mattamyHOMES CARDEL HOMES

May 2017

5505 Fernbank Road
Blackstone Phases 4-8

Transportation Impact Study

PARSONS

5505 Fernbank Road
Blackstone
Phases 4 – 8

Transportation Impact Study

prepared for:
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476217-01000

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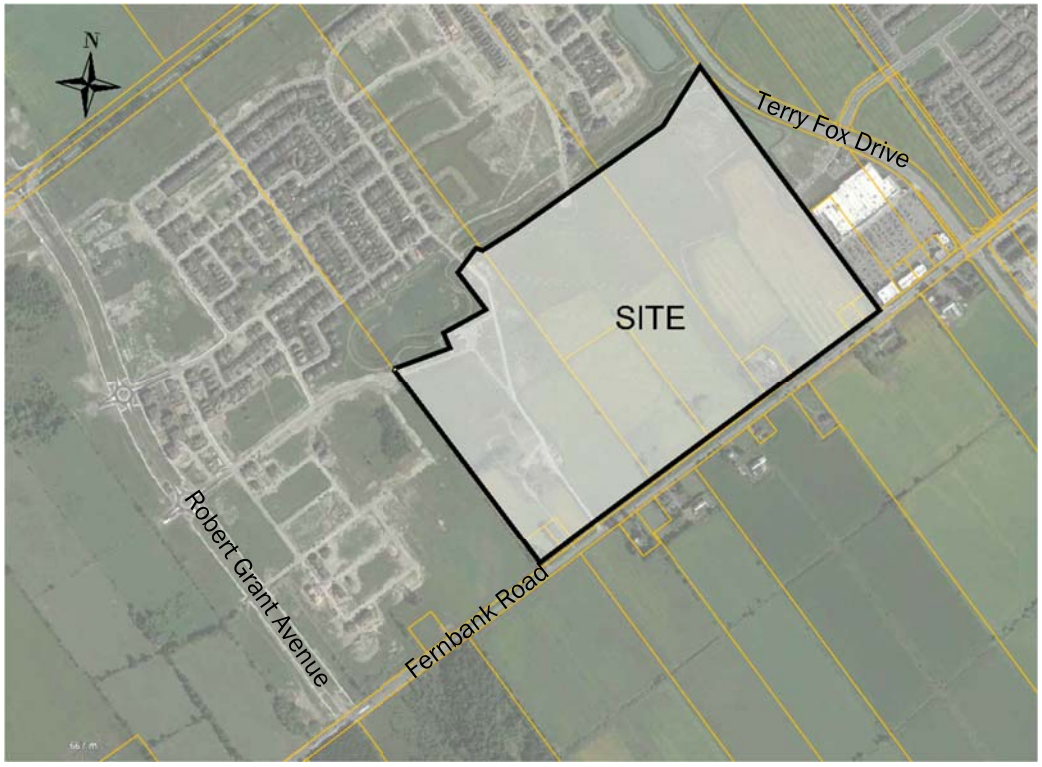
Blackstone Transportation Impact Study

1. INTRODUCTION

This study has been prepared to support a Draft Plan of Subdivision application for Mattamy Homes' and Cardel Homes' proposed developments at 5505 Fernbank Road, referred to as the Blackstone South Development. The proposed development includes single detached and townhome style houses. The site will be constructed in several phases, but is anticipated to be built out quickly and multiple phases will be constructed concurrently. The subject site connects at several points to the adjacent developments as well as the adjacent road network.

Figure 1 shows the site location and the nearby road network. Figure 2 shows the proposed site plan.

Figure 1: Local Site Context



Consistent with the City of Ottawa's 2006 Transportation Impact Assessment Guidelines (TIA Guidelines), a Transportation Impact Study (TIS) is required to support the subject development application. The following horizons will be considered in the demand forecasting and operational analysis, 2017 (Existing Conditions), 2025 (Full Build-out, assumed), and 2030 (Full build-out plus 5 years).

Prior to commencement of this study a pre-consultation / scoping e-mail was sent to City Staff for discussion / approval. E-mail correspondence with City Staff has been included as Appendix A.

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Blackstone South

April 5, 2017

Lot Count (Mattamy)

21' Village Townhome	92
21' Widelot Townhome	127
32' Single Detached	201
46' Single Detached	40
Residential Block	156
	616

Lot Count (Cardel)

Singles	182
Towns	157
	339

1.1. CONTEXT

The development is part of the Fernbank Community, located within the West Urban Community of the City of Ottawa. The Fernbank Community was the subject of a Community Design Plan (CDP) in 2006. The CDP outlines the planning context and planning principles that influence the design and construction of the Fernbank Community. Through this planning process the outline of the road network was established.

A Transportation Brief has been completed for 570 Hazeldean Road, Mattamy's development to the north of the subject development. This TB, completed in 2013, outlined the traffic generated by the proposed development. The previous study assumes that the development would be fully built-out in 2021. It is assumed that this build-out horizon has remained unchanged.

