Regional Municipality of Halton

Ninth Line (Dundas Street to 407 ETR) Environmental Assessment Study

Traffic Study and Safety Study Report

B000637

October 2017

CIMA+ Partners in excellence

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Table of Contents

Figures

Tables

1. Introduction

CIMA+ was retained by the Regional Municipality of Halton (the Region) to conduct a Municipal Class Environmental Assessment (MCEA) Study for road improvements of Ninth Line as identified in the Region's Transportation Master Plan "*The Road to Change (2011)*". This project follows a Schedule C process as outlined in the *Municipal Class Environmental Assessment* (October 2000, as amended in 2007, 2011 and 2015). The MCEA involves widening and improvements of Ninth Line between the intersections with Dundas Street and Hwy 407 ETR, within the Town of Oakville.

The study area, which includes the intersections of Ninth Line with Dundas Street and with Burnhamthorpe Road, is shown in **Figure 1** (marked in dash green). Ninth Line is a major north-south arterial roadway between Upper Middle Road and Steeles Avenue and represents the boundary between Halton Region and Peel Region, with the Town of Oakville to the west of Ninth Line and the City of Mississauga to the east within the study limits. It is an undivided two-lane road (posted speed = 60 km/h) with a rural cross-section (narrow unpaved shoulders) and urban treatments at the signalized intersections. Burnhamthorpe Road is an undivided two-lane road, while Dundas Street is a divided six-lane road.

Land use within the study area is mainly rural, but include the following developments.

+ Glen Oaks Funeral Home and Cemetery;
+ Kingdom Hall of Jehovah's Witnesses;
+ Open Space
+ Residential Homes
+ Fern Hill School, a private primary and secondary school;
+ Ninth Line Sports Park; and
+ The Tennis School.

In addition, there is a listed Heritage Property at 3480 Ninth Line (Snider's Corners), and the Joshua Valley Park North natural heritage system located just west of Ninth Line.

This report reviews existing conditions from both a traffic operations and safety perspective and evaluates future traffic conditions following the proposed road widening. For this study, CIMA+ completed the following tasks:

+ Traffic operational analysis;
+ Collision analysis;
+ Field investigation; and
+ Study findings and recommendations.

Figure 1: Study Area

2. Analysis Methodology

2.1 Intersection Analysis

The traffic analysis was conducted using the Synchro 9 Traffic Signal Coordination Software, which implements the methodologies of the *Highway Capacity Manual*. Synchro analyzes both signalized and unsignalized intersections in a road corridor or network taking into account the spacing, interaction, queues and operations between intersections. The analysis of signalized intersection considers two separate measures of performance:

+ The volume-to-capacity ratio (v/c ratio); and
+ The level of service (LOS), which is based on the delay per vehicle for the various movements through the intersection and for the overall intersection.

LOS is a qualitative measure of operational performance and is based on control delay. The LOS criteria for signalized intersections are illustrated in **Table 1**. LOS A is represented by a delay of less than 10 seconds per vehicle (referred to as free flow operating conditions). LOS F is represented by a control delay greater than 80 seconds per vehicle (referred to as restricted flow operating conditions).

Table 1: LOS Criteria for Signalized Intersections

LOS	Control Delay (seconds/vehicle)	Traffic Flow Characteristics
A	0 – 10	Very good (free flow)
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

2.2 Link Analysis

In addition, a link analysis was conducted for Ninth Line to assess traffic capacity requirements under existing and future traffic conditions. This analysis is based on a planning level capacity of 850 vehicles per lane per hour. For the purpose of this assessment, Ninth Line was divided into two segments:

+ Segment 1: between Dundas Street and Burnhamthorpe Road; and
+ Segment 2: north of Burnhamthorpe Road.

The link analysis was based on the Region's TMP Model plots for the 2006 and 2031 PM peak hours (total volumes), and analysis for William Halton Parkway (conducted per North Oakville Transportation Corridor Modelling Request – November 2012).

The performance measure for the roadway segments is the v/c ratio. The Region typically aims to increase road capacity when the v/c ratio reaches 0.90 during the PM peak hour. **Table 2** summarizes the Region's v/c ratio definitions:

Table 2: Halton Region's Volume-to-Capacity Definitions

v/c Ratio	Operating Conditions
Less than 0.90	Under capacity
Between 0.90 and 1.00	Congested conditions, users experience delays and queuing. Approaching or at capacity, significant delays and queuing are expected
Greater than 1.00	Over capacity, severe delays and queuing

3. Existing Conditions

3.1 Intersection Configurations and Traffic Volumes

Both intersections within the study area (at Dundas Street and Burnhamthorpe Road) are signalized. The intersection at Dundas Street has already been widened on both the Dundas (6 Lanes) and Ninth Line (4 Lanes) approaches. Ninth Line south of Dundas Street has been widened to 4 lanes. Intersection lane configurations are shown in **Figure 2**.

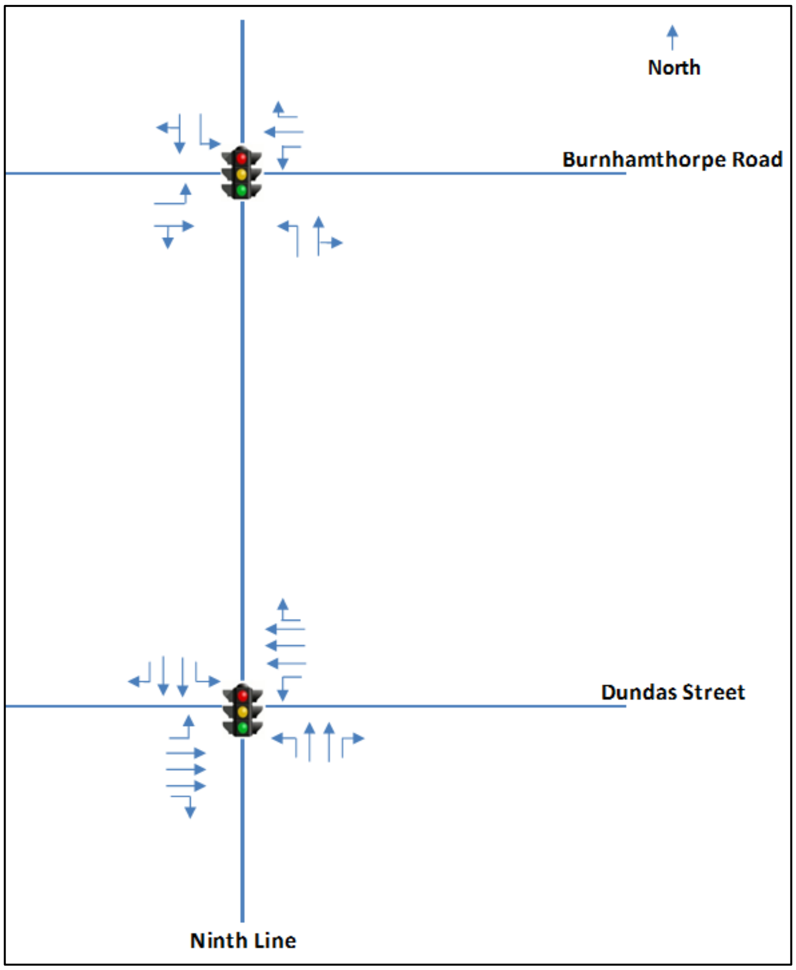

Figure 2: Existing Lane Configuration

Turning movement counts were obtained from Halton Region (**Appendix A**). The counts (**Figure 3**), which were taken in June 2015, show the following:

+ Pedestrian activity is very low at the intersections;
+ The heaviest approach volumes are along the intersecting roadways (Burnhamthorpe Road and Dundas Street);
+ There are high truck volumes along Dundas Street; and
+ Overall intersection volumes are higher in the AM peak hour.

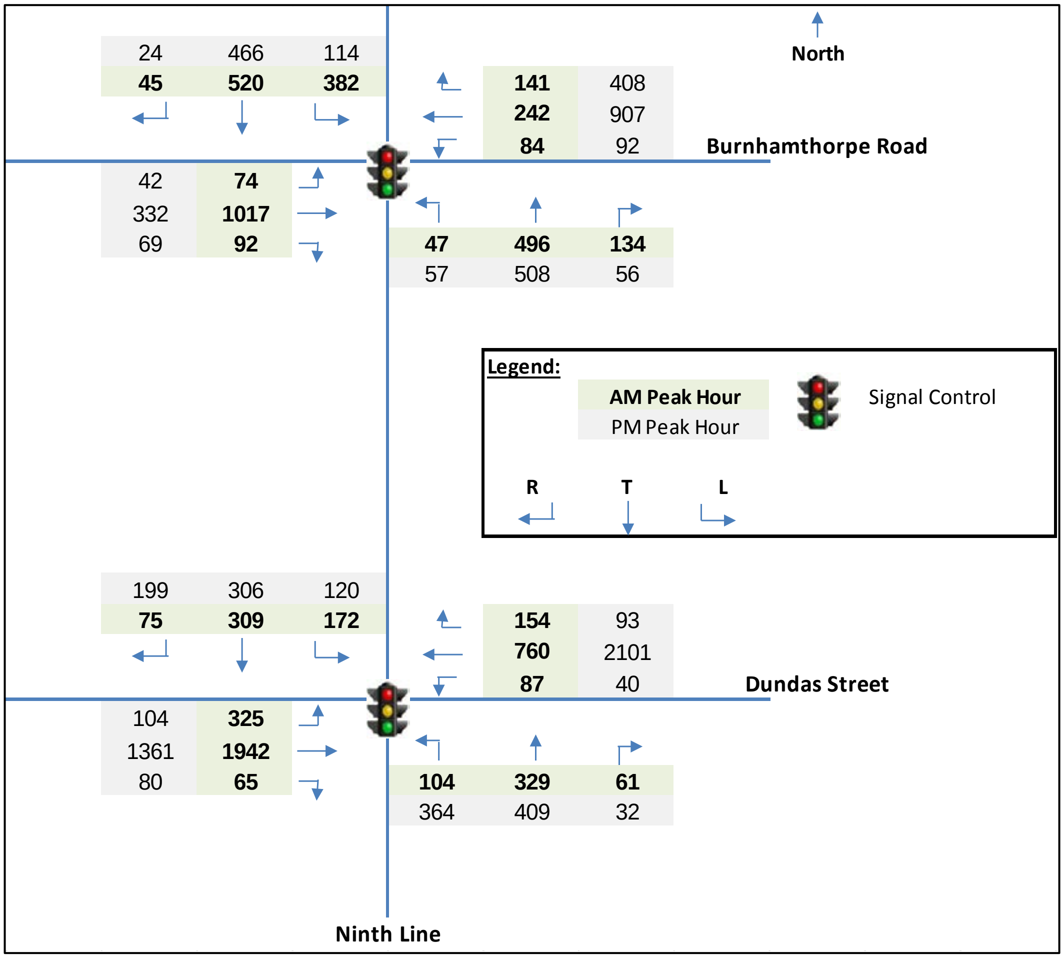

Figure 3: Existing Traffic Volumes

3.2 Intersection Traffic Operations

Analysis results for existing-conditions traffic operations for the study-area intersections are shown in **Table 3**.

The analysis was based on the current signal timing plans provided by the Region. Synchro worksheets are provided in **Appendix B**.

Key conclusions from the traffic analysis are as follows:

+ **Ninth Line at Burnhamthorpe Road –** The intersection operates above capacity with an overall LOS F during both peak periods and v/c ratios of 1.45 and 1.18 during the AM and PM peak hours, respectively. The north and southbound travel directions along Ninth Line operate poorly with LOS E or F during the AM and PM peak hours. Traffic along Burnhamthorpe Road is directional with AM peak flows highest in the eastbound direction (i.e. toward Mississauga) and evening PM peak flows highest in the westbound direction. Peak flow directions experience LOS F.
+ **Ninth Line at Dundas Street –** The intersection operates well during the AM peak with a LOS C and v/c ratio of 0.77, and above capacity during the PM peak hour with a LOS F and v/c ratio 1.16.

In should be noted that the only critical through movements are the westbound through and northbound left both with a LOS F.

Table 3: Existing Traffic Conditions

Intersection	Movement	Weekday AM Peak Hour			Weekday PM Peak Hour		
		LOS	v/c	Control Delay (s)	LOS	v/c	Control Delay (s)
Ninth Line at Burnhamthorpe Road	**Overall**	**F**	**1.45**	**190.0**	**F**	**1.18**	**88.2**
	EB L	C	0.18	20.3	D	0.49	35.6
	EB TR	F	1.45	239.7	C	0.61	23.0
	WB L	F	1.39	279.0	C	0.37	20.7
	WB T	C	0.32	21.8	F	1.33	181.3
	WB R	B	0.10	18.9	B	0.41	19.3
	NB L	F	0.78	83.5	C	0.61	33.6
	NB TR	F	1.37	219.1	F	1.10	95.5
	SB L	F	1.45	253.8	C	0.61	23.7
	SB TR	F	1.20	149.2	E	0.97	56.9
Ninth Line at Dundas Street	**Overall**	**C**	**0.77**	**34.9**	**D**	**1.09**	**46.6**
	EB L	C	0.65	21.5	D	0.73	37.2
	EB T	C	0.88	34.1	C	0.65	20.5
	EB R	B	0.05	16.5	B	0.06	12.9
	WB L	D	0.65	46.3	B	0.22	12.7
	WB T	C	0.49	33.0	D	0.96	37.9
	WB R	C	0.10	27.6	B	0.06	13.5
	NB L	D	0.41	40.0	F	1.33	209.4
	NB T	D	0.44	44.5	D	0.72	49.8
	NB R	D	0.05	39.1	D	0.02	39.9
	SB L	D	0.60	46.1	D	0.56	41.6
	SB T	D	0.40	43.7	D	0.66	50.8
	SB R	D	0.05	39.0	D	0.54	49.6

Note: The table assumes Ninth Line to have a north/south alignment.

