial A2 from 60 m south of the SP47 TMP intersection with the East-West Arterial to 200 m east of Regional Road 50; Coleraine Drive from 1 km south of Countryside Drive to its south terminus; and Regional Road 50 from 850 m north of Major Mackenzie Drive to Cadetta Road.

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
	Residential/Business Access and Displacement	Potential adverse effects, including changes to existing entrances.	• Minimal impact to existing development.	• Westbound right ramp will cut off access to four properties in the northeast quadrant of the Regional Road 50 / Major Mackenzie Drive intersection, and necessitate buyout of the one property located immediately at the existing intersection. • Access will be cut off for one existing industrial complex in the southwest quadrant of the intersection. • Access to Cadetta Road will become right-in/right-out only, eliminating access from this development to Highway 427.	• Realignment of Regional Road 50 and provision of the westbound right ramp will cut off access to four properties in the northeast quadrant of the Regional Road 50 / Major Mackenzie Drive intersection. • Access and parking will be removed for one existing industrial complex in the southwest quadrant of the intersection. • Access to Cadetta Road will become right-in/right-out only, eliminating access from this development to Highway 427.
					
		Impact to planned residential and commercial development, including accesses.	• Reconfiguration of the proposed industrial development along Coleraine Drive will be required to accommodate westerly relocation of the Coleraine Drive / Arterial A2 intersection (no change in area of available developable land). • Minor property impacts resulting from expansion of the Regional Road 50 / Major Mackenzie Drive intersection anticipated. • Will have edge impacts on 2 parcels, require buyout of 1 industrial property, and have access implications for 1 parcel.	• Reconfiguration of the proposed industrial development along Coleraine Drive will be required to accommodate westerly relocation of the Coleraine Drive / Arterial A2 intersection (no change in area of available developable land). • Property will be required in the northwest quadrant of the Regional Road 50 / Major Mackenzie Drive intersection to accommodate proposed southbound ramps/lanes. This will require changes to the proposed office development at this intersection. • Will have edge impacts on 4 parcels, require buyout of 3 industrial property, and have access implications for 3 parcels.	• Reconfiguration of the proposed industrial and office developments along Coleraine Drive will be required to accommodate realignment of Regional Road 50 and construction of the interchange west of the current Regional Road 50 / Coleraine Drive intersection. • Maintenance of road access along the exisitng Regional Road 50 alignment will be required to provide access to property east of Coleraine Drive, which would otherwise become land locked. • Will have edge impacts on 6 parcels, require buyout of 6 parcels (including 3 existing residential properties), and have access implications for 3 parcels.
					
	Emergency Services (Police, Fire, Ambulance)	Potential to reduce response times. Potential adverse effects include changes to existing entrances.	• No anticipated changes in response times as a result of implementation of this alternative.	• Grade separation of Regional Road 50 will reduce north-south travel times in comparison to an at-grade signalized intersection.	• East-west and north-south travels times through the interchange will be reduced compared to that of an at-grade signalized intersection. • Continuous north-south travel along Regional Road 50 requires a turn movement through the new intersection with Coleraine Drive. As this intersection is anticipated to be significantly congested, reductions in travel time through the interchange are anticipated to be offset by this intersection.
					
	Archaeological, Built Heritage and Cultural Landscape Impacts	Potential adverse effects on archaeological and built heritage resources.	• No impacts to any properties containing infrastructure with built or cultural heritage value.	• No impacts to any properties containing infrastructure with built or cultural heritage value.	• No impacts to any properties containing infrastructure with built or cultural heritage value.
					

Category	Criteria	Criteria Indicator	Alternative 1 At-Grade Intersection	Alternative 2 Single Point Urban Interchange	Alternative 3 Modified Parclo 'A'
	Agricultural Impacts		• 10.7 ha of existing agricultural land will be impacted to construct portions of Arterial A2, Coleraine Drive, East-West Arterial and their associated intersections.	• 10.8 ha of existing agricultural land will be impacted to construct portions of Arterial A2, Coleraine Drive, East-West Arterial and their associated intersections. • The interchange will primarily be constructed on existing industrial land and/or within existing road right-of-way.	• 13.5 ha of existing agricultural land will be required to construct the interchange and adjacent intersections.
					