A Transportation Impact Analysis is underway for the Abbott-Fernbank Holdings to the east of the subject development, referred to as Abbott Fernbank Phase 4. This TIA, to be completed in 2017, will outline the traffic generated by the proposed development. This study assumes that development would be fully built-out in 2021. This information has been provided by the author of the Abbott - Fernbank study in advance of the submission.

Appendix B contains excerpts of the Dawson Transportation Brief and Abbott Fernbank Phase 4, detailing the site generated trips.

As no other development applications were indicated by the City Staff to be pending at the time of this study, it is assumed that other developments would be fully built out beyond the full build out horizon of 5505 Fernbank Road.

2. EXISTING CONDITIONS

2.1. STUDY AREA ROAD NETWORK

The Study Area road network is summarized below:

Fernbank Road is an east-west arterial road that runs between Dwyer Hill Road and Eagleson Road. Fernbank Road has a two-lane undivided rural cross section with gravel shoulders. The posted speed limit is 80km/h along the frontage of 5505 Fernbank Road, it is assumed that this speed limit would be reduced to 60 km/h by the completion of the subject development. It is identified as a transit priority corridor with isolated measures (City of Ottawa Transportation Master Plan (TMP) 2013, Ultimate Network) and widening has been proposed in the Network Concept Map 10 (TMP). The widening is not included in the affordable network and was therefore not considered in this study.

Robert Grant Avenue is a north-south arterial road that runs through the Fernbank Community. This road is currently only constructed from Fernbank Road to Abbot Street East, but will ultimately connect to the Palladium Drive Highway 417 interchange.

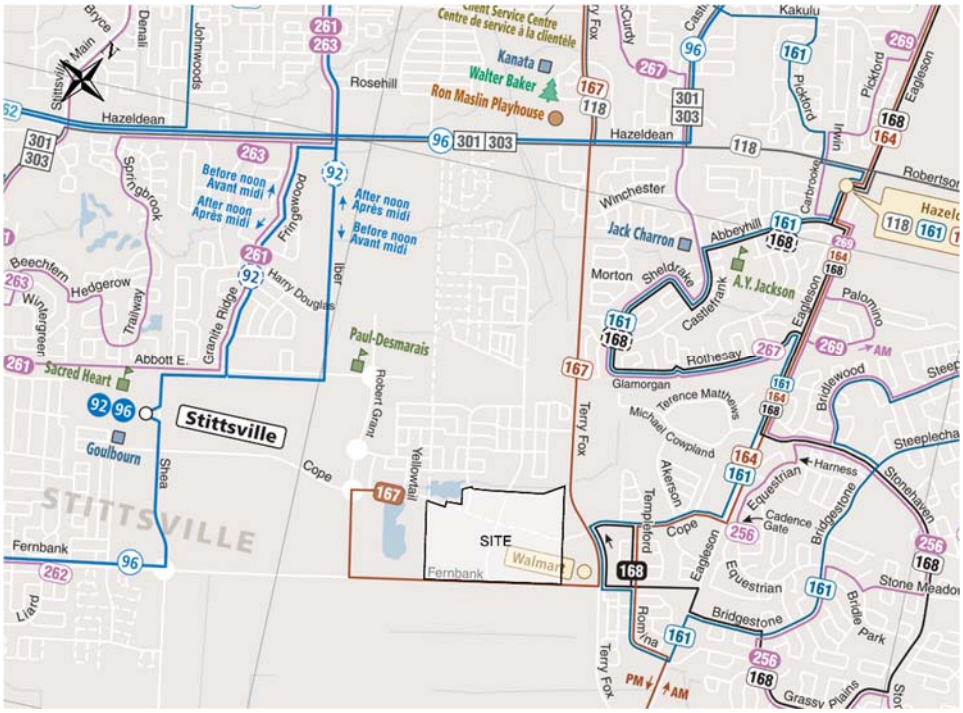
Cope Drive is an east-west collector road that is not currently continuous, but will be connected as part of the proposed development. This road connects to Eagleson Road east of the subject development and Robert Grant Avenue west of the subject development.

Rouncey Road is a north-south collector road that is not currently continuous, but would be connected as part of the proposed development. This road connects the northern part of the Fernbank Community to both Cope Drive and Fernbank Road.

2.2. TRANSIT NETWORK

OC Transpo Route 96 and 262 run along Fernbank Road, Route 96 and 92 run along Shea Road. Bus Route 167 currently serves the Blackstone community with a transit stop at Rouncey Road / Westphalian Avenue. The closest transit stop on Fernbank Road is located at Laird Street and on Shea Road, the Goulbourn Complex is the last stop. Figure 3 shows the transit routes through the Study Area.