3.3 Link Analysis

Results of the link analysis presented in **Table 4** and **Table 5** indicates that Ninth Line presently operates over capacity north of Burnhamthorpe Road (Segment 2) during both the AM and PM peak hours. In addition, Segment 1 is very nearing capacity with a v/c ratio of 0.95 during the AM peak hour.

Table 4: AM Peak Hour – Link Analysis for Existing Conditions

Ninth Line Segment	Number of Lanes	Peak direction traffic volume	v/c ratio
1 –Dundas Street to Burnhamthorpe Road	1	808	0.95
2 – north of Burnhamthorpe Road	1	947	1.11

Table 5: PM Peak Hour – Link Analysis for Existing Conditions

Ninth Line Segment	Number of Lanes	Traffic Volume Peak Direction (2015)	v/c ratio
1 – Dundas Street to Burnhamthorpe Road	1	625	0.73
2 – north of Burnhamthorpe Road	1	958	1.12

4. Future Scenarios – 2031 Horizon Year

4.1 Network Assumptions

Halton Region's planning for roadway capital projects for the 2017 – 2031 period includes the following projects in and around the study area. Trafalgar Road is a north-south arterial roadway located to the west of Ninth Line.

Table 6: Halton Region Capital Projects (2017 – 2031)

Roadway	Proposed works	Location	Proposed construction start
Trafalgar Road	Widening from 4 to 6 lanes	Dundas Street to Highway 407	2018
Trafalgar Road	Widening from 4 to 6 lanes	Hwy 407 to Britannia Road	2027
Ninth Line	Widening from 2 to 4 lanes	Dundas Street to Burnhamthorpe Road	2025
Ninth Line	Widening from 2 to 4 lanes	Burnhamthorpe Road to Highway 407	2023

In addition, the Region is planning to construct a new continuous east-west transportation corridor from Regional Road 25 to Ninth Line. This new corridor, named William Halton Parkway, will replace Burnhamthorpe Road and will have a four-lane cross-section with on-road bicycle lanes, sidewalks and a multi-use trail. Burnhamthorpe Road will remain in place and become a local road under the jurisdiction of the Town of Oakville. As part of these works, the signalized intersection of Ninth Line at

Burnhamthorpe will be replaced with an approved roundabout with construction to start Summer 2018. The roundabout is proposed to have two lanes initially and three lanes in its final configuration.

4.2 Land Use Assumptions

As noted in Section 1 the land use within the study area is primarily rural with localized institutional and residential areas. The Town of Oakville indicated that existing land uses on the west side of the corridor have significant redevelopment potential with several proposals. **Figure 4** identifies current development applications, and **Figure 5** shows the overall development strategy of the North Oakville Master Plan. It is important to note that no direct access between the proposed developments and Ninth Line is being considered.

In addition to the above, the City of Mississauga and the Region of Peel are conducting a joint study "*to establish a regional and municipal planning framework to guide future growth on the Ninth Line Lands*" to the north of the study area. This study is called *"Shaping Ninth Line: Draft Emerging Land Use Concept".* Although no future development is projected for the land east of the Ninth Line corridor between Highway 403 and Britannia Road (currently zoning agricultural) this study considers the corridor as part of the proposed Transitway alignment.

Figure 4: Current development applications (Source: Town of Oakville)

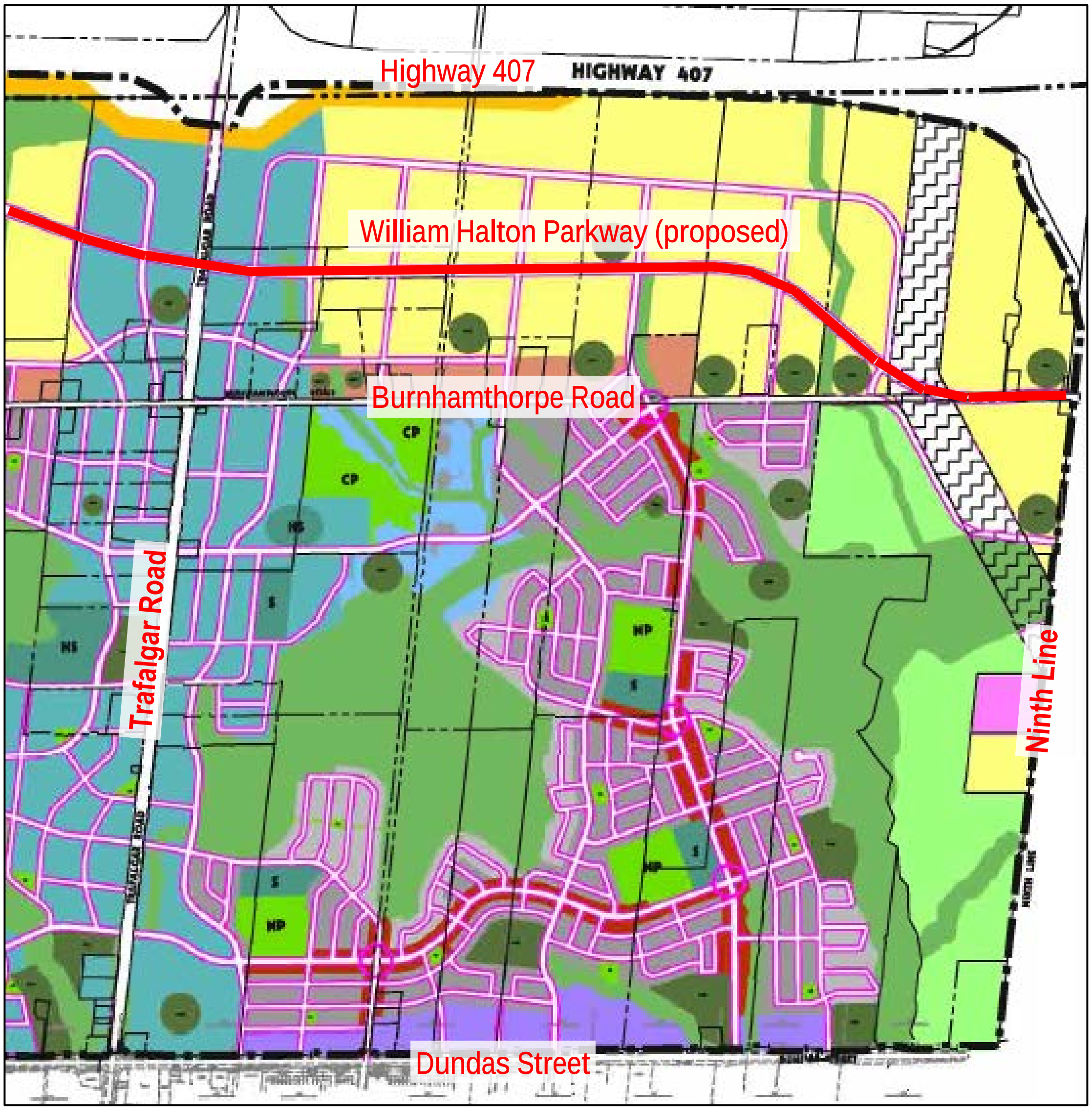

Figure 5: North Oakville Master Plan (Source: Town of Oakville)

4.3 2031 Traffic Volumes

The projection of traffic volumes for the 2031 horizon year was completed in five steps:

+ **Step 1** – Link volumes generated by the Halton TMP model for the 2006 base case scenario (PM peak) were compared against the counts collected during 2006 to estimate Ninth Line traffic;
+ **Step 2** – Link volumes estimated in Stage 1 were added to link volumes generated by the Halton TMP model for the 2031 horizon year;
+ **Step 3** – The impact of the William Halton Parkway diversion as presented in the 2012 report (conducted per North Oakville Transportation Corridor Modelling Request – November 2012) was added to the link volumes estimated in Stage 2;

+ **Step 4 –** The projected link volumes for the 2031 horizon year were distributed at both study-area intersections in accordance with the turning movements projected by the 2012 report for the PM peak period.
+ **Step 5 –** The projected link and turning movements for the PM Peak hour were adjusted using the AM/PM peak factors presented in the 2012 report to estimate the 2031 traffic volumes for the AM peak period.

It should be noted that the above forecasting procedure incorporates the Region's approved Best Planning Estimates (BPE, version 3.032) as provided by the Region and is consistent with the Region's Transportation Master Plan. The projected traffic volumes are shown in **Figure 6**.

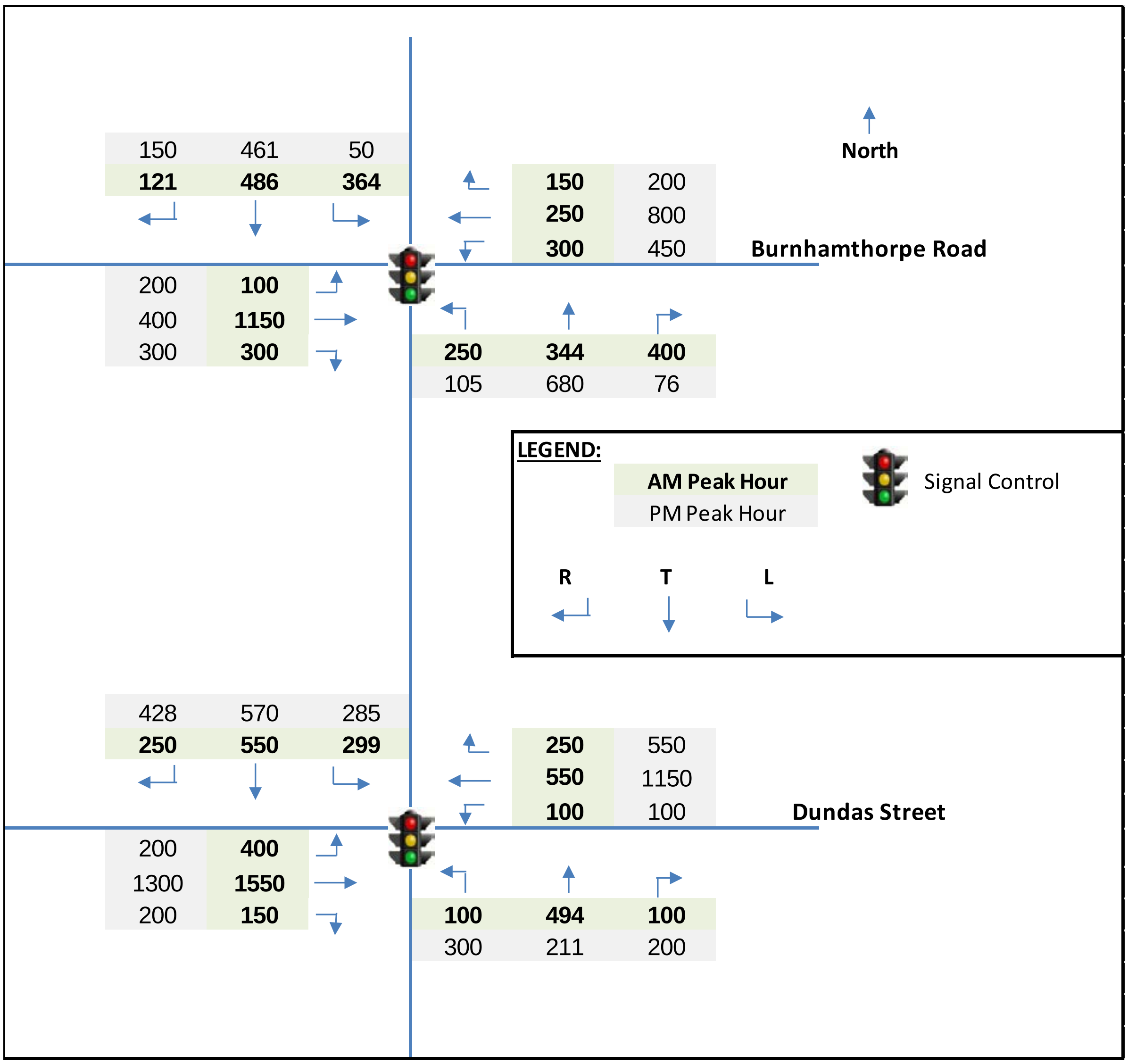

Figure 6: 2031 Future Link Traffic Volumes

4.4 Future Ninth Line Corridor Traffic Conditions

The analysis of future conditions was conducted for two scenarios, i.e. "Do Nothing" and "With Improvements". The "Do Nothing" scenario maintains Ninth Line as a two-lane road, and the "With Improvements" scenario widens Ninth Line to 4 lanes. The following assumptions were made:

+ Existing configuration of the intersection with Dundas Street will remain the same with no modifications for future conditions as per work previously conducted by the Region;
+ The existing signalized intersection with Burhamthorpe Road will be replaced with a 2-lane roundabout in the interim stage with a final 3-lane roundabout configuration by the 2031 horizon year; and
+ Since both intersections are considered as part of previous and/or current Class EAs conducted by others, operational analysis of the intersections are not included as part of this report.