	Impact to Natural Heritage Features such as vegetation and watercourses	Proximity, size, characteristics, and sensitivity of significant rural areas, terrestrial ecosystems, and wetlands. Potential impact or loss of natural areas, terrestrial ecosystems or wetland areas, function or habitat.	• 1.3 ha of transportation infrastructure associated with the future intersection of Arterial A2 / East-West Arterial and Coleraine Drive will be located within the proposed Rainbow Creek Natural Heritage System	• 1.3 ha of transportation infrastructure associated with the future intersection of Arterial A2 / East-West Arterial and Coleraine Drive will be located within the proposed Rainbow Creek Natural Heritage System.	• 0.8 ha of transportation infrastructure associated with Arterial A2 will be located within the proposed Rainbow Creek Natural Heritage System.
					
OVERALL RANKING, ALL CRITERIA WEIGHTED EVENLY					
OVERALL RANKING (LIFECYCLE COST WITHOUT CONGESTION, COST WEIGHTED AT 50% OF TOTAL SCORING)					
OVERALL RANKING (LIFECYCLE COST WITH CONGESTION, COST WEIGHTED AT 50% OF TOTAL SCORING)					
PREFERRED ALTERNATIVE	With lifecycle cost (construction, operations, maintenance) valued at 50% of the overall scoring, the preferred alternative for reconfiguration of the transportation network within Special Policy Area 2 is Alternative 1 (At-Grade) if congestion is not considered, and Alternative 2 (Single Point Urban Interchange) if congestion is considered. As Alternative 1 ranks heighest overall (all criteria even), and when congestion is not considered, it is recommended that Alternative 1 be implemented until such time as congestion becomes a significant concern. For this reason, sufficient property to construct the SPUI interchange (Alternative 2) should be secured at the time of development.			

APPENDIX A

High Level Functional Cost Estimates

Title: **SP47 Arterial Roadway Construction Cost Estimates**
Location: **City of Brampton**