Figure 3: Existing Transit Network



Accessed January 9, 2017

2.3. PEDESTRIAN & CYCLING NETWORK

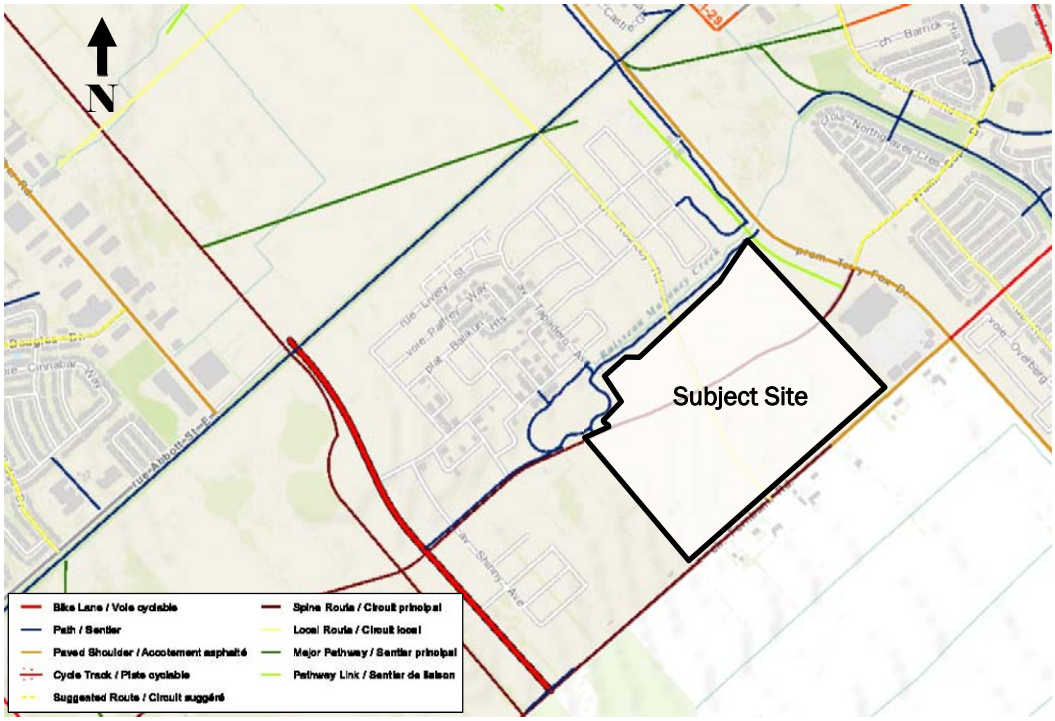
Sidewalks are provided within the immediate study area. The existing sidewalks connect Robert Grant Avenue to Abbott Street East and the residential area west of the site.

Cycle Tracks are provided on both sides of Robert Grant Avenue, which connects at the south to paved shoulders on Fernbank Road and the Trans-Canada Trail to the north.

A major pathway connection terminates at the roundabout at the intersection of Fernbank Road and Robert Grant Avenue which originates at the Trans Canada Trail. The Ottawa Pedestrian Plan (2013) does not identify any extension to this pathway.

The City of Ottawa's 2013 Cycling Plan identifies Fernbank Road as a Spine or Citywide-cycling route. Figure 4 illustrates the study area, and surrounding area, cycling network.

Figure 4: Cycling Network



A cross-section for Cope Road has been previously defined as part of the Abbot-Fernbank Lands and this cross-section will be carried through the subject development. The cross-section includes a multi-use pathway along the north side and a sidewalk is included along the south side. The typical cross-section has been included in Appendix C.

2.4. COLLISION REPORTS

Collision data was requested from the City of Ottawa for the intersections of Cope Drive at Robert Grant Avenue and Fernbank Road at Robert Grant Avenue for the most recent 3 years prior to the commencement of this study. However, no data was available for this intersection, and therefore it is inferred that no reportable collisions have occurred within the 3 years prior to this study.

2.5. EXISTING TRAFFIC OPERATIONS

To establish the baseline intersection operations an operational analysis of the existing traffic conditions has been undertaken for the study area intersection. No recent counts were available from the City of Ottawa. New turning movement counts were undertaken on Thursday February 16, 2017 and Tuesday February 21, 2017, these are summarized on Figure 5. Appendix D contains the detailed traffic data sheets.