The link analysis for the "Do Nothing" scenario shows that the Ninth-Line corridor would be operating well above capacity during both the AM and PM peak hours (**Table 7 and Table 8**). Widening of Ninth Line to four lanes is expected to provide sufficient road capacity to accommodate 2031 forecast traffic volumes.

Table 7: AM Peak Hour – Link Analysis for 2031

Ninth Line Segment	Number of Lanes	Traffic Volume Peak Direction (2031)	v/c ratio	
			Do Nothing (1 lane per direction)	With Improvements (2 lanes per direction)
1 – Dundas Street to Burnhamthorpe Road	1	1144	**1.34**	0.67
2 – north of Burnhamthorpe Road	1	971	**1.14**	0.57

Table 8: PM Peak Hour – Link Analysis for 2031

Ninth Line Segment	Number of Lanes	Traffic Volume Peak Direction (2031)	v/c ratio	
			Do Nothing (1 lane per direction)	With Improvements (2 lanes per direction)
1 – Dundas Street to Burnhamthorpe Road	1	1211	**1.42**	0.71
2 – north of Burnhamthorpe Road	1	1080	**1.27**	0.63

5. Road Safety Assessment

The objectives of the road safety assessment are to evaluate whether road safety issues exist under existing conditions and to recommend mitigation measures as appropriate. The safety assessment consists of 3 separate tasks:

+ Descriptive analysis of collision data to identify collision types and trends;
+ Predictive analysis of collision data to evaluate potential for improvement; and
+ Field investigation with respect to road design elements.

5.1 Descriptive Collision Analysis

Historical road user collision data between January 1, 2011 and December 31, 2015, which was obtained from the Region, was reviewed to gain an in-depth understanding of collision patterns and potential contributing factors within the study area. **Table 9** summarizes the total number of collisions which have occurred within the study area both for midblock and intersection locations. Most of the collisions were of the type "Property Damage Only" (PDO) or "Non-reportable" (NR).

Table 9: Total Number of Reported Collisions

Ninth Line Location	Geo ID	Segment length (m)	PDO and NR Collisions	Injury Collisions	Total # of Collisions
		Midblock			
Dundas Street to Burnhamthorpe Rd	1158570	2147	18	1	19
Burnhamthorpe Rd. E to a point 900 m north of Burnhamthorpe Road	1158590	902	5	2	7
A point 900 m north of Burnhamthorpe Road to Lower Base Line	1158610	1231	-	-	-
		Intersection			
Burnhamthorpe Rd.	10068301		14	3	17

5.1.1 Midblock Collisions

Figure 7 summarize midblock collisions by impact type. Note that the following analysis excludes Ninth Line between a point 900 m north of Burnhamthorpe Road to Lower Base Line as the provided data did not note any collisions during the study period for this segment.

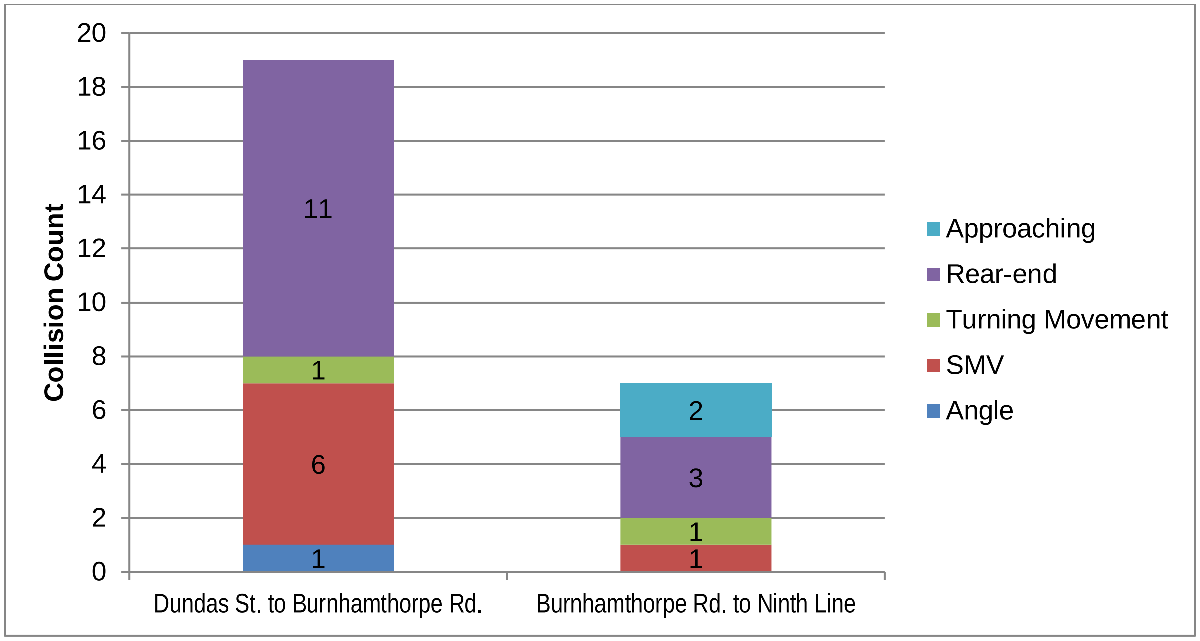

Figure 7: Summary of Midblock Collisions by Impact Type (January 2011 – December 2015)

Ninth Line from Dundas Street to Burnhamthorpe Road

Figure 8 and **Figure 9** show that rear-end collisions are the major collision type with 11 incidents of a total of 19 collisions, followed by SMV collisions with a total of 5 incident. The majority of collisions occurred during dry road surface conditions and during daylight lighting conditions. Northbound motorists were more often involved in collisions. Eight out of 11 rear-end collisions occurred in the northbound direction and 3 in the southbound direction. Three out of 5 SMV collisions occurred in the northbound direction with 2 in the southbound direction. The collision data did not reveal any other specific patterns.

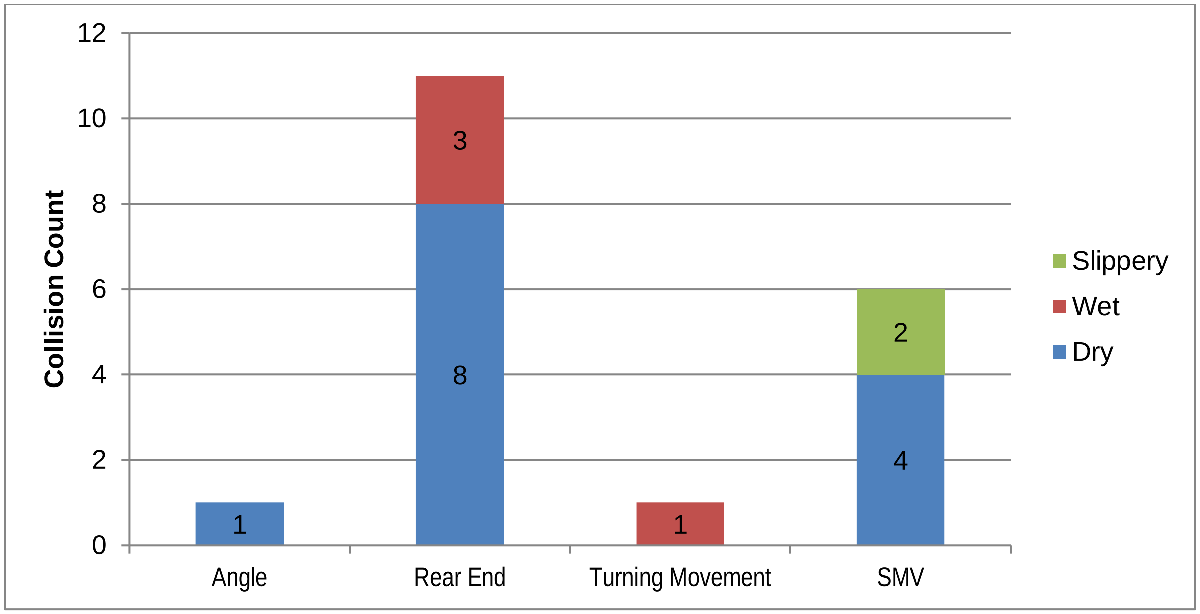

Figure 8: Collisions by Road Surface Condition (January 2011 – December 2015)

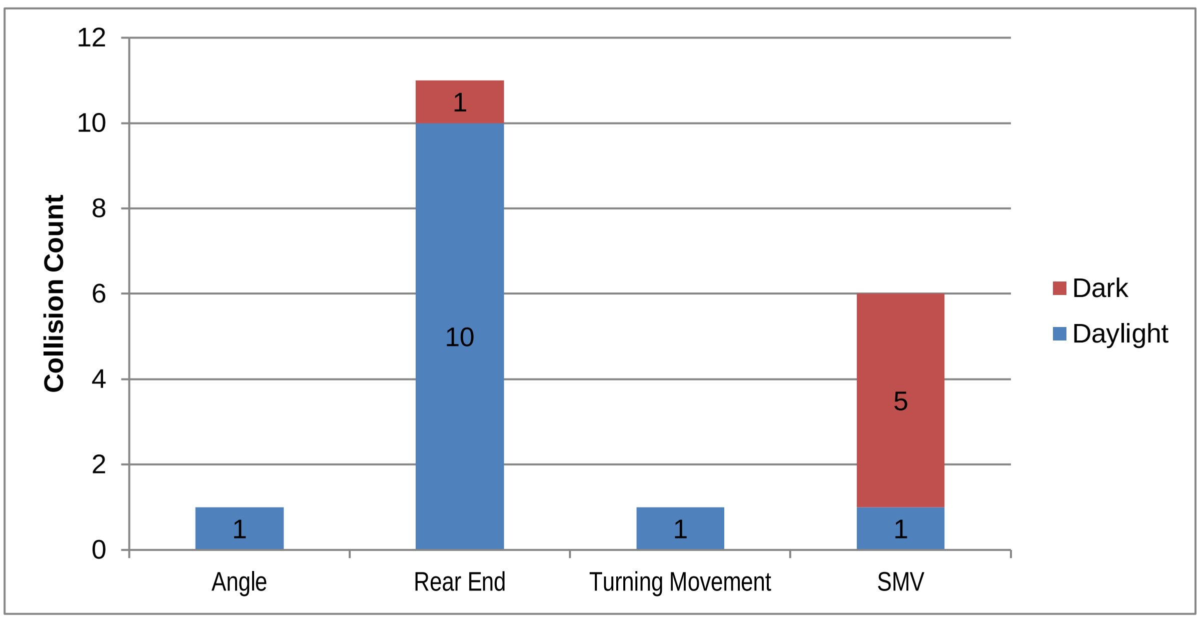

Figure 9: Collisions by Lighting Condition (January 2011 – December 2015)

Ninth Line from Burnhamthorpe Road to a Point 900 m North of Burnhamthorpe Road

Figure 10 and **Figure 11** show that rear-end collisions are the main collision type in this segment as well, with only 3 incidents of a total of 7 collisions. All rear-end collisions occurred in the southbound direction and were non-intersection related. Collisions involving approaching vehicles were the second-most important collision type with 2 incidents. Both approaching collisions involved a vehicle that was out of control. The majority of collisions occurred during dry road surface conditions and daylight lighting conditions. In general, the collision data did not reveal any specific collision patterns.

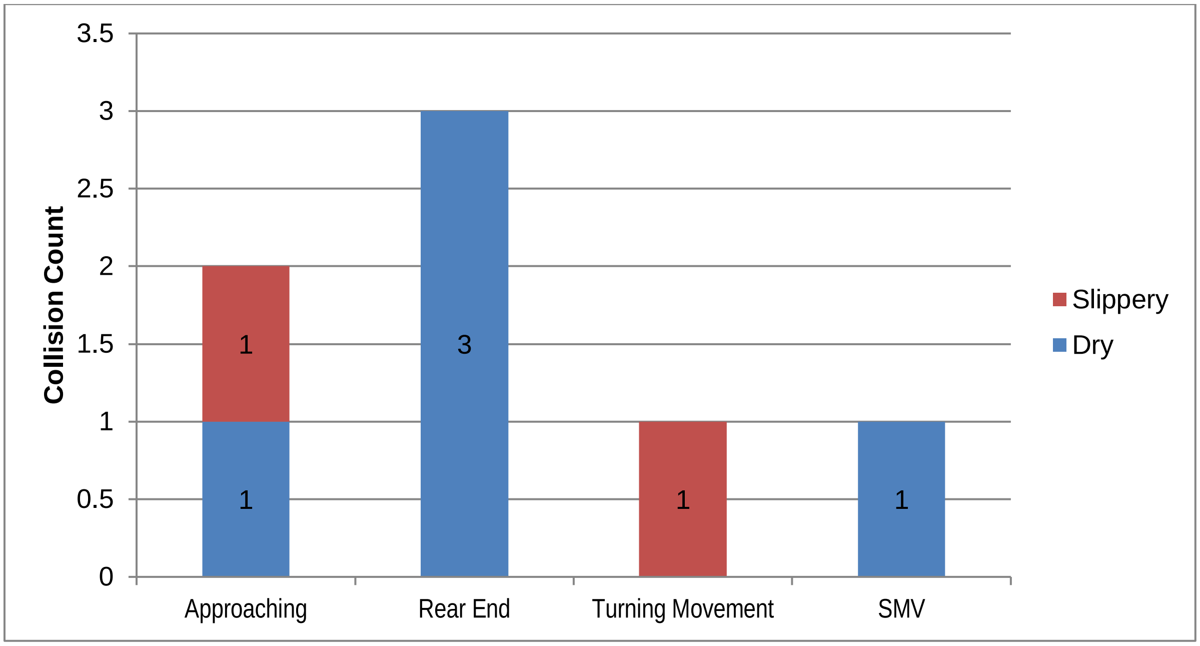

Figure 10: Collisions by Road Surface Condition (January 2011 – December 2015)