FUNCTIONAL CONSTRUCTION COST ESTIMATES

				Engineer's Estimate					
				Alternative 1		Alternative 2		Alternative 3.2	
Item	Item Description	Unit	Unit Price	Quantity	Amount	Quantity	Amount	Quantity	Amount
General									
A1	Bonding								
	a) 100% Performance Labour and Materials Bond	LS	$150,000.00	1	$150,000.00	1	$150,000.00	1	$150,000.00
A2	Pre-Construction Survey	LS	$25,000.00	1	$25,000.00	1	$25,000.00	1	$25,000.00
A3	Site Office	LS	$30,000.00	1	$30,000.00	1	$30,000.00	1	$30,000.00
A4	Construction Layout	LS	$25,000.00	1	$25,000.00	1	$25,000.00	1	$25,000.00
A5	Traffic Control and Staging	LS	$75,000.00	1	$75,000.00	1	$75,000.00	1	$75,000.00
A6	Clearing and Grubbing			1	$0.00	1	$0.00	1	$0.00
	a) Remove and dispose of bush, including hedges and roots, and trees less than 100 mm diameter	LS	$25,000.00	1	$25,000.00	1	$25,000.00	1	$25,000.00
	b) Tree and stump removal - greater than and equal to 100mm diameter	LS	$20,000.00	1	$20,000.00	1	$20,000.00	1	$20,000.00
A7	Construction Signs, Traffic Control and Traffic Management Plan	LS	$75,000.00	1	$75,000.00	1	$75,000.00	1	$75,000.00
	Subtotal Section A				**$425,000.00**		**$425,000.00**		**$425,000.00**
Roadwork									
	Earth Excavation	m^3	$25.00		$0.00		$0.00		$0.00
	Earth Borrow (Clean Fill)	m^3	$25.00		$0.00	58,500	$1,462,500.00	96,980	$2,424,500.00
	Asphalt Removal Partial Depth (90mm)	m^2	$4.00		$0.00		$0.00		$0.00
	Asphalt Removal Full Depth	m^2	$6.00		$0.00		$0.00		$0.00
	Area of Asphalt	m^2		113,109		117,825		102,930	
	Hot Mix HL-3 HS (50 mm)	t	$75.00	14,987	$1,124,020.69	15,612	$1,170,885.94	13,638	$1,022,866.88
	Hot Mix HL-8 HS (85 mm)	t	$75.00	25,478	$1,910,835.17	26,540	$1,990,506.09	23,185	$1,738,873.69
	Granular 'A' Crushed Limestone (150 mm)	t	$20.00	61,927	$1,238,543.55	64,509	$1,290,183.75	56,354	$1,127,083.50
	Granular 'B' Crushed Limestone (450 mm)	t	$20.00	185,782	$3,715,630.65	193,528	$3,870,551.25	169,063	$3,381,250.50
	Tack Coat	m^2	$0.50	113,109	$56,554.50	117,825	$58,912.50	102,930	$51,465.00
	Concrete Curb and Gutter	m	$65.00	16,540	$1,075,100.00	19,045	$1,237,925.00	20,500	$1,332,500.00
	150mm Subdrain Including Geotextile	m	$25.00	16,540	$413,500.00	19,045	$476,125.00	20,500	$512,500.00
	Pavement Markings - Permanent	0							
	a) 10cm Solid and Dashed, White or Yellow Lines	m						17,520	
	b) 60cm Crosswalk	m	$30.00	189	$5,670.00	147	$4,410.00	409	$12,270.00
	c) 60cm Stop Bar	m	$200.00	95	$18,900.00	74	$14,700.00	198	$39,600.00
	d) Symbols	ea	$180.00	54	$9,720.00	42	$7,560.00	79	$14,220.00
	3m Wide HL3 Asphalt Path	m^2	$12.00	21,300	$255,600.00	21,500	$258,000.00	30,700	$368,400.00
	125mm Concrete Sidewalk (OPSD 310.010)	m^2	$65.00	3,960	$257,400.00	3,980	$258,700.00	950	$61,750.00
	150mm Concrete Maintenance Strip	m^2	$60.00	16,540	$992,400.00	19,045	$1,142,700.00	20,500	$1,230,000.00
	150mm Concrete Median	m^2	$60.00	10,120	$607,200.00	9,790	$587,400.00	10,770	$646,200.00
	Seed and Mulch and 100mm Imported Topsoil	m^2	$5.00	25,000	$125,000.00	27,750	$138,750.00	50,300	$251,500.00
	914mm x 610mm Tactile Warning Plates	ea	$450.00	32	$14,400.00		$0.00	102	$45,900.00
	Subtotal Section B				**$11,820,474.56**		**$13,969,809.53**		**$14,260,879.56**
Storm Sewer									
C1	600 x 600 Catchbasins (75 m spacing)	ea	$3,000.00	128	$384,800.00	128	$384,800.00	108	$324,800.00
C2	600 mm storm sewer	m	$550.00	4,810	$2,645,500.00	4,810	$2,645,500.00	4,060	$2,233,000.00
C3	250 mm catchbasin leads	m	$250.00	1,443	$360,750.00	1,443	$360,750.00	1,218	$304,500.00
C4	Maintenance Hole (200 m spacing)	ea	$5,000.00	24	$120,250.00	24	$120,250.00	20	$101,500.00
	Subtotal Section C				**$3,511,300.00**		**$3,511,300.00**		**$2,963,800.00**
Traffic Signals									
D1	Full intersection signalization	LS	$300,000.00	2	$600,000.00	2	$600,000.00	2	$600,000.00
	Subtotal Section D				**$600,000.00**		**$600,000.00**		**$600,000.00**
Structural									
E1	Concrete Bridge Structure	m^2	$4,500.00	10500	$47,250,000.00	12,800	$57,600,000.00	9700	$43,650,000.00
E2	Retaining Walls	m^2	$500.00		$0.00	160	$80,000.00	320	$160,000.00
	Subtotal Section E				**$47,250,000.00**		**$57,680,000.00**		**$43,810,000.00**