To assess the peak hour traffic conditions at the existing roundabout a level of service analysis has been completed using the traffic analysis software Sidra. The key parameters used in the analysis include:

- Existing lane arrangements
- A value of 2% Heavy Vehicle volume was used
- Default values for all other inputs (as defined by Sidra)

To assess the peak hour traffic conditions at the signalized and unsignalized intersections a level of service analysis has been completed using Trafficware Synchro 9.1, which implements the methods of the 2000 Highway Capacity Manual. The key parameters used in the analysis include:

- A saturation flow rate of 1800 (as per the City of Ottawa TIA Guidelines)
- Default values for all other inputs (as defined by Synchro 9.1)

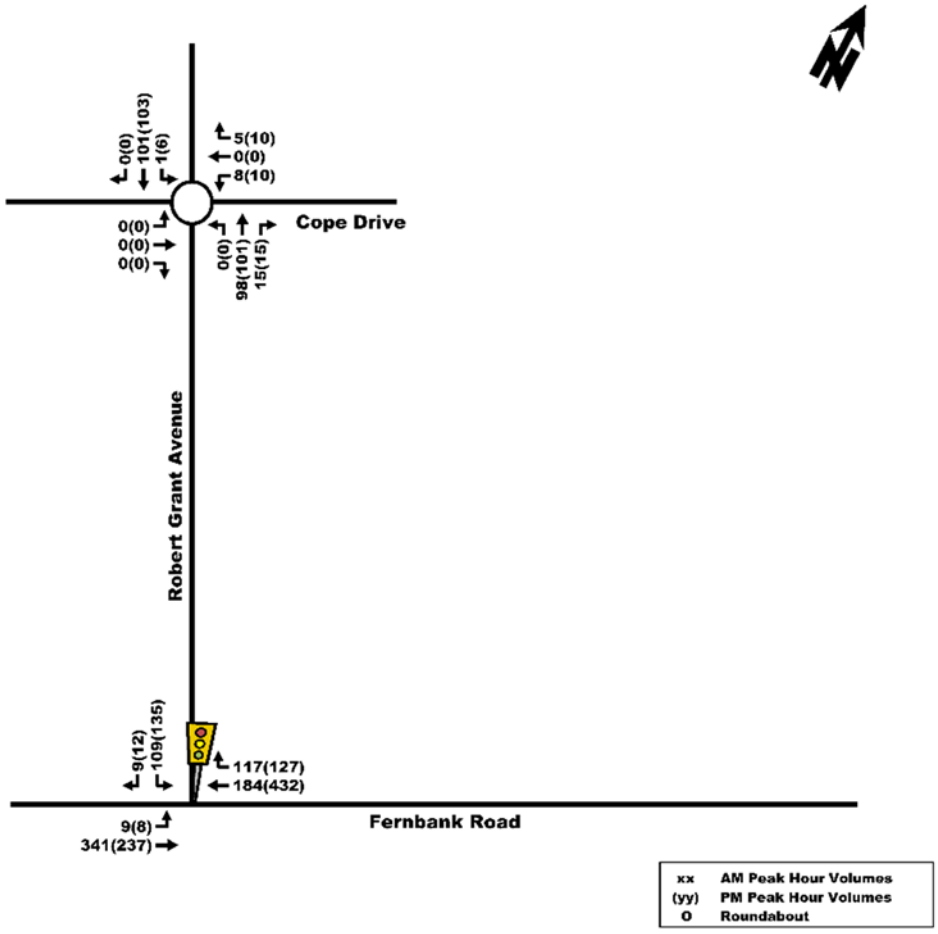
The results of the operational analysis are summarized in Table 1. The Sidra and Synchro analysis outputs are provided in Appendix E.

Table 1: Intersection Operational Analysis
2017 Existing Conditions

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection		
	LoS	max. v/c or avg. delay (s)	Movement	Delay (s)	LoS	v/c
Fernbank Road/Robert Grant Avenue [1]	A(A)	0.37(0.45)	EBT(WBT)	9.4(10.7)	A(A)	0.35(0.42)
Robert Grant Avenue/Cope Drive[3]	A(A)	5.2(4.3)	SB(SB)	5.0(4.3)	-	-
Note: *1- Signalized Intersection* *2- Unsignalized Intersection* *3- Roundabout Intersection*						

The existing roundabout at Robert Grant Avenue and Cope Drive as well as the signalized intersection of Fernbank at Robert Grant Avenue were shown to operate with good overall levels of service and no critical movements. As a result, no mitigation measures are recommended.

Figure 5: Existing Peak Hour Traffic Volumes



3. DEMAND FORECASTING

3.1. BACKGROUND TRAFFIC GROWTH

To account for background growth along Fernbank Road and Robert Grant Avenue several background developments have been considered. All the developments considered are expected to reach full build-out prior to the 2025 horizon. To account for background growth beyond the study area, a 2% background growth rate per annum (compounded) has been applied. The background development traffic volumes were combined with the existing traffic volumes and the percent background growth to estimate the future background traffic for 2025 and 2030. Figure 6 shows the future background traffic volumes for the 2025 horizon. Figure 7 shows the future background traffic volumes for the 2030 horizon.

3.2. SITE TRIP GENERATION

The number of vehicle trips has been estimated, based on the proposed land uses, to project the impact of the proposed development on the surrounding road network. Table 2 documents the proposed land uses, the ITE Land Use Codes, and the independent variables that are being proposed for the Blackstone South Development.