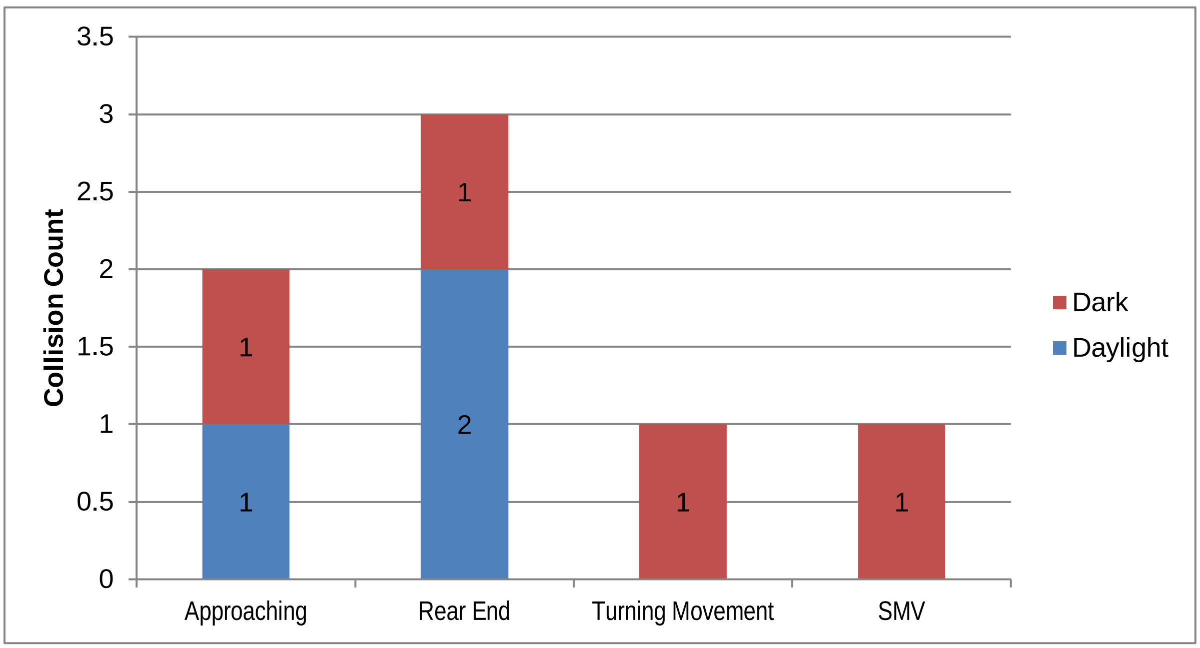

Figure 11: Collisions by Lighting Condition (January 2011 – December 2015)

5.1.2 Intersection of Ninth Line and Burnhamthorpe Road

This section only evaluates the intersection of Ninth Line and Burnhamthorpe Road, as the intersection of Ninth Line and Dundas Street was recently upgraded. Based on **Figure 12,** angle collisions are the major collision type at this intersection with 9 incidents of a total of 17 collisions. No specific directional movements were found to be involved more often than others in the angle collisions. Four angle collisions were reported to involve "Disobeyed Traffic Control" driver action.

Rear-end and turning movement collisions are ranked as the number-two collision type. Two of 3 rear-end collisions occurred in the eastbound direction with one in the northbound direction. Two of 3 turning movement collisions occurred involved southbound left-turn motorists and northbound through motorists. The majority of collisions occurred during dry road surface conditions as demonstrated in **Figure 13** and during daylight lighting conditions as demonstrated in **Figure 14**. In general, the collision data did not reveal any specific patterns that pinpoint to any particular deficiency.

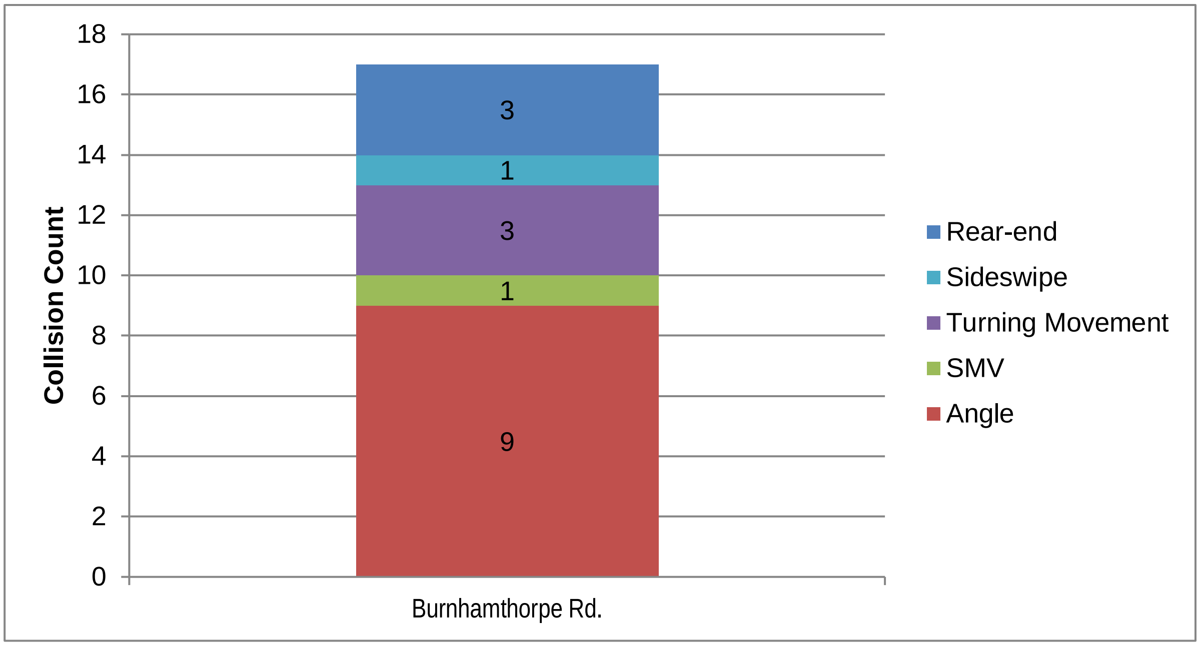

Figure 12: Summary of Collisions by Impact Type for the Intersection of Ninth Line and Burnhamthorpe Road (January 2011 – December 2015)

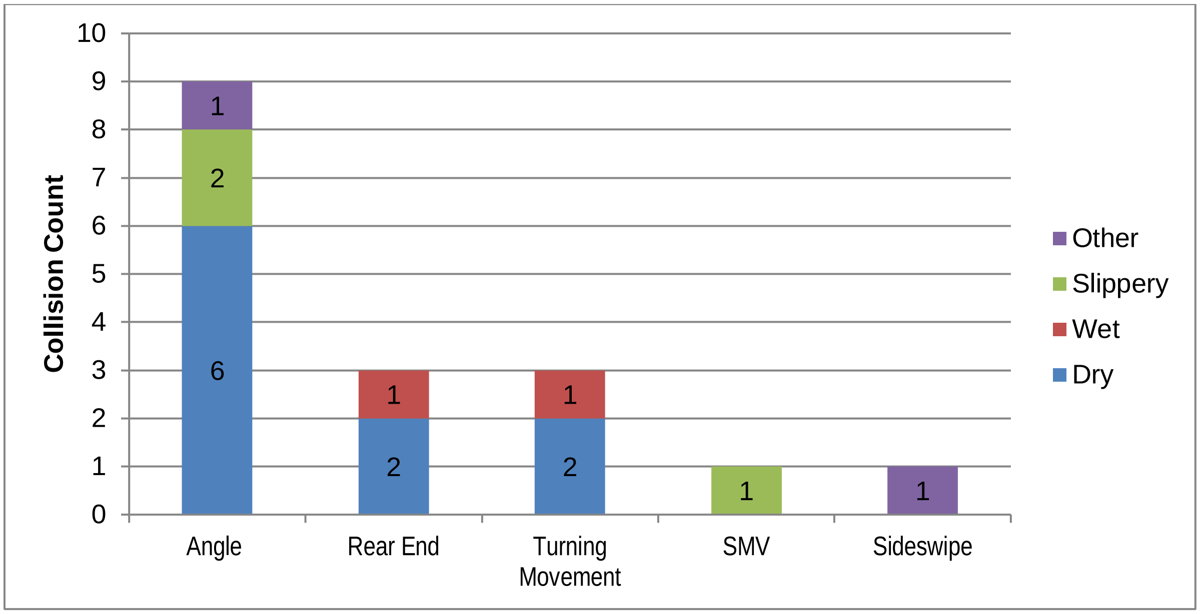

Figure 13: Collisions by Road Surface Condition for the Intersection of Ninth Line and Burnhamthorpe Road (January 2011 – December 2015)

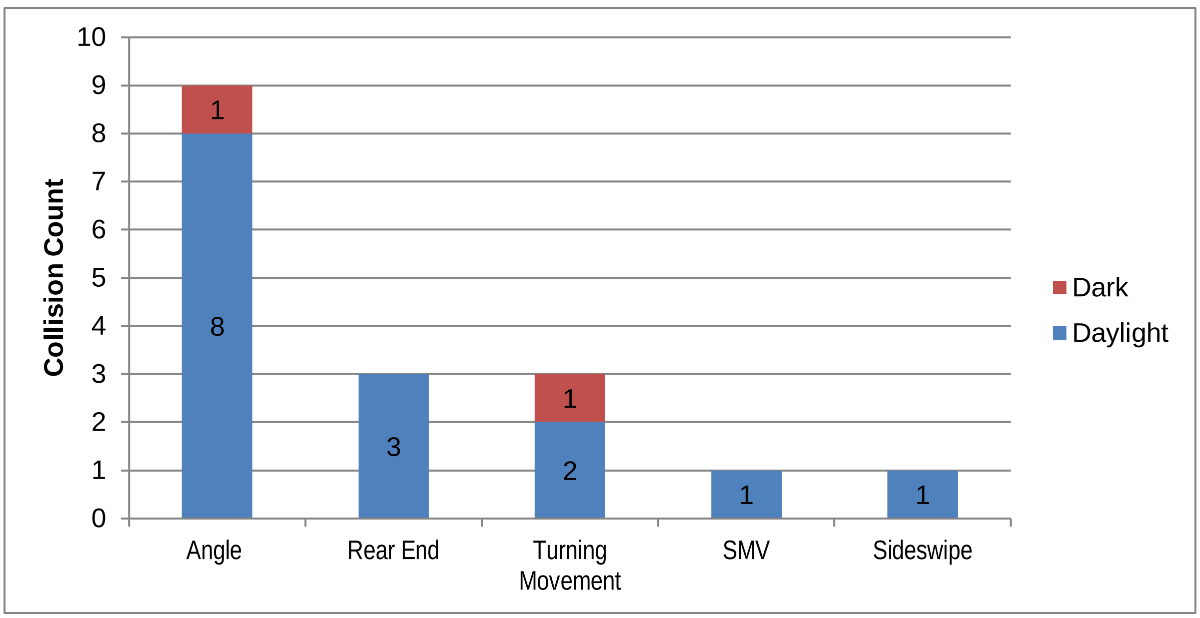

Figure 14: Collisions by Lighting Condition for the Intersection of Ninth Line and Burnhamthorpe Road (January 2011 – December 2015)

5.1.3 Predictive Collision Analysis

In order to identify the locations within the study area which have a potential for safety improvement, the "Potential for Safety Improvement" (PSI) analysis results provided by the Region were reviewed. Halton uses PSI results to identify and prioritize hazardous locations within the Region. For this analysis the expected number of collisions associated with the subject entity (e.g., roadway segment or intersection) is compared to those of similar entities within the Region. If the expected number of collisions for the subject location is larger than the expected number of collisions of the similar entities, it shows that the subject entity has a potential for safety improvement. The expected number of collisions of similar entities is calculated using Safety Performance Functions (SPF). The Region has its own SPFs for conducting the PSI analysis.

The expected number of collisions for the subject entity is calculated using Empirical Bayes (EB) technique by combining the observed number of collisions with those calculated using SPFs. The difference of these two values, if positive, is the PSI for the subject entity. A PSI equal to zero indicates that the collision experience of the subject entity is not unusual.

The results of the PSI analysis provided by the Region indicated that all roadway segments and the intersection of Ninth Line and Burnhamthorpe Road have a PSI = 0. In addition, the Region also advised that an over-representation analysis was conducted in 2015, which found that none of the collision variables (e.g., collision severity, impact types, lighting condition, road surface condition, season, or time of day) was over-represented within the study area. Therefore, it can be concluded that the roads and intersections within the study area do not exhibit collision trends that are unusual.

5.2 Field Investigation

CIMA undertook a field investigation on Thursday April 14, 2016 during the AM peak and off-peak periods. The focus of the field visit was to identify any contributing factors to collisions and/or potential safety risks unrelated to the collision data. During the field investigation, the study team observed conformance, consistency and conditions of site geometrics, traffic control devices, site operations, road user interactions and positive guidance, physical characteristics and traffic operations within the portions of the study area covered under the safety assessment for existing conditions. It should be noted that since the time Ninth Line was originally constructed there might have been significant change in design practices and standards. Through this project, all design aspects of Ninth Line are expected to be updated to current standards.