Summary			
General	$430,000	$430,000	$430,000
Roadwork	$11,820,000	$13,970,000	$14,260,000
Storm Sewer	$3,510,000	$3,510,000	$2,960,000
Traffic Signals	$600,000	$600,000	$600,000
Structural	$47,250,000	$57,680,000	$43,810,000
30% Contingency	$19,080,000	$22,860,000	$18,620,000
Property	$26,500,000	$28,500,000	$37,800,000
TOTAL TENDER	**$109,190,000**	**$127,550,000.00**	**$118,480,000.00**

APPENDIX B

Annualized Congestion, (Re) Construction and Operations Costs

40 Year Lifecycle Costing for Special Policy Area 2 Configuration Alternatives

GROWTH RATES Traffic 1.20%
Inflation 1.60%

LEGEND: Resurfacing of Asphalt Required (10 Year Cycle)
Roadway Reconstruction Required (20 Year Cycle)

FULL COST SUMMARY - INCLUDING CONGESTION

Annual Operations Costs

Operating and maintenance costs per lane-km =	10,000	
Operating and maintenance costs per signal =	7000	
Structural Maintenance Costs=	0.01	of Construction Costs
Retaining Wall Maintenance Costs =	0.025	of Construction Costs

	Alternative 1 - At-Grade Intersection				Alternative 2 - SPUI				Alternative 3 - Modified Parclo 'A' Version 3.2			
Assessment Year	Congestion Cost	(Re) Construction Cost	Annual Operations	Total Annual Cost	Congestion Cost	(Re) Construction Cost	Annual Operations	Total Annual Cost	Congestion Cost	(Re) Construction Cost	Annual Operations	Total Annual Cost
2021	$ 19,948,830.37	$ 109,190,000.00	$ 770,250.00	$ 129,909,080.37	$ 15,006,132.72	$ 127,550,000.00	$ 878,600.00	$ 143,434,732.72	$ 22,840,029.34	$ 118,480,000.00	$ 715,700.00	$ 142,035,729.34
2022	$ 20,519,434.82		$ 791,964.89	$ 21,311,399.70	$ 15,435,359.19		$ 903,369.49	$ 16,338,728.68	$ 23,493,331.92		$ 735,877.01	$ 24,229,208.93
2023	$ 21,106,360.49		$ 814,291.96	$ 21,920,652.45	$ 15,876,862.99		$ 928,837.28	$ 16,805,700.28	$ 24,165,321.17		$ 756,622.86	$ 24,921,944.03
2024	$ 21,710,074.23		$ 837,248.48	$ 22,547,322.71	$ 16,330,995.31		$ 955,023.06	$ 17,286,018.37	$ 24,856,531.60		$ 777,953.57	$ 25,634,485.17
2025	$ 22,331,056.24		$ 860,852.19	$ 23,191,908.43	$ 16,798,117.36		$ 981,947.07	$ 17,780,064.43	$ 25,567,513.00		$ 799,885.64	$ 26,367,398.64
2026	$ 22,969,800.46		$ 885,121.34	$ 23,854,921.79	$ 17,278,600.69		$ 1,009,630.13	$ 18,288,230.81	$ 26,298,830.89		$ 822,436.01	$ 27,121,266.91
2027	$ 23,626,814.92		$ 910,074.68	$ 24,536,889.60	$ 17,772,827.47		$ 1,038,093.62	$ 18,810,921.09	$ 27,051,066.96		$ 845,622.13	$ 27,896,689.09
2028	$ 24,302,622.24		$ 935,731.50	$ 25,238,353.75	$ 18,281,190.83		$ 1,067,359.55	$ 19,348,550.38	$ 27,824,819.54		$ 869,461.91	$ 28,694,281.45