Table 2: Proposed Land Uses

Land Use	Data Source	Independent Variable
Single-Family Detached Housing	ITE 210	423 Units
Residential Condominium / Townhouse	ITE 230	376 Units
Residential Condominium Block	ITE 220	156 Units
High School	ITE 530	1,916 Students
Elementary School	ITE 520	650 Students

The ITE Land Use Codes and independent variables described above were used to develop the baseline automobile trip generation. The baseline automobile trip generation is multiplied by 1.30 to estimate the number of peak hour person trips that could be generated by the proposed development. The 2011 NCR Household Origin – Destination Survey was reviewed to determine the mode share characteristics of the subject area, specifically, the Kanata – Stittsville Area. Table 3 documents the mode share based on the O-D survey.

Table 3: South Nepean Existing Mode Share

Travel Mode	Mode Share
Auto Driver	60%
Auto Passenger	15%
Transit	10%
Non-motorized	15%
Total Person Trips	100%

Table 4 summarizes the vehicle trip generation for the full build-out of the proposed development based on the foregoing assumptions. A full trip generation table is included in Appendix F.

Table 4: Site Trip Generation (Full Build-Out)

	AM Peak Hour			PM Peak Hour		
	Inbound	Outbound	Total	Inbound	Outbound	Total
Net new Vehicle Trips	666	683	1,349	514	362	876

3.3. VEHICLE TRAFFIC DISTRIBUTION AND ASSIGNMENT

The vehicle traffic distribution and assignment was developed using the 2011 NCR Household Origin – Destination Survey. The resultant distribution is outlined in Table 5.

Table 5: Traffic Distribution

To/From	Distribution
North	40%
South	10%
East	40%
West	10%
Total	100%

Using these distributions and the access configuration, new site-generated trips were assigned to the study area intersections. Figure 8 shows the full build-out site generated traffic volumes.

3.4. PROJECTED TRAFFIC VOLUMES

The background traffic volumes were combined with the site traffic to determine the weekday AM and PM peak hour total traffic forecasts. The future total traffic volumes for the 2025, and 2030 horizon years are shown in Figure 9, and Figure 10 respectively.

Figure 6: Future Background Traffic (2025)

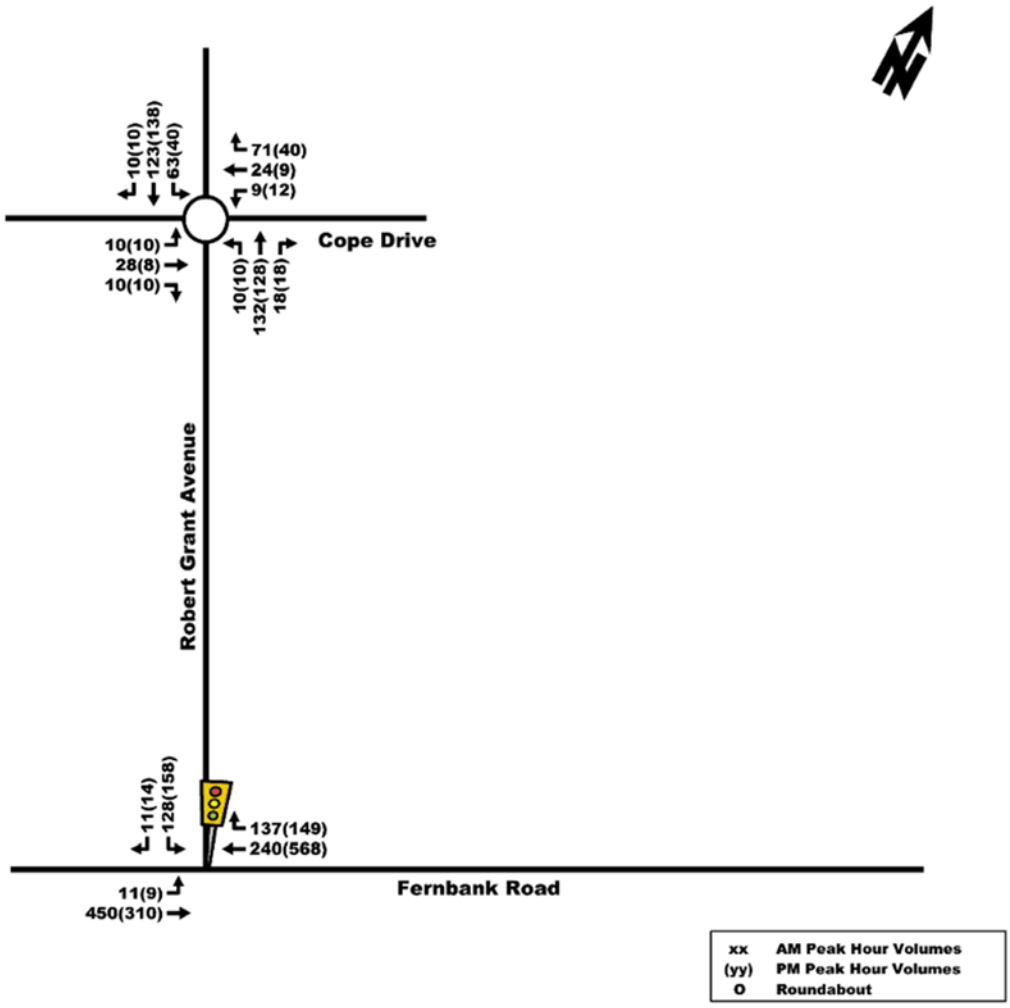


Figure 7: Future Background Traffic (2030)