5.2.1 Signage

CIMA reviewed traffic signage in the study area, including regulatory, warning, guide and information signs. Signage was checked for conformity with the Ontario Traffic Manual (OTM) with respect to application, condition and approximate placement.

In the southbound direction on Ninth Line, a curve warning sign is placed immediately after the Highway 403 overpass bridge (just before 407 E to 403 N ramp). It was found that the placement of this sign obstructs the visibility of a speed-limit sign (**Figure 15**). No other signage deficiencies were observed. Signs appeared to be adequately designed according to the principles of positive guidance.

Figure 15: Curve Warning Sign Blocking Speed Limit Sign (Southbound)

5.2.2 Illumination

Ninth Line is not illuminated presently, except at the signalized intersections within the study area.

5.2.3 Intersection of Ninth Line and Burnhamthorpe Road

Alignment

The vertical alignment of the intersection of Ninth Line and Burnhamthorpe Road is not level as a result of the bridge on the east leg of the intersection over Highway 403. As seen in **Figure 16**, the crest curve creates an approach downgrade in the westbound direction on Burnhamthorpe Road at Ninth Line which continues past the intersection. The downgrade may contribute to increased vehicle speeds as motorists approach the intersection which could contribute to rear-end collisions when motorists apply sudden brakes to avoid entering the intersection during the red signal indication or angle collisions in the event they are not able to make a timely stop. The review of collision history noted some angle collisions at this intersection. However, there is no evidence that suggests that the downgrade was a contributing factor.

Significant embankment depths were also observed in three of the four corners of the intersection. The southeast corner is shown in **Figure 17.**

Figure 16: Downgrade at East Approach at Intersection of Ninth Line and Burnhamthorpe Road (Looking East)

Figure 17: Southeast corner at Intersection of Ninth Line and Burnhamthorpe Road (Looking East)

Pedestrian Facilities

Pedestrian pushbuttons and signal heads were present in all corners of the intersection. The pushbuttons were fully functional. Marked crosswalks and landing pads were also present for pedestrians waiting to cross the roadways, despite Ninth Line and Burnhamthorpe Road not providing any pedestrian facilities (e.g., sidewalks, multi-use trails). Along the north side of the east leg of the intersection (Burnhamthorpe Road), there is insufficient space for pedestrians to safely walk between the curb and guide rail as can be seen in **Figure 18**.

Pedestrian signage should be provided to inform pedestrians that there is no sidewalk along the north side of the bridge structure.

Figure 18: Pedestrian Facility along East Leg of Intersection (Burnhamthorpe Road West)

5.2.4 Roadside Safety

In order to reduce serious collisions involving run off the road vehicles, a clear zone within the roadside should be provided. Clear zone includes the area starting at the edge of the travelled way, available for safe use by errant vehicles and may consist of a shoulder, a recoverable slope, a non-recoverable (traversable) slope, and/or a clear run-out area. Clear zones can end on recoverable slopes without the need of any additional recovery area. Recoverable slopes are generally the slopes flatter than 4:1 on which a driver can retain or regain the control of the vehicle in a run-off the road event. However, if the clear zone ends on a non-recoverable slope, additional clear run out area is required at the toe of the slope to provide a recovery area to the errant vehicle. Non-recoverable slopes may be traversable (slope between 4:1 and 3:1) or critical (slope steeper than 3:1). If the clear zone ends on a critical slope, a traffic barrier may be warranted if the slope cannot readily be flattened[1].

Generally speaking, for the existing geometric and traffic conditions a clear-zone width of 5 metres should be provided within the study area based on a design speed of 80 km/h and AADT in excess of than 6000 vehicles (Ontario's Road Safety Manual). It should be noted that the 5m clear-zone width only applies to tangent alignments. The clear zone should be increased where horizontal curvature is present. Several issues relating to shoulders, roadside slopes, fixed objects and guide rails were identified.

[1] Ontario Road Safety Manual RSM 0205-2

Roadside Shoulders

The shoulders on Ninth Line were found to be of variable condition in both surface and width. The gravel shoulders on Ninth Line between Dundas Street and Burnhamthorpe Road (**Figure 19**), were generally narrow and in some areas, measured to be as narrow as 1.75 meters. At certain locations, the shoulders appeared to be soft as a result of erosion/aging.

North of the intersection of Ninth Line and Burnhamthorpe Road, the roadway appears to have been resurfaced recently with wide partially paved shoulders (**Figure 20**). The paved portion of the shoulder on this section of Ninth Line was found to be in good condition.

Figure 19: Narrow Gravel Shoulders on Ninth Line south of Burnhamthorpe Road

Figure 20: Paved and Gravel Shoulder on Ninth Line North of Burnhamthorpe Road

Roadside Slopes

The side slopes of the roadway were generally found to be irregular. In certain locations of Ninth Line, the slopes appeared to be steeper than 3:1 with a depth of approximately 3 metres or more. **Figure 21** illustrates a typical roadside slope within the clear zone north of Burnhamthorpe Road.

Figure 21: Typical Side Slope on Ninth Line north of Burnhamthorpe Road

South of Burnhamthorpe Road on the west side of Ninth Line within the vicinity of the Glen Oaks Funeral Home, significant roadside embankment depths between 4-5 meters were observed. Roadside slopes of 3:1 or steeper are considered critical slopes. However, the collision history did not reveal any collisions involving these slopes. It is recommended that the side slopes be flattened to recoverable slopes during construction. If flattening of slope is not possible due to property constraints, consider providing appropriate shielding by using steel beam guide rails.

Fixed Objects

Examination of fixed objects along the roadside found that a significant number of non-breakaway utility poles that do not meet the clear zone requirement. Hydro poles on Ninth Line between Dundas Street and Burnhamthorpe Road (**Figure 22**) are located on the east side of the roadway, some of which are only 2.1 metres from the edge of pavement and therefore are within the clear zone. While placement of hydro poles within the clear zone is not uncommon, it would be desirable to relocate hydro poles outside the clear zone when the roadway is widened.

Additionally, a few culvert embankments located at the driveways are located within the clear zone (**Figure 23**). When ditches parallel to the through roadway cross intersecting roadways or driveways, culverts are placed at the base of the ditch to allow water to flow through under the driveway. Many run off the road vehicles follow the ditch line and if a culvert embankment is present, it can potentially be struck head on by an errant vehicle.

Figure 22: Utility Pole on East Side of Ninth Line south of Burnhamthorpe Road

Figure 23: Culvert on West Side of Ninth Line north of Burnhamthorpe Road

The Road Safety Manual recommends side slopes of 4:1 or flatter for embankments of intersecting roadways or entrances. The manual also recommends that the inlet and outlet slope of the culvert should be matched to the embankment slopes, which will result in a smaller target area for an errant vehicle.

A review of collision history did not reveal any collisions involving these fixed objects. As a proactive interim measure, the Region may consider to mark these hazards using object marker signs as per guidelines provided in OTM Book 11 as follows:

+ Any wooden poles located on the shoulder or within 2.0 m of the edge of the roadway (if not on the shoulder) should be marked with object marker signs; and
+ Any culvert embankments within 2.0 m of the edge of the roadway should be marked with object marker signs.

Guide Rails

The application and condition of guide rails within the study area were also reviewed. Some steel beam guide rails are present along Ninth Line mainly in the vicinity of 407 ETR structures. The steel posts of the steel beam guide rail installed immediately north of the 407 ETR northbound on-ramp on the east side were observed to be deformed as shown in **Figure 24**. The leaving end of this guide rail was also found out to be turned down. The south ends of the guide rails connected to the overpass structure of 407 ETR main line were also found to be turned down as demonstrated in **Figure 25**.

All leaving end treatments on undivided highways must be treated as approach ends and the turned down end treatment for the approach ends of guide rails should be used only where the end is installed beyond the clear zone. All guide rail ends located within the clear zone must be protected by an approved end treatment or energy attenuation device[2]. It should be noted that since Ninth Line was constructed, the guide rail standards might have been updated. It is expected that as part of this project, the guide rails and the roadside design will be upgraded to current practices and standards.

Figure 24: Poor Condition of Guide Rail located north of 407 ETR Northbound On-ramp

Figure 25: Downturned End Treatments

5.2.5 Traffic Operations

During the AM peak hour, significant southbound vehicle queues of approximately 260 metres were observed at the north approach of the intersection of Ninth Line and Burnhamthorpe Road, which is consistent with the results of our operational analysis and supports the widening. Several motorists were observed performing aggressive manoeuvers around queued vehicles by crossing into the opposing lane as shown in **Figure 26**.

[2] Ontario Provincial Standard Specification 732

Figure 26: Southbound Vehicle Queue at Intersection of Ninth Line and Burnhamthorpe Road

6. Conclusions

This traffic operations and safety report was prepared in support of a Municipal Class Environmental Assessment, the objective of which is to evaluate potential improvements to Ninth Line between Dundas Street and Highway 407 ETR. The Region's listing of Capital Projects proposes the start of construction for widening of Ninth Line from 2 to 4 lanes from Burnhamthorpe Road to Highway 407 and from Dundas Street to Burnhamthorpe Road by 2023 and 2025, respectively.

6.1 Traffic Operations

The traffic analysis confirmed that the existing roadway operates above capacity north of Burnhamthorpe Road during the PM peak with the entire corridor operating over the planning capacity of 850 vehicles per hour per lane during the AM peak period. Under future (2031) traffic conditions, with no improvements to the corridor between Dundas Street and Lower Base Line traffic operations will deteriorate for both the AM and the PM peak periods.

+ Traffic operations along Ninth Line under existing conditions are over capacity north of Burnhamthorpe Road during the PM peak with the entire corridor operating over the planning capacity of 850 vehicles per hour per lane during the AM peak period;
+ Existing configuration of the intersection with Dundas Street will remain the same with no modifications for future conditions as per work previously conducted by the Region;
+ The existing signalized intersection with Burhamthorpe Road will be replaced with a 2-lane roundabout in the interim stage with a final 3-lane roundabout configuration by the 2031 horizon year;
+ Under the projected traffic volumes for the 2031 horizon year with no improvements to the corridor between Dundas Street and Lower Base Line traffic operations will deteriorate for both the AM and the PM peak periods; and

+ Traffic operations along Ninth Line under future conditions will work below capacity for both the AM and the PM peak period if an additional lane per direction is added along the corridor under study.

6.2 Traffic Safety

From the analysis of collision history and our detailed field investigations, we suggest the following improvements based on the identified deficiencies during the upcoming widening of Ninth Line.

+ Enhance shoulder widths to minimum standards, remove shoulder edge drop-offs, and maintain eroded shoulders;
+ Wherever possible, flatten the side slopes to recoverable slopes. If flattening of slopes is not possible due to property constraints, consider providing appropriate shielding by using steel beam guide rails;
+ Consider relocating utility poles and other fixed objects, such as culvert head walls outside of the clear zone. As an interim proactive measure, the Region could consider to delineate the fixed object hazards. The utility poles located on the shoulder as well as poles within 2.0 m of the traveled lane (if not on the shoulder) should be marked with object marker signs. Likewise, culvert head walls within 2.0 m of the travelled lane should be marked with object marker signs;
+ Protect the ends of guide rails by using approved end treatments; and
+ Provide appropriate storage lengths for left turn lanes at the intersection of Ninth Line and Burnhamthorpe Road.

Appendix A – Turning Movement Counts

Dundas St @ Ninth Line

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: Halton Region
Site #: 0000002560
Intersection: Dundas St & Ninth Line
TFR File #: 5
Count date: 8-Jun-2015

Weather conditions:
Clear/Dry

Person(s) who counted:
Leszek
Dominik

**** Signalized Intersection ****

Major Road: Dundas St runs W/E

North Leg Total: 1364
North Entering: 556
North Peds: 0
Peds Cross: ⋈

Heavys	1	4	1	6
Trucks	2	7	2	11
Cars	72	298	169	539
Totals	75	309	172	

Heavys	4
Trucks	31
Cars	773
Totals	808

East Leg Total: 3176
East Entering: 1001
East Peds: 0
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
89	41	809	939

Dundas St

Cars	Trucks	Heavys	Totals
152	2	0	154
654	24	82	760
75	8	4	87
881	34	86	

N
W E
S

Heavys	Trucks	Cars	Totals
0	14	311	325
39	218	1685	1942
3	11	51	65
42	243	2047	

Dundas St

Cars	Trucks	Heavys	Totals
1905	227	43	2175

Ninth Line

Peds Cross: ⧗
West Peds: 0
West Entering: 2332
West Leg Total: 3271

Cars	424
Trucks	26
Heavys	11
Totals	461

Cars	83	310	51	444
Trucks	15	15	7	37
Heavys	6	4	3	13
Totals	104	329	61	

Peds Cross: ⋈
South Peds: 0
South Entering: 494
South Leg Total: 955

Comments

Dundas St @ Ninth Line

Mid-day Peak Diagram

Specified Period
From: 11:00:00
To: 14:00:00

One Hour Peak
From: 12:45:00
To: 13:45:00

Municipality: Halton Region
Site #: 0000002560
Intersection: Dundas St & Ninth Line
TFR File #: 5
Count date: 8-Jun-2015

Weather conditions:
Clear/Dry

Person(s) who counted:
Leszek
Dominik

**** Signalized Intersection ****

Major Road: Dundas St runs W/E

North Leg Total: 556
North Entering: 270
North Peds: 1
Peds Cross: ⋈

Heavys	1	2	0	3
Trucks	2	4	1	7
Cars	54	129	77	260
Totals	57	135	78	

Heavys	9
Trucks	21
Cars	256
Totals	286

East Leg Total: 2494
East Entering: 1160
East Peds: 0
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
52	34	1049	1135