2029	$ 24,997,759.95		$ 962,111.64	$ 25,959,871.60	$ 18,804,095.10		$ 1,097,450.56	$ 19,901,545.66	$ 28,620,704.08		$ 893,973.78	$ 29,514,677.86
2030	$ 25,712,780.97		$ 989,235.50	$ 26,702,016.46	$ 19,341,956.22		$ 1,128,389.88	$ 20,470,346.10	$ 29,439,353.63		$ 919,176.69	$ 30,358,530.32
2031	$ 26,448,254.01	$ 3,556,928.61	$ 1,017,124.02	$ 31,022,306.64	$ 19,895,202.00	$ 3,705,232.24	$ 1,160,201.45	$ 24,760,635.68	$ 30,281,419.34	$ 3,236,830.50	$ 945,090.12	$ 34,463,339.96
2032	$ 27,204,764.09		$ 1,045,798.78	$ 28,250,562.88	$ 20,464,272.49		$ 1,192,909.85	$ 21,657,182.34	$ 31,147,570.99		$ 971,734.10	$ 32,119,305.09
2033	$ 27,982,912.94		$ 1,075,281.94	$ 29,058,194.88	$ 21,049,620.33		$ 1,226,540.36	$ 22,276,160.69	$ 32,038,497.53		$ 999,129.23	$ 33,037,626.76
2034	$ 28,783,319.48		$ 1,105,596.29	$ 29,888,915.78	$ 21,651,711.11		$ 1,261,118.99	$ 22,912,830.10	$ 32,954,907.60		$ 1,027,296.68	$ 33,982,204.28
2035	$ 29,606,620.38		$ 1,136,765.26	$ 30,743,385.65	$ 22,271,023.74		$ 1,296,672.45	$ 23,567,696.20	$ 33,897,530.12		$ 1,056,258.22	$ 34,953,788.34
2036	$ 30,453,470.49		$ 1,168,812.95	$ 31,622,283.44	$ 22,908,050.82		$ 1,333,228.24	$ 24,241,279.06	$ 34,867,114.85		$ 1,086,036.26	$ 35,953,151.10
2037	$ 31,324,543.39		$ 1,201,764.12	$ 32,526,307.52	$ 23,563,299.04		$ 1,370,814.62	$ 24,934,113.65	$ 35,864,433.00		$ 1,116,653.79	$ 36,981,086.79
2038	$ 32,220,531.95		$ 1,235,644.26	$ 33,456,176.20	$ 24,237,289.59		$ 1,409,460.62	$ 25,646,750.21	$ 36,890,277.85		$ 1,148,134.49	$ 38,038,412.34
2039	$ 33,142,148.82		$ 1,270,479.54	$ 34,412,628.36	$ 24,930,558.56		$ 1,449,196.13	$ 26,379,754.69	$ 37,945,465.35		$ 1,180,502.70	$ 39,125,968.05
2040	$ 34,090,127.08		$ 1,306,296.90	$ 35,396,423.97	$ 25,643,657.38		$ 1,490,051.87	$ 27,133,709.26	$ 39,030,834.80		$ 1,213,783.43	$ 40,244,618.24
2041	$ 35,065,220.73	$ 22,946,721.19	$ 1,343,124.02	$ 59,355,065.95	$ 26,377,153.26	$ 24,174,415.42	$ 1,532,059.41	$ 52,083,628.10	$ 40,147,249.52	$ 22,974,400.12	$ 1,248,002.42	$ 64,369,652.05
2042	$ 36,053,779.44		$ 1,380,989.37	$ 37,434,768.81	$ 27,120,777.97		$ 1,575,251.23	$ 28,696,029.20	$ 41,279,080.78		$ 1,283,186.10	$ 42,562,266.88
2043	$ 37,070,207.59		$ 1,419,922.22	$ 38,490,129.81	$ 27,885,366.94		$ 1,619,660.72	$ 29,505,027.66	$ 42,442,820.62		$ 1,319,361.68	$ 43,762,182.30
2044	$ 38,115,290.88		$ 1,459,952.67	$ 39,575,243.55	$ 28,671,511.20		$ 1,665,322.19	$ 30,336,833.40	$ 43,639,368.62		$ 1,356,557.13	$ 44,995,925.75
2045	$ 39,189,837.16		$ 1,501,111.66	$ 40,690,948.82	$ 29,479,818.45		$ 1,712,270.95	$ 31,192,089.40	$ 44,869,649.70		$ 1,394,801.19	$ 46,264,450.89