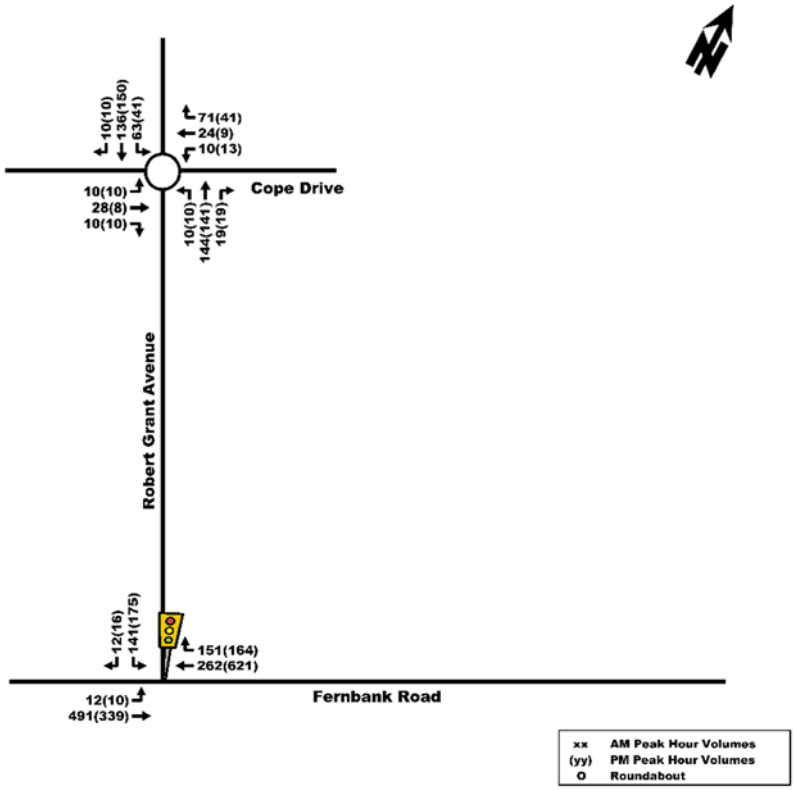


Figure 8: Site Generated Traffic Volumes (Full Build-Out)

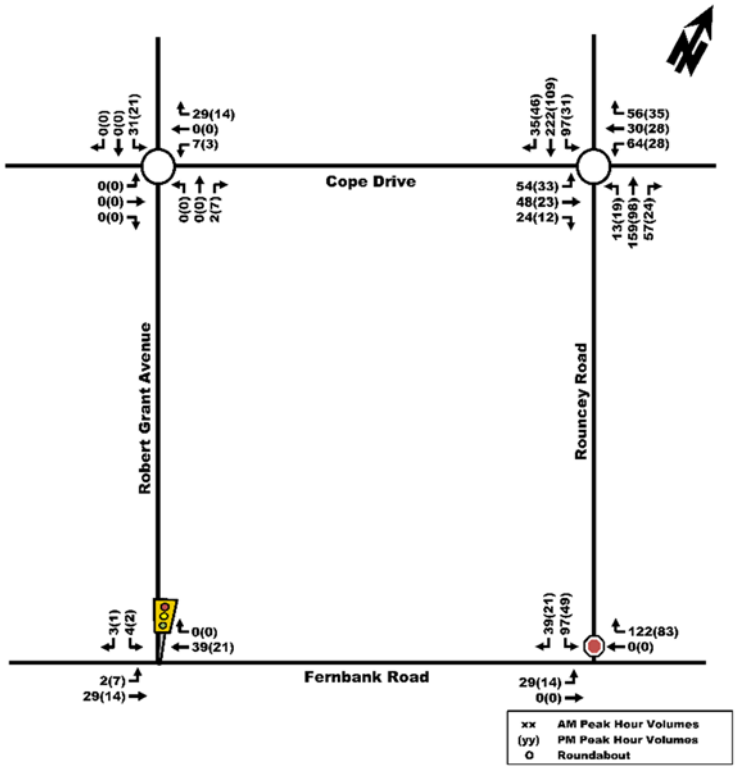


Figure 9: Future Total Traffic (2025)