Cars	Trucks	Heavys	Totals
36	4	3	43
926	27	48	1001
110	5	1	116
1072	36	52	

Dundas St

N
W E
S

Heavys	Trucks	Cars	Totals
1	5	77	83
45	174	991	1210
8	10	54	72
54	189	1122	

Dundas St

Cars	Trucks	Heavys	Totals
1109	180	45	1334

Ninth Line

Peds Cross: ⧗
West Peds: 5
West Entering: 1365
West Leg Total: 2500

Cars	293
Trucks	19
Heavys	11
Totals	323

Cars	69	143	41	253
Trucks	5	12	5	22
Heavys	3	5	0	8
Totals	77	160	46	

Peds Cross: ⋈
South Peds: 0
South Entering: 283
South Leg Total: 606

Comments

Dundas St @ Ninth Line

Afternoon Peak Diagram

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

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

Municipality: Halton Region
Site #: 0000002560
Intersection: Dundas St & Ninth Line
TFR File #: 5
Count date: 8-Jun-2015

Weather conditions:
Clear/Dry

Person(s) who counted:
Leszek
Dominik

**** Signalized Intersection ****

Major Road: Dundas St runs W/E

North Leg Total: 1231
North Entering: 625
North Peds: 0
Peds Cross: ⋈

Heavys	0	4	3	7
Trucks	3	3	1	7
Cars	196	299	116	611
Totals	199	306	120	

Heavys	5
Trucks	27
Cars	574
Totals	606

East Leg Total: 3747
East Entering: 2234
East Peds: 0
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
26	32	2606	2664

Cars	Trucks	Heavys	Totals
90	3	0	93
2065	12	24	2101
37	2	1	40
2192	17	25	

Dundas St

N
W E
S

Heavys	Trucks	Cars	Totals
0	7	97	104
68	283	1010	1361
4	7	69	80
72	297	1176	

Dundas St

Cars	Trucks	Heavys	Totals
1152	289	72	1513

Ninth Line

Peds Cross: ⧗
West Peds: 0
West Entering: 1545
West Leg Total: 4209

Cars	405
Trucks	12
Heavys	9
Totals	426

Cars	345	387	26	758
Trucks	17	17	5	39
Heavys	2	5	1	8
Totals	364	409	32	

Peds Cross: ⋈
South Peds: 0
South Entering: 805
South Leg Total: 1231

Comments

Dundas St @ Ninth Line

Total Count Diagram

Municipality: Halton Region
Site #: 0000002560
Intersection: Dundas St & Ninth Line
TFR File #: 5
Count date: 8-Jun-2015

Weather conditions:
Clear/Dry

Person(s) who counted:
Leszek
Dominik

**** Signalized Intersection ****

Major Road: Dundas St runs W/E

North Leg Total: 7724
North Entering: 3616
North Peds: 1
Peds Cross: ⋈

Heavys	8	23	9	40
Trucks	16	33	6	55
Cars	890	1679	952	3521
Totals	914	1735	967	

Heavys	38
Trucks	277
Cars	3793
Totals	4108

East Leg Total: 23752
East Entering: 10998
East Peds: 0
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
436	278	11307	12021

Dundas St

Cars	Trucks	Heavys	Totals
589	17	8	614
9285	158	391	9834
506	33	11	550
10380	208	410	

N
W E
S

Heavys	Trucks	Cars	Totals
3	72	1255	1330
358	1859	9186	11403
33	64	417	514
394	1995	10858	

Dundas St

Cars	Trucks	Heavys	Totals
10453	1923	378	12754

Ninth Line

Peds Cross: ⧗
West Peds: 6
West Entering: 13247
West Leg Total: 25268

Cars	2602
Trucks	130
Heavys	67
Totals	2799

Cars	1132	1949	315	3396
Trucks	104	188	58	350
Heavys	37	27	11	75
Totals	1273	2164	384	

Peds Cross: ⋈
South Peds: 3
South Entering: 3821
South Leg Total: 6620

Comments

Burnhamthorpe Rd @ Ninth Line

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: Halton Region
Site #: 0000002530
Intersection: Burnhamthorpe Rd & Ninth Line
TFR File #: 2
Count date: 15-Jun-2015

Weather conditions:
Cloudy, Rain

Person(s) who counted:
Margaret
Frank

**** Signalized Intersection ****

Major Road: Burnhamthorpe Rd runs W/E

North Leg Total: 1658
North Entering: 947
North Peds: 1
Peds Cross: ⋈

Heavys	0	5	3	8
Trucks	1	12	2	15
Cars	44	503	377	924
Totals	45	520	382	

Heavys	8
Trucks	24
Cars	679
Totals	711

East Leg Total: 2000
East Entering: 467
East Peds: 0
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
4	10	320	334

Cars	Trucks	Heavys	Totals
134	4	3	141
230	9	3	242
84	0	0	84
448	13	6	

Burnhamthorpe Rd

N
W E
S

Heavys	Trucks	Cars	Totals
1	5	68	74
8	12	997	1017
1	3	88	92
10	20	1153	

Burnhamthorpe Rd

Cars	Trucks	Heavys	Totals
1504	16	13	1533

Ninth Line

Peds Cross: ⧗
West Peds: 0
West Entering: 1183
West Leg Total: 1517

Cars	675
Trucks	15
Heavys	6
Totals	696

Cars	46	477	130	653
Trucks	0	15	2	17
Heavys	1	4	2	7
Totals	47	496	134	

Peds Cross: ⋈
South Peds: 0
South Entering: 677
South Leg Total: 1373

Comments

Burnhamthorpe Rd @ Ninth Line

Mid-day Peak Diagram

Specified Period		One Hour Peak	
From:	11:00:00	**From:**	11:45:00
To:	14:00:00	**To:**	12:45:00

Municipality: Halton Region
Site #: 0000002530
Intersection: Burnhamthorpe Rd & Ninth Line
TFR File #: 2
Count date: 15-Jun-2015

Weather conditions:
Cloudy, Rain

Person(s) who counted:
Margaret
Frank

**** Signalized Intersection ****

Major Road: Burnhamthorpe Rd runs W/E

North Leg Total: 805
North Entering: 363
North Peds: 0
Peds Cross: ⋈

Ninth Line (North approach, entering)

Heavys	0	10	1	11
Trucks	1	8	5	14
Cars	29	187	122	338
Totals	30	205	128	

North exiting

Heavys	16
Trucks	17
Cars	409
Totals	442

East Leg Total: 1004
East Entering: 531
East Peds: 0
Peds Cross: ⧗

Burnhamthorpe Rd (West exiting)

Heavys	Trucks	Cars	Totals
9	14	358	381

East approach (entering)

Cars	Trucks	Heavys	Totals
127	6	6	139
287	9	7	303
86	2	1	89
500	17	14	

N
W E
S

West approach (entering)

Heavys	Trucks	Cars	Totals
1	2	32	35
9	12	268	289
1	2	48	51
11	16	348	

Burnhamthorpe Rd (East exiting)

Cars	Trucks	Heavys	Totals
443	18	12	473

Ninth Line

Peds Cross: ⧗
West Peds: 0
West Entering: 375
West Leg Total: 756

South exiting

Cars	321
Trucks	12
Heavys	12
Totals	345

South approach (entering)

Cars	42	250	53	345
Trucks	4	9	1	14
Heavys	2	9	2	13
Totals	48	268	56	

Peds Cross: ⋈
South Peds: 0
South Entering: 372
South Leg Total: 717

Comments

Burnhamthorpe Rd @ Ninth Line

Afternoon Peak Diagram

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

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

Municipality: Halton Region
Site #: 0000002530
Intersection: Burnhamthorpe Rd & Ninth Line
TFR File #: 2
Count date: 15-Jun-2015

Weather conditions:
Cloudy, Rain

Person(s) who counted:
Margaret
Frank

**** Signalized Intersection ****

Major Road: Burnhamthorpe Rd runs W/E

North Leg Total: 1562
North Entering: 604
North Peds: 3
Peds Cross: ⋈

Heavys	1	6	1	8
Trucks	2	12	5	19
Cars	21	448	108	577
Totals	24	466	114	

Heavys	12
Trucks	19
Cars	927
Totals	958

East Leg Total: 1909
East Entering: 1407
East Peds: 5
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
6	15	967	988

Cars	Trucks	Heavys	Totals
395	9	4	408
891	11	5	907
88	3	1	92
1374	23	10	

Burnhamthorpe Rd

N
W E
S

Heavys	Trucks	Cars	Totals
0	0	42	42
3	13	316	332
2	4	63	69
5	17	421	

Burnhamthorpe Rd

Cars	Trucks	Heavys	Totals
479	19	4	502

Ninth Line

Peds Cross: ⧗
West Peds: 0
West Entering: 443
West Leg Total: 1431

Cars	599
Trucks	19
Heavys	9
Totals	627

Cars	55	490	55	600
Trucks	2	10	1	13
Heavys	0	8	0	8
Totals	57	508	56	

Peds Cross: ⋈
South Peds: 4
South Entering: 621
South Leg Total: 1248

Comments

Burnhamthorpe Rd @ Ninth Line

Total Count Diagram

Municipality: Halton Region
Site #: 0000002530
Intersection: Burnhamthorpe Rd & Ninth Line
TFR File #: 2
Count date: 15-Jun-2015

Weather conditions:
Cloudy, Rain

Person(s) who counted:
Margaret
Frank

**** Signalized Intersection ****

Major Road: Burnhamthorpe Rd runs W/E

North Leg Total: 9368
North Entering: 4510
North Peds: 7
Peds Cross: ⋈

Heavys	4	58	15	77
Trucks	12	79	35	126
Cars	242	2793	1272	4307
Totals	258	2930	1322	

Heavys	76
Trucks	129
Cars	4653
Totals	4858

East Leg Total: 11392
East Entering: 5881
East Peds: 8
Peds Cross: ⧗

Ninth Line

Heavys	Trucks	Cars	Totals
44	87	4009	4140

Burnhamthorpe Rd

Cars	Trucks	Heavys	Totals
1598	42	23	1663
3353	61	34	3448
740	22	8	770
5691	125	65	

N
W E
S

Heavys	Trucks	Cars	Totals
3	8	299	310
40	82	3457	3579
7	17	442	466
50	107	4198	

Burnhamthorpe Rd

Cars	Trucks	Heavys	Totals
5314	130	67	5511

Ninth Line

Peds Cross: ⧗
West Peds: 0
West Entering: 4355
West Leg Total: 8495

Cars	3975
Trucks	118
Heavys	73
Totals	4166

Cars	414	2756	585	3755
Trucks	14	79	13	106
Heavys	6	50	12	68
Totals	434	2885	610	

Peds Cross: ⋈
South Peds: 6
South Entering: 3929
South Leg Total: 8095

Comments

Appendix B – Synchro Reports

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	74	1017	92	84	242	141	47	496	134	382	520	45
Future Volume (vph)	74	1017	92	84	242	141	47	496	134	382	520	45
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	8.5	8.5		3.0	8.5	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.97		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1671	1837		1770	1827	1538	1770	1772		1770	1824	
Flt Permitted	0.56	1.00		0.08	1.00	1.00	0.13	1.00		0.13	1.00	
Satd. Flow (perm)	980	1837		146	1827	1538	237	1772		237	1824	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	79	1082	98	89	257	150	50	528	143	406	553	48
RTOR Reduction (vph)	0	3	0	0	0	83	0	9	0	0	3	0
Lane Group Flow (vph)	79	1177	0	89	257	67	50	662	0	406	598	0
Heavy Vehicles (%)	8%	2%	4%	2%	4%	5%	2%	4%	3%	2%	3%	2%
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		pm+pt	NA	
Protected Phases		2			2			4		3	4	
Permitted Phases	2			2		2	4			4		
Actuated Green, G (s)	51.0	51.0		51.0	51.0	51.0	31.5	31.5		45.5	31.5	
Effective Green, g (s)	51.0	51.0		51.0	51.0	51.0	31.5	31.5		45.5	31.5	
Actuated g/C Ratio	0.44	0.44		0.44	0.44	0.44	0.27	0.27		0.40	0.27	
Clearance Time (s)	7.0	7.0		7.0	7.0	7.0	8.5	8.5		3.0	8.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	434	814		64	810	682	64	485		280	499	
v/s Ratio Prot		c0.64			0.14			0.37		c0.18	0.33	
v/s Ratio Perm	0.08			0.61		0.04	0.21			c0.40		
v/c Ratio	0.18	1.45		1.39	0.32	0.10	0.78	1.37		1.45	1.20	
Uniform Delay, d1	19.4	32.0		32.0	20.7	18.6	38.6	41.8		32.3	41.8	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.9	207.7		247.0	1.0	0.3	45.0	177.4		221.4	107.5	
Delay (s)	20.3	239.7		279.0	21.8	18.9	83.5	219.1		253.8	149.2	
Level of Service	C	F		F	C	B	F	F		F	F	
Approach Delay (s)		226.0			67.1			209.7			191.4	
Approach LOS		F			E			F			F	