2046	$ 40,294,677.05		$ 1,543,431.00	$ 41,838,108.05	$ 30,310,913.49		$ 1,760,543.30	$ 32,071,456.79	$ 46,134,614.86		$ 1,434,123.42	$ 47,568,738.29
2047	$ 41,430,664.58		$ 1,586,943.40	$ 43,017,607.99	$ 31,165,438.76		$ 1,810,176.53	$ 32,975,615.30	$ 47,435,241.93		$ 1,474,554.23	$ 48,909,796.16
2048	$ 42,598,677.88		$ 1,631,682.51	$ 44,230,360.39	$ 32,044,054.81		$ 1,861,209.03	$ 33,905,263.84	$ 48,772,536.27		$ 1,516,124.86	$ 50,288,661.13
2049	$ 43,799,619.81		$ 1,677,682.91	$ 45,477,302.71	$ 32,947,440.81		$ 1,913,680.24	$ 34,861,121.04	$ 50,147,531.61		$ 1,558,867.45	$ 51,706,399.06
2050	$ 45,034,418.69		$ 1,724,980.14	$ 46,759,398.83	$ 33,876,295.06		$ 1,967,630.71	$ 35,843,925.77	$ 51,561,290.82		$ 1,602,815.04	$ 53,164,105.87
2051	$ 46,304,029.02	$ 4,885,953.25	$ 1,773,610.78	$ 52,963,593.05	$ 34,831,335.57	$ 5,089,669.62	$ 2,023,102.15	$ 41,944,107.34	$ 53,014,906.73	$ 4,446,252.45	$ 1,648,001.61	$ 59,109,160.78
2052	$ 47,609,432.21		$ 1,823,612.42	$ 49,433,044.62	$ 35,813,300.58		$ 2,080,137.45	$ 37,893,438.03	$ 54,509,502.98		$ 1,694,462.07	$ 56,203,965.05
2053	$ 48,951,637.32		$ 1,875,023.70	$ 50,826,661.02	$ 36,822,949.15		$ 2,138,780.68	$ 38,961,729.83	$ 56,046,234.89		$ 1,742,232.34	$ 57,788,467.23
2054	$ 50,331,681.88		$ 1,927,884.37	$ 52,259,566.25	$ 37,861,061.73		$ 2,199,077.19	$ 40,060,138.92	$ 57,626,290.34		$ 1,791,349.36	$ 59,417,639.70
2055	$ 51,750,632.65		$ 1,982,235.28	$ 53,732,867.94	$ 38,928,440.78		$ 2,261,073.57	$ 41,189,514.36	$ 59,250,890.72		$ 1,841,851.08	$ 61,092,741.80
2056	$ 53,209,586.49		$ 2,038,118.46	$ 55,247,704.95	$ 40,025,911.39		$ 2,324,817.76	$ 42,350,729.15	$ 60,921,291.83		$ 1,893,776.54	$ 62,815,068.38
2057	$ 54,709,671.15		$ 2,095,577.10	$ 56,805,248.25	$ 41,154,321.88		$ 2,390,359.02	$ 43,544,680.90	$ 62,638,784.89		$ 1,947,165.89	$ 64,585,950.78
2058	$ 56,252,046.20		$ 2,154,655.61	$ 58,406,701.81	$ 42,314,544.52		$ 2,457,748.02	$ 44,772,292.55	$ 64,404,697.52		$ 2,002,060.39	$ 66,406,757.91
2059	$ 57,837,903.89		$ 2,215,399.66	$ 60,053,303.54	$ 43,507,476.16		$ 2,527,036.86	$ 46,034,513.02	$ 66,220,394.75		$ 2,058,502.48	$ 68,278,897.23
2060	$ 59,468,470.07		$ 2,277,856.20	$ 61,746,326.28	$ 44,734,038.93		$ 2,598,279.08	$ 47,332,318.01	$ 68,087,280.12		$ 2,116,535.78	$ 70,203,815.90
2061	$ 61,145,005.18		$ 2,342,073.53	$ 63,487,078.71	$ 45,995,180.95		$ 2,671,529.76	$ 48,666,710.72	$ 70,006,796.72		$ 2,176,205.16	$ 72,183,001.88
Total Cost in 2021 CAD$				$ 1,713,380,633.49				$ 1,366,196,113.72				$ 1,937,351,357.69
Net Present Value				$1,227,703,350.31				$991,447,986.80				$1,386,537,795.98