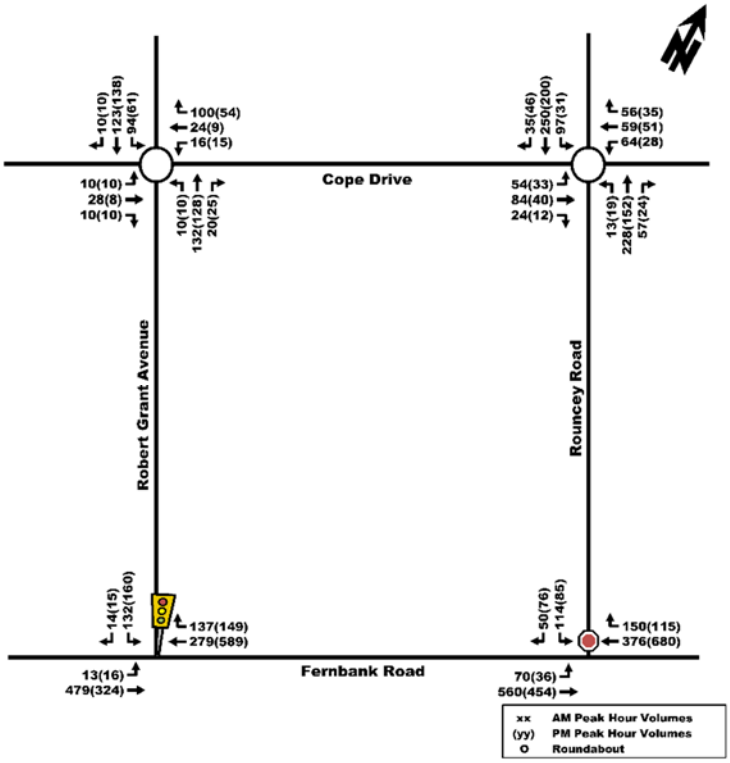
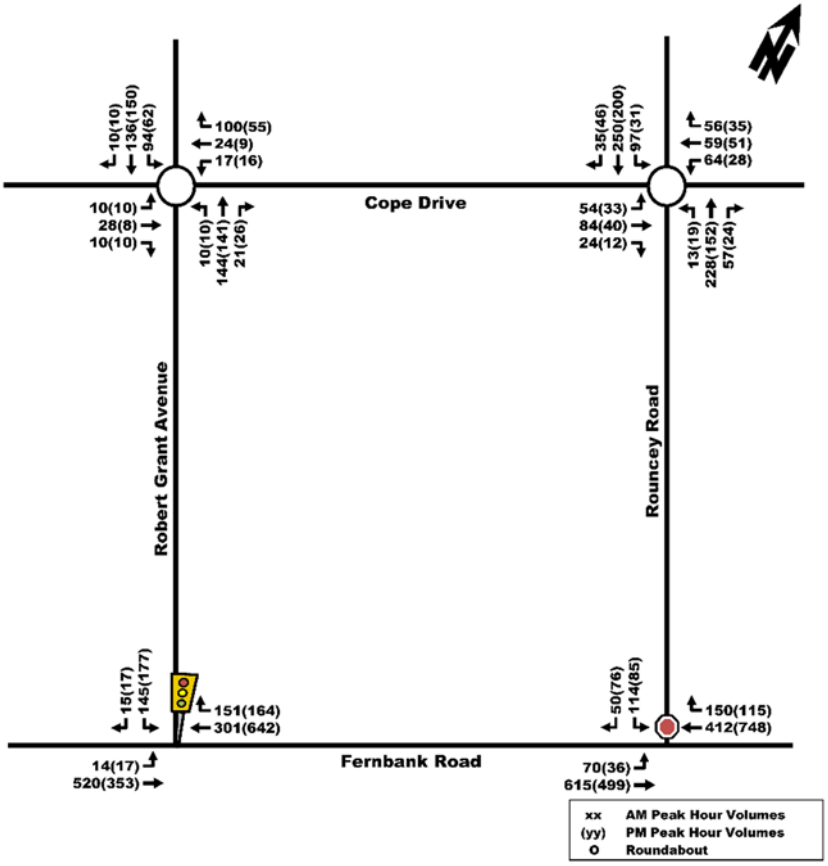


Figure 10: Future Total Traffic (2030)



4. FUTURE TRAFFIC OPERATIONS

4.1. 2025 FUTURE BACKGROUND CONDITIONS

A level of service analysis of the future background AM and PM peak hour operating conditions was undertaken using the same parameters as in the analysis of existing conditions. Table 6 summarizes the operational analysis for the projected 2025 future background conditions. Sidra analysis outputs are included in Appendix G.