Intersection Summary			
HCM 2000 Control Delay	190.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.45		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	141.5%	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)	325	1942	65	87	760	154	104	329	61	172	309	75
Future Volume (vph)	325	1942	65	87	760	154	104	329	61	172	309	75
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	6.0	6.0	3.0	6.0	6.0
Lane Util. Factor	1.00	0.91	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)	1736	4590	1335	1597	4472	1583	1504	3438	1392	1770	3505	1583
Flt Permitted	0.26	1.00	1.00	0.08	1.00	1.00	0.48	1.00	1.00	0.45	1.00	1.00
Satd. Flow (perm)	469	4590	1335	142	4472	1583	754	3438	1392	830	3505	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	342	2044	68	92	800	162	109	346	64	181	325	79
RTOR Reduction (vph)	0	0	34	0	0	103	0	0	49	0	0	61
Lane Group Flow (vph)	342	2044	34	92	800	59	109	346	15	181	325	18
Heavy Vehicles (%)	4%	13%	21%	13%	16%	2%	20%	5%	16%	2%	3%	2%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases	2		2	6		6	4		4	8		8
Actuated Green, G (s)	76.0	65.6	65.6	54.8	47.4	47.4	37.8	30.0	30.0	38.2	30.2	30.2
Effective Green, g (s)	76.0	65.6	65.6	54.8	47.4	47.4	37.8	30.0	30.0	38.2	30.2	30.2
Actuated g/C Ratio	0.58	0.50	0.50	0.42	0.36	0.36	0.29	0.23	0.23	0.29	0.23	0.23
Clearance Time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	523	2316	673	142	1630	577	264	793	321	301	814	367
v/s Ratio Prot	c0.13	c0.45		0.04	0.18		0.02	0.10		c0.04	0.09	
v/s Ratio Perm	0.25		0.03	0.24		0.04	0.10		0.01	c0.14		0.01
v/c Ratio	0.65	0.88	0.05	0.65	0.49	0.10	0.41	0.44	0.05	0.60	0.40	0.05
Uniform Delay, d1	15.2	28.8	16.4	25.7	32.0	27.3	35.3	42.8	38.9	37.5	42.2	38.8
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	6.3	5.3	0.1	20.6	1.1	0.4	4.7	1.7	0.3	8.6	1.5	0.3
Delay (s)	21.5	34.1	16.5	46.3	33.0	27.6	40.0	44.5	39.1	46.1	43.7	39.0
Level of Service	C	C	B	D	C	C	D	D	D	D	D	D
Approach Delay (s)		31.8			33.3			42.9			43.8	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 5: Ninth line & Burnhamthorpe Road

Movement	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	T	R	L	TR	L	TR
Maximum Queue (m)	79.9	628.5	160.0	759.6	160.0	79.9	895.8	80.0	179.0
Average Queue (m)	24.8	619.3	153.3	603.6	34.5	28.5	881.4	79.0	170.2
95th Queue (m)	77.7	625.8	178.3	1001.1	124.1	82.9	965.5	87.1	174.9
Link Distance (m)		611.6		744.6			891.8		164.4
Upstream Blk Time (%)		92		61			24		73
Queuing Penalty (veh)		0		0			189		0
Storage Bay Dist (m)	50.0		120.0		130.0	50.0		50.0	
Storage Blk Time (%)		57	93	0			75	73	33
Queuing Penalty (veh)		42	358	0			35	413	124

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	T
Maximum Queue (m)	198.6	270.9	258.4	162.2	125.0	39.0	78.6	84.6	77.7	32.0	78.5	109.2
Average Queue (m)	71.7	112.0	118.3	111.8	19.2	18.1	50.7	53.0	45.9	14.3	31.4	58.6
95th Queue (m)	170.7	220.2	213.9	149.8	78.6	33.8	71.4	75.8	73.0	26.1	77.3	110.6
Link Distance (m)		1610.2	1610.2	1610.2			909.6	909.6	909.6			161.0
Upstream Blk Time (%)											0	2
Queuing Penalty (veh)											0	0
Storage Bay Dist (m)	200.0				85.0	210.0				80.0	135.0	
Storage Blk Time (%)	7	0		20					0			3
Queuing Penalty (veh)	43	2		13					1			4

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	NB	NB	B9	SB	SB	SB	SB
Directions Served	T	R	T	L	T	T	R
Maximum Queue (m)	94.4	30.3	7.1	55.6	54.9	44.0	17.7
Average Queue (m)	44.5	10.0	0.6	23.1	30.4	16.2	5.7
95th Queue (m)	96.1	22.5	7.5	43.5	48.7	36.4	14.4
Link Distance (m)	161.0		48.5		152.6	152.6	
Upstream Blk Time (%)	0						
Queuing Penalty (veh)	0						
Storage Bay Dist (m)		120.0		135.0			60.0
Storage Blk Time (%)	3						
Queuing Penalty (veh)	2						

Intersection: 12: Ninth line

Movement	EB	EB	NB	NB	B10	B10
Directions Served	L	R	L	T	T	
Maximum Queue (m)	23.2	19.5	32.4	1050.1	162.4	163.4
Average Queue (m)	5.4	7.1	18.9	636.2	47.9	30.2
95th Queue (m)	21.2	15.4	44.5	1284.7	164.2	131.9
Link Distance (m)	76.1	76.1		1016.5	152.6	152.6
Upstream Blk Time (%)				31	8	3
Queuing Penalty (veh)				252	31	11
Storage Bay Dist (m)			25.0			
Storage Blk Time (%)			0	84		
Queuing Penalty (veh)			0	38		

Network Summary

Network wide Queuing Penalty: 1557

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	104	1361	80	40	2101	93	364	409	32	120	306	199
Future Volume (vph)	104	1361	80	40	2101	93	364	409	32	120	306	199
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	6.0	6.0	3.0	6.0	6.0
Lane Util. Factor	1.00	0.91	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)	1687	4150	1429	1687	4433	1568	1719	3438	1369	1752	3539	1568
Flt Permitted	0.06	1.00	1.00	0.13	1.00	1.00	0.34	1.00	1.00	0.38	1.00	1.00
Satd. Flow (perm)	112	4150	1429	230	4433	1568	607	3438	1369	693	3539	1568
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	112	1463	86	43	2259	100	391	440	34	129	329	214
RTOR Reduction (vph)	0	0	39	0	0	47	0	0	28	0	0	94
Lane Group Flow (vph)	112	1463	47	43	2259	53	391	440	6	129	329	120
Heavy Vehicles (%)	7%	25%	13%	7%	17%	3%	5%	5%	18%	3%	2%	3%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases	2		2	6		6	4		4	8		8
Actuated Green, G (s)	70.0	63.5	63.5	67.0	62.0	62.0	32.8	20.8	20.8	25.6	16.6	16.6
Effective Green, g (s)	70.0	63.5	63.5	67.0	62.0	62.0	32.8	20.8	20.8	25.6	16.6	16.6
Actuated g/C Ratio	0.60	0.54	0.54	0.57	0.53	0.53	0.28	0.18	0.18	0.22	0.14	0.14
Clearance Time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.0	6.0	3.0	6.0	6.0
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)	154	2246	773	193	2343	828	294	609	242	232	500	221
v/s Ratio Prot	c0.04	0.35		0.01	c0.51		c0.15	0.13		0.04	0.09	
v/s Ratio Perm	0.39		0.03	0.12		0.03	c0.22		0.00	0.08		0.08
v/c Ratio	0.73	0.65	0.06	0.22	0.96	0.06	1.33	0.72	0.02	0.56	0.66	0.54
Uniform Delay, d1	21.5	19.1	12.8	12.1	26.6	13.5	39.4	45.5	39.9	38.8	47.7	46.8
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	15.7	1.5	0.1	0.6	11.4	0.0	170.0	4.2	0.0	2.9	3.1	2.7
Delay (s)	37.2	20.5	12.9	12.7	37.9	13.5	209.4	49.8	39.9	41.6	50.8	49.6
Level of Service	D	C	B	B	D	B	F	D	D	D	D	D
Approach Delay (s)		21.3			36.5			121.5			48.6	
Approach LOS		C			D			F			D	

Intersection Summary			
HCM 2000 Control Delay	46.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	117.3	Sum of lost time (s)	19.0
Intersection Capacity Utilization	92.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Intersection: 5: Ninth Line /Ninth Line & Burnhamthorpe Road

Movement	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	T	R	L	TR	L	TR
Maximum Queue (m)	59.8	81.5	159.9	763.3	160.0	79.8	180.8	79.9	149.9
Average Queue (m)	16.2	45.9	69.7	741.9	155.8	19.5	87.1	36.8	95.7
95th Queue (m)	38.9	71.1	188.5	836.1	191.8	58.5	188.1	82.6	166.7
Link Distance (m)		611.6		744.6			891.7		164.4
Upstream Blk Time (%)				70					10
Queuing Penalty (veh)				0					0
Storage Bay Dist (m)	50.0		120.0		130.0	50.0		50.0	
Storage Blk Time (%)	1	5		59		0	28	0	37
Queuing Penalty (veh)	5	2		294		0	16	1	43

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	T
Maximum Queue (m)	44.4	125.2	130.1	132.7	42.4	269.9	928.8	928.8	928.8	130.0	161.0	194.8
Average Queue (m)	18.8	72.6	80.9	81.6	9.6	91.4	916.4	915.5	913.9	64.6	160.0	184.5
95th Queue (m)	36.1	109.7	119.0	119.9	27.9	294.3	968.7	970.3	977.0	164.3	162.0	191.3
Link Distance (m)		1610.2	1610.2	1610.2			909.6	909.6	909.6			161.0
Upstream Blk Time (%)							84	82	87		46	73
Queuing Penalty (veh)							0	0	0		0	0
Storage Bay Dist (m)	200.0				85.0	210.0				80.0	135.0	
Storage Blk Time (%)				7			66		64		99	0
Queuing Penalty (veh)				5			26		59		202	0

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	NB	NB	B9	SB	SB	SB	SB
Directions Served	T	R	T	L	T	T	R
Maximum Queue (m)	166.5	22.4	66.0	48.6	67.9	59.1	52.3
Average Queue (m)	69.5	4.3	56.0	21.3	40.3	25.1	23.4
95th Queue (m)	179.4	14.5	62.5	40.0	61.4	49.4	43.9
Link Distance (m)	161.0		48.5		152.6	152.6	
Upstream Blk Time (%)	1		81				
Queuing Penalty (veh)	0		0				
Storage Bay Dist (m)		120.0		135.0			60.0
Storage Blk Time (%)						0	0
Queuing Penalty (veh)						0	0

Intersection: 11: Ninth Line & School Acess

Movement	EB	EB	NB	B10	SB
Directions Served	L	R	L	T	TR
Maximum Queue (m)	9.8	12.3	10.3	48.3	1.1
Average Queue (m)	1.6	4.6	1.6	1.6	0.0
95th Queue (m)	7.1	11.9	7.4	26.7	0.8
Link Distance (m)	90.7	90.7		152.6	891.7
Upstream Blk Time (%)				0	
Queuing Penalty (veh)				0	
Storage Bay Dist (m)			25.0		
Storage Blk Time (%)					
Queuing Penalty (veh)					

Network Summary

Network wide Queuing Penalty: 654

Intersection: 5: Ninth line & Burnhamthorpe Road

Movement	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	TR	L	T	R	L	T	TR	L	TR
Maximum Queue (m)	80.0	625.9	160.0	757.9	90.9	80.0	473.6	452.6	80.0	180.1
Average Queue (m)	28.5	615.7	158.7	746.5	9.4	78.7	325.9	258.8	79.5	170.5
95th Queue (m)	85.8	622.8	162.2	753.7	48.9	89.4	636.6	553.2	86.0	176.3
Link Distance (m)		607.8		741.0			890.4	890.4		163.9
Upstream Blk Time (%)		98		100						81
Queuing Penalty (veh)		0		0						0
Storage Bay Dist (m)	50.0		120.0		130.0	50.0			50.0	
Storage Blk Time (%)		66	100			92	2		93	20
Queuing Penalty (veh)		66	400			158	5		564	73

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	T
Maximum Queue (m)	133.1	133.4	141.3	141.2	124.9	48.2	67.2	70.1	67.4	39.2	155.2	146.4
Average Queue (m)	66.2	83.6	93.9	98.1	28.2	24.0	41.3	42.0	33.8	20.1	100.8	40.1
95th Queue (m)	116.8	122.0	132.4	136.2	88.3	41.7	60.7	63.4	58.4	33.3	161.5	111.8
Link Distance (m)		1610.2	1610.2	1610.2			909.6	909.6	909.6			161.0
Upstream Blk Time (%)											1	1
Queuing Penalty (veh)											0	0
Storage Bay Dist (m)	200.0				85.0	210.0				80.0	135.0	
Storage Blk Time (%)				15					0		7	0
Queuing Penalty (veh)				22					0		8	0

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	NB	NB	B9	SB	SB	SB	SB
Directions Served	T	R	T	L	T	T	R
Maximum Queue (m)	91.3	70.2	10.8	65.2	66.4	58.7	26.9
Average Queue (m)	21.8	28.2	1.1	25.9	39.3	26.6	11.1
95th Queue (m)	54.1	55.2	13.7	51.1	61.2	52.2	22.2
Link Distance (m)	161.0		48.5		152.6	152.6	
Upstream Blk Time (%)			0				
Queuing Penalty (veh)			0				
Storage Bay Dist (m)		120.0		135.0			60.0
Storage Blk Time (%)						0	
Queuing Penalty (veh)						0	

Intersection: 9: Bend

Movement	SB	SB
Directions Served	T	
Maximum Queue (m)	28.7	1.2
Average Queue (m)	1.0	0.0
95th Queue (m)	21.4	0.9
Link Distance (m)	161.0	161.0
Upstream Blk Time (%)	0	
Queuing Penalty (veh)	0	
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 12: Ninth line & School Access