40 Year Lifecycle Costing for Special Policy Area 2 Configuration Alternatives

GROWTH RATES

Traffic	1.20%
Inflation	1.60%

LEGEND:

- Resurfacing of Asphalt Required (10 Year Cycle)
- Roadway Reconstruction Required (20 Year Cycle)

FULL COST SUMMARY - NO COGESTION COSTS

Annual Operations Costs

Operating and maintenance costs per lane-km =	10,000	
Operating and maintenance costs per signal =	7000	
Structural Maintenance Costs=	0.01	of Construction Costs
Retaining Wall Maintenance Costs =	0.025	of Construction Costs

	Alternative 1 - At-Grade Intersection				Alternative 2 - SPUI				Alternative 3 - Modified Parclo 'A' Version 3.2			
Assessment Year	Congestion Cost	(Re) Construction Cost	Annual Operations	Total Annual Cost	Congestion Cost	(Re) Construction Cost	Annual Operations	Total Annual Cost	Congestion Cost	(Re) Construction Cost	Annual Operations	Total Annual Cost
2021		$ 109,190,000.00	$ 770,250.00	$ 109,960,250.00		$ 127,550,000.00	$ 878,600.00	$ 128,428,600.00		$ 118,480,000.00	$ 715,700.00	$ 119,195,700.00
2022			$ 791,964.89	$ 791,964.89			$ 903,369.49	$ 903,369.49			$ 735,877.01	$ 735,877.01
2023			$ 814,291.96	$ 814,291.96			$ 928,837.28	$ 928,837.28			$ 756,622.86	$ 756,622.86
2024			$ 837,248.48	$ 837,248.48			$ 955,023.06	$ 955,023.06			$ 777,953.57	$ 777,953.57
2025			$ 860,852.19	$ 860,852.19			$ 981,947.07	$ 981,947.07			$ 799,885.64	$ 799,885.64
2026			$ 885,121.34	$ 885,121.34			$ 1,009,630.13	$ 1,009,630.13			$ 822,436.01	$ 822,436.01
2027			$ 910,074.68	$ 910,074.68			$ 1,038,093.62	$ 1,038,093.62			$ 845,622.13	$ 845,622.13
2028			$ 935,731.50	$ 935,731.50			$ 1,067,359.55	$ 1,067,359.55			$ 869,461.91	$ 869,461.91
2029			$ 962,111.64	$ 962,111.64			$ 1,097,450.56	$ 1,097,450.56			$ 893,973.78	$ 893,973.78
2030			$ 989,235.50	$ 989,235.50			$ 1,128,389.88	$ 1,128,389.88			$ 919,176.69	$ 919,176.69
2031		$ 3,556,928.61	$ 1,017,124.02	$ 4,574,052.63		$ 3,705,232.24	$ 1,160,201.45	$ 4,865,433.68		$ 3,236,830.50	$ 945,090.12	$ 4,181,920.62
2032			$ 1,045,798.78	$ 1,045,798.78			$ 1,192,909.85	$ 1,192,909.85			$ 971,734.10	$ 971,734.10
2033			$ 1,075,281.94	$ 1,075,281.94			$ 1,226,540.36	$ 1,226,540.36			$ 999,129.23	$ 999,129.23
2034			$ 1,105,596.29	$ 1,105,596.29			$ 1,261,118.99	$ 1,261,118.99			$ 1,027,296.68	$ 1,027,296.68
2035			$ 1,136,765.26	$ 1,136,765.26			$ 1,296,672.45	$ 1,296,672.45			$ 1,056,258.22	$ 1,056,258.22
2036			$ 1,168,812.95	$ 1,168,812.95			$ 1,333,228.24	$ 1,333,228.24			$ 1,086,036.26	$ 1,086,036.26
2037			$ 1,201,764.12	$ 1,201,764.12			$ 1,370,814.62	$ 1,370,814.62			$ 1,116,653.79	$ 1,116,653.79