Movement	EB	EB	NB
Directions Served	L	R	L
Maximum Queue (m)	9.2	20.0	16.4
Average Queue (m)	2.5	6.6	4.4
95th Queue (m)	8.5	14.5	13.0
Link Distance (m)	79.0	79.0	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (m)			15.0
Storage Blk Time (%)			0
Queuing Penalty (veh)			1

Network Summary

Network wide Queuing Penalty: 1297

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	100	1150	300	300	250	150	250	344	400	364	486	121
Future Volume (vph)	100	1150	300	300	250	150	250	344	400	364	486	121
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	8.5	8.5		3.0	8.5	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.92		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1671	1798		1770	1827	1538	1770	1688		1770	1793	
Flt Permitted	0.53	1.00		0.09	1.00	1.00	0.12	1.00		0.09	1.00	
Satd. Flow (perm)	928	1798		166	1827	1538	215	1688		171	1793	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	106	1223	319	319	266	160	266	366	426	387	517	129
RTOR Reduction (vph)	0	8	0	0	0	97	0	9	0	0	8	0
Lane Group Flow (vph)	106	1534	0	319	266	63	266	783	0	387	638	0
Heavy Vehicles (%)	8%	2%	4%	2%	4%	5%	2%	4%	3%	2%	3%	2%
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		pm+pt	NA	
Protected Phases		2			2			4		3	4	
Permitted Phases	2			2		2	4			4		
Actuated Green, G (s)	45.0	45.0		45.0	45.0	45.0	43.5	43.5		51.5	43.5	
Effective Green, g (s)	45.0	45.0		45.0	45.0	45.0	43.5	43.5		51.5	43.5	
Actuated g/C Ratio	0.39	0.39		0.39	0.39	0.39	0.38	0.38		0.45	0.38	
Clearance Time (s)	7.0	7.0		7.0	7.0	7.0	8.5	8.5		3.0	8.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	363	703		64	714	601	81	638		187	678	
v/s Ratio Prot		0.85			0.15			0.46		c0.14	0.36	
v/s Ratio Perm	0.11			c1.93		0.04	c1.24			0.78		
v/c Ratio	0.29	2.18		4.98	0.37	0.10	3.28	1.23		2.07	0.94	
Uniform Delay, d1	24.1	35.0		35.0	24.9	22.2	35.8	35.8		29.4	34.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.0	536.7		1827.5	1.5	0.3	1058.8	115.9		499.2	21.2	
Delay (s)	26.1	571.7		1862.5	26.4	22.6	1094.5	151.7		528.6	55.7	
Level of Service	C	F		F	C	C	F	F		F	E	
Approach Delay (s)		536.6			811.8			388.7			232.9	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	477.5	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	3.94		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	180.2%	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)	400	1550	150	100	550	250	300	211	200	299	550	250
Future Volume (vph)	400	1550	150	100	550	250	300	211	200	299	550	250
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	6.0	6.0	3.0	6.0	6.0
Lane Util. Factor	1.00	0.91	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)	1736	4590	1335	1597	4472	1583	1504	3438	1392	1770	3505	1583
Flt Permitted	0.34	1.00	1.00	0.11	1.00	1.00	0.17	1.00	1.00	0.61	1.00	1.00
Satd. Flow (perm)	612	4590	1335	180	4472	1583	268	3438	1392	1142	3505	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	421	1632	158	105	579	263	316	222	211	315	579	263
RTOR Reduction (vph)	0	0	82	0	0	188	0	0	135	0	0	209
Lane Group Flow (vph)	421	1632	76	105	579	75	316	222	76	315	579	54
Heavy Vehicles (%)	4%	13%	21%	13%	16%	2%	20%	5%	16%	2%	3%	2%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases	2		2	6		6	4		4	8		8
Actuated Green, G (s)	64.4	53.4	53.4	45.3	37.3	37.3	52.6	31.5	31.5	44.7	26.6	26.6
Effective Green, g (s)	64.4	53.4	53.4	45.3	37.3	37.3	52.6	31.5	31.5	44.7	26.6	26.6
Actuated g/C Ratio	0.50	0.41	0.41	0.35	0.29	0.29	0.40	0.24	0.24	0.34	0.20	0.20
Clearance Time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.0	6.0	3.0	6.0	6.0
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)	511	1885	548	149	1283	454	327	833	337	480	717	323
v/s Ratio Prot	c0.15	c0.36		0.04	0.13		c0.17	0.06		0.09	0.17	
v/s Ratio Perm	0.25		0.06	0.20		0.05	c0.22		0.05	0.13		0.03
v/c Ratio	0.82	0.87	0.14	0.70	0.45	0.17	0.97	0.27	0.23	0.66	0.81	0.17
Uniform Delay, d1	22.4	35.0	23.9	30.9	38.0	34.7	34.9	39.9	39.5	34.0	49.3	42.6
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	10.4	5.6	0.5	14.1	0.3	0.2	40.4	0.2	0.3	3.2	6.7	0.2
Delay (s)	32.8	40.7	24.4	44.9	38.2	34.9	75.2	40.1	39.8	37.3	55.9	42.8
Level of Service	C	D	C	D	D	C	E	D	D	D	E	D
Approach Delay (s)		38.0			38.0			54.8			47.9	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	42.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Intersection: 5: Ninth Line /Ninth Line & Burnhamthorpe Road

Movement	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	TR	L	T	R	L	T	TR	L	TR
Maximum Queue (m)	80.0	626.6	160.0	758.0	160.0	80.0	235.6	224.6	79.9	178.4
Average Queue (m)	70.9	617.4	153.9	748.9	123.8	79.5	166.6	125.9	30.0	127.6
95th Queue (m)	108.0	624.6	191.9	760.3	227.7	82.1	261.9	239.5	85.1	204.3
Link Distance (m)		607.9		741.0			894.0	894.0		163.9
Upstream Blk Time (%)		100		85						23
Queuing Penalty (veh)		0		0						0
Storage Bay Dist (m)	50.0		120.0		130.0	50.0			50.0	
Storage Blk Time (%)	1	82	9	71		100	2			47
Queuing Penalty (veh)	9	164	88	460		339	2			24

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	T
Maximum Queue (m)	84.8	124.7	140.2	148.0	124.3	57.6	127.3	134.9	124.5	109.0	137.3	96.0
Average Queue (m)	39.9	80.0	89.1	90.3	26.9	23.3	79.9	83.7	77.5	49.2	78.9	29.0
95th Queue (m)	71.6	115.3	128.9	128.5	76.2	46.1	116.1	120.3	112.9	90.0	133.0	64.4
Link Distance (m)		1610.2	1610.2	1610.2			909.6	909.6	909.6			161.0
Upstream Blk Time (%)											0	0
Queuing Penalty (veh)											0	0
Storage Bay Dist (m)	200.0				85.0	210.0				80.0	135.0	
Storage Blk Time (%)				11					7	1	2	0
Queuing Penalty (veh)				22					39	5	3	0

Intersection: 6: Ninth Line & Dundas Street/Dundas Street

Movement	NB	NB	B9	SB	SB	SB	SB
Directions Served	T	R	T	L	T	T	R
Maximum Queue (m)	63.9	62.6	6.1	69.8	105.4	105.5	79.9
Average Queue (m)	18.6	26.7	0.3	35.4	69.6	58.8	38.5
95th Queue (m)	45.1	51.0	5.1	59.9	100.9	100.0	75.9
Link Distance (m)	161.0		48.5		152.6	152.6	
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (m)		120.0		135.0			60.0
Storage Blk Time (%)						6	1
Queuing Penalty (veh)						26	3

Intersection: 9: Bend

Movement	SB
Directions Served	T
Maximum Queue (m)	128.3
Average Queue (m)	8.7
95th Queue (m)	65.8
Link Distance (m)	161.0
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (m)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 12: Ninth Line

Movement	EB	EB	NB	SB
Directions Served	L	R	L	TR
Maximum Queue (m)	8.3	13.3	9.6	2.6
Average Queue (m)	1.1	4.3	3.2	0.1
95th Queue (m)	5.6	11.9	10.3	2.0
Link Distance (m)	32.0	32.0		894.0
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (m)			15.0	
Storage Blk Time (%)			0	
Queuing Penalty (veh)			0	

Network Summary

Network wide Queuing Penalty: 1184

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	200	400	300	450	800	200	105	680	76	50	461	150
Future Volume (vph)	200	400	300	450	800	200	105	680	76	50	461	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	7.0		4.5	7.0	7.0	8.5	8.5		3.0	8.5	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.94		1.00	1.00	0.85	1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1673		1736	1863	1568	1752	1819		1719	1719	
Flt Permitted	0.19	1.00		0.18	1.00	1.00	0.22	1.00		0.14	1.00	
Satd. Flow (perm)	350	1673		335	1863	1568	413	1819		246	1719	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	217	435	326	489	870	217	114	739	83	54	501	163
RTOR Reduction (vph)	0	34	0	0	0	158	0	5	0	0	14	0
Lane Group Flow (vph)	217	727	0	489	870	59	114	817	0	54	650	0
Heavy Vehicles (%)	2%	5%	8%	4%	2%	3%	3%	3%	2%	5%	4%	14%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	Perm	NA		pm+pt	NA	
Protected Phases	1	6		5	2			4		3	8	
Permitted Phases	6			2		2	4			8		
Actuated Green, G (s)	26.3	21.3		27.3	21.8	21.8	26.4	26.4		33.2	33.2	
Effective Green, g (s)	26.3	21.3		27.3	21.8	21.8	26.4	26.4		33.2	33.2	
Actuated g/C Ratio	0.33	0.27		0.34	0.27	0.27	0.33	0.33		0.42	0.42	
Clearance Time (s)	4.5	7.0		4.5	7.0	7.0	8.5	8.5		3.0	8.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	203	445		210	507	427	136	600		172	713	
v/s Ratio Prot	0.07	0.43		c0.16	0.47			c0.45		0.01	c0.38	
v/s Ratio Perm	0.28			c0.63		0.04	0.28			0.12		
v/c Ratio	1.07	1.63		2.33	1.72	0.14	0.84	1.36		0.31	0.91	
Uniform Delay, d1	26.1	29.4		25.2	29.1	22.0	24.8	26.8		18.3	22.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	82.6	294.8		612.5	330.5	0.7	34.0	173.6		0.4	15.9	
Delay (s)	108.8	324.1		637.7	359.6	22.7	58.8	200.4		18.7	37.9	
Level of Service	F	F		F	F	C	E	F		B	D	
Approach Delay (s)		276.3			399.5			183.1			36.5	
Approach LOS		F			F			F			D	

Intersection Summary			
HCM 2000 Control Delay	260.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.81		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	128.9%	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)	200	1300	200	100	1150	550	300	211	200	285	570	428
Future Volume (vph)	200	1300	200	100	1150	550	300	211	200	285	570	428
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	6.0	6.0	3.0	6.0	3.0
Lane Util. Factor	1.00	0.91	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)	1687	4150	1429	1687	4433	1568	1719	3438	1369	1752	3539	1568
Flt Permitted	0.11	1.00	1.00	0.12	1.00	1.00	0.15	1.00	1.00	0.61	1.00	1.00
Satd. Flow (perm)	188	4150	1429	208	4433	1568	270	3438	1369	1125	3539	1568
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	215	1398	215	108	1237	591	323	227	215	306	613	460
RTOR Reduction (vph)	0	0	128	0	0	349	0	0	146	0	0	57
Lane Group Flow (vph)	215	1398	87	108	1237	242	323	227	69	306	613	403
Heavy Vehicles (%)	7%	25%	13%	7%	17%	3%	5%	5%	18%	3%	2%	3%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	pm+ov
Protected Phases	5	2		1	6		7	4		3	8	5
Permitted Phases	2		2	6		6	4		4	8		8
Actuated Green, G (s)	61.1	50.5	50.5	50.9	43.3	43.3	50.5	30.3	30.3	43.0	25.8	40.6
Effective Green, g (s)	61.1	50.5	50.5	50.9	43.3	43.3	50.5	30.3	30.3	43.0	25.8	40.6
Actuated g/C Ratio	0.49	0.41	0.41	0.41	0.35	0.35	0.41	0.24	0.24	0.35	0.21	0.33
Clearance Time (s)	3.0	7.0	7.0	3.0	7.0	7.0	3.0	6.0	6.0	3.0	6.0	3.0
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)	270	1681	579	175	1540	544	361	836	332	474	732	510
v/s Ratio Prot	c0.09	c0.34		0.04	0.28		c0.16	0.07		0.09	0.17	0.09
v/s Ratio Perm	0.29		0.06	0.21		0.15	c0.21		0.05	0.13		0.16
v/c Ratio	0.80	0.83	0.15	0.62	0.80	0.44	0.89	0.27	0.21	0.65	0.84	0.79
Uniform Delay, d1	26.8	33.2	23.5	24.7	36.8	31.4	33.0	38.2	37.6	32.4	47.4	38.1
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	14.9	5.0	0.5	6.3	3.1	0.6	23.4	0.2	0.3	3.0	8.3	8.2
Delay (s)	41.7	38.2	24.0	31.0	39.9	32.0	56.4	38.4	37.9	35.4	55.7	46.3
Level of Service	D	D	C	C	D	C	E	D	D	D	E	D
Approach Delay (s)		36.9			37.0			45.8			48.1	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	40.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	124.6	Sum of lost time (s)	19.0
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

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