2038			$ 1,235,644.26	$ 1,235,644.26			$ 1,409,460.62	$ 1,409,460.62			$ 1,148,134.49	$ 1,148,134.49
2039			$ 1,270,479.54	$ 1,270,479.54			$ 1,449,196.13	$ 1,449,196.13			$ 1,180,502.70	$ 1,180,502.70
2040			$ 1,306,296.90	$ 1,306,296.90			$ 1,490,051.87	$ 1,490,051.87			$ 1,213,783.43	$ 1,213,783.43
2041		$ 22,946,721.19	$ 1,343,124.02	$ 24,289,845.21		$ 24,174,415.42	$ 1,532,059.41	$ 25,706,474.84		$ 22,974,400.12	$ 1,248,002.42	$ 24,222,402.53
2042			$ 1,380,989.37	$ 1,380,989.37			$ 1,575,251.23	$ 1,575,251.23			$ 1,283,186.10	$ 1,283,186.10
2043			$ 1,419,922.22	$ 1,419,922.22			$ 1,619,660.72	$ 1,619,660.72			$ 1,319,361.68	$ 1,319,361.68
2044			$ 1,459,952.67	$ 1,459,952.67			$ 1,665,322.19	$ 1,665,322.19			$ 1,356,557.13	$ 1,356,557.13
2045			$ 1,501,111.66	$ 1,501,111.66			$ 1,712,270.95	$ 1,712,270.95			$ 1,394,801.19	$ 1,394,801.19
2046			$ 1,543,431.00	$ 1,543,431.00			$ 1,760,543.30	$ 1,760,543.30			$ 1,434,123.42	$ 1,434,123.42
2047			$ 1,586,943.40	$ 1,586,943.40			$ 1,810,176.53	$ 1,810,176.53			$ 1,474,554.23	$ 1,474,554.23
2048			$ 1,631,682.51	$ 1,631,682.51			$ 1,861,209.03	$ 1,861,209.03			$ 1,516,124.86	$ 1,516,124.86
2049			$ 1,677,682.91	$ 1,677,682.91			$ 1,913,680.24	$ 1,913,680.24			$ 1,558,867.45	$ 1,558,867.45
2050			$ 1,724,980.14	$ 1,724,980.14			$ 1,967,630.71	$ 1,967,630.71			$ 1,602,815.04	$ 1,602,815.04
2051		$ 4,885,953.25	$ 1,773,610.78	$ 6,659,564.03		$ 5,089,669.62	$ 2,023,102.15	$ 7,112,771.78		$ 4,446,252.45	$ 1,648,001.61	$ 6,094,254.05
2052			$ 1,823,612.42	$ 1,823,612.42			$ 2,080,137.45	$ 2,080,137.45			$ 1,694,462.07	$ 1,694,462.07
2053			$ 1,875,023.70	$ 1,875,023.70			$ 2,138,780.68	$ 2,138,780.68			$ 1,742,232.34	$ 1,742,232.34
2054			$ 1,927,884.37	$ 1,927,884.37			$ 2,199,077.19	$ 2,199,077.19			$ 1,791,349.36	$ 1,791,349.36
2055			$ 1,982,235.28	$ 1,982,235.28			$ 2,261,073.57	$ 2,261,073.57			$ 1,841,851.08	$ 1,841,851.08
2056			$ 2,038,118.46	$ 2,038,118.46			$ 2,324,817.76	$ 2,324,817.76			$ 1,893,776.54	$ 1,893,776.54
2057			$ 2,095,577.10	$ 2,095,577.10			$ 2,390,359.02	$ 2,390,359.02			$ 1,947,165.89	$ 1,947,165.89
2058			$ 2,154,655.61	$ 2,154,655.61			$ 2,457,748.02	$ 2,457,748.02			$ 2,002,060.39	$ 2,002,060.39
2059			$ 2,215,399.66	$ 2,215,399.66			$ 2,527,036.86	$ 2,527,036.86			$ 2,058,502.48	$ 2,058,502.48
2060			$ 2,277,856.20	$ 2,277,856.20			$ 2,598,279.08	$ 2,598,279.08			$ 2,116,535.78	$ 2,116,535.78
2061			$ 2,342,073.53	$ 2,342,073.53			$ 2,671,529.76	$ 2,671,529.76			$ 2,176,205.16	$ 2,176,205.16
Total Cost in 2021 CAD$				$ 198,675,916.30				$ 226,787,958.40				$ 203,119,347.91
Net Present Value				$172,454,261.40				$197,656,692.59				$178,350,663.86