Table 6: Intersection Operational Analysis
2025 Future Background Conditions

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection		
	LoS	max. v/c or avg. delay (s)	Movement	Delay (s)	LoS	v/c
Fernbank Road/Robert Grant Avenue [1]	A(A)	0.43(0.60)	EBT(WBT)	9.9(12.1)	A(A)	0.40(0.56)
Robert Grant Avenue/Cope Drive[3]	A(A)	5.3(5.2)	NB(NB)	5.2(5.0)	-	-
Note: *1- Signalized Intersection* *2- Unsignalized Intersection* *3- Roundabout Intersection*						

The roundabout intersection of Robert Grant Avenue and Cope Drive, with the addition of the background developments, is projected to operate well, with Level of Service A (LOS A) during the AM and PM peak periods. The signalized intersection at Fernbank Road and Robert Grant Avenue is projected to operate at LOS B for the AM and PM peak periods.

4.2. 2025 TOTAL FUTURE CONDITIONS

A level of service analysis of the future AM and PM peak hour operating conditions, including the subject development, was undertaken using the same parameters as in the analysis of existing conditions, with the addition of the intersections of Rouncey Road at Cope Drive and Rouncey Road at Fernbank Road.

Table 7 summarizes the operational analysis for the projected 2025 total future conditions. Sidra and Synchro analysis outputs are included in Appendix H.

Table 7: Intersection Operational Analysis
2025 Future Traffic Conditions

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection		
	LoS	max. v/c or avg. delay (s)	Movement	Delay (s)	LoS	v/c
Fernbank Road/Robert Grant Avenue [1]	A(B)	0.50(0.65)	EBT(WBT)	10.3(12.8)	A(A)	0.47(0.60)
Rouncey Road/Fernbank Road [2]	E(E)	41.6(47.0)	SB(SB)	5.6(5.5)	-	-
Robert Grant Avenue/Cope Drive [3]	A(A)	5.7(5.4)	NB(NB)	5.5(5.2)	-	-
Rouncey Road /Cope Drive [3]	A(A)	8.9(6.8)	NB(NB)	8.5(6.1)	-	-
Note: *1- Signalized Intersection* *2- Unsignalized Intersection* *3- Roundabout Intersection*						

The new unsignalized intersection at Fernbank Road and Rouncey Road will operate at LOS E during the AM and PM peak hour. The poor operation is due to the high through volumes along Fernbank Road. It should be noted that the through volumes on the east – west legs of the intersection operate with LOS A. A signal warrant was examined using OTM Book 12 methodology for a future intersection with future volumes. Using this methodology, a traffic control signal is not warranted at this location for the 2025 Total Future Conditions. The roundabout at Robert Grant Avenue and the newly added roundabout at Rouncey Road and Cope Drive is projected to operate at LOS A for both AM and PM peak periods. The signalized intersection at Fernbank Road and Robert Grant Avenue is projected to operate at LOS B in the AM and LOS C in the PM peak hour.

A left turn lane warrant was examined at Rouncey Road and Fernbank Road for the eastbound direction along Fernbank Road, and was found to be warranted. For the westbound direction along Fernbank a right turn lane was added to improve the conditions at the intersection of Fernbank Road and Rouncey Road as the right turn volumes were greater than 60 veh/h for both AM and PM peak periods. Appendix I documents the left turn lane warrant.

4.3. 2030 FUTURE BACKGROUND CONDITIONS

A level of service analysis of the 2030 future background AM and PM peak hour operating conditions was undertaken using the same parameters as in the analysis of 2025 future background conditions. Table 8 summarizes the operational analysis for the projected 2030 future background conditions. Sidra and Synchro analysis outputs are included in Appendix J.

Table 8: Intersection Operational Analysis
2030 Future Background Conditions

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection		
	LoS	max. v/c or avg. delay (s)	Movement	Delay (s)	LoS	v/c
Fernbank Road/Robert Grant Avenue [1]	B(B)	0.61(0.68)	EBT(WBT)	11.6(13.4)	A(B)	0.56(0.64)
Robert Grant Avenue/Cope Drive [3]	A(A)	5.5(5.3)	NB(NB)	5.3(5.1)	-	-
Note: *1- Signalized Intersection* *2- Unsignalized Intersection* *3- Roundabout Intersection*						

The roundabout at Robert Grant Avenue and Cope Drive is shown to operate well with LOS A and short delays in both the AM and PM peak hours. The signalized intersection at Fernbank Road and Robert Grant Avenue is shown to operate at LOS B for AM and PM peak periods.

4.4. 2030 TOTAL FUTURE CONDITIONS

A level of service analysis of the 2030 total future AM and PM peak hour operating conditions was undertaken using the same parameters as in the analysis of 2025 total future conditions. Table 9 summarizes the operational analysis for the projected 2030 total future conditions. Sidra and Synchro analysis outputs are included in Appendix K.

Table 9: Intersection Operational Analysis
2030 Future Traffic Conditions

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection		
	LoS	max. v/c or avg. delay (s)	Movement	Delay (s)	LoS	v/c
Fernbank Road/Robert Grant Avenue [1]	B(B)	0.63(0.69)	EBT(WBT)	11.9(13.7)	A(B)	0.58(0.64)
Rouncey Road/Fernbank Road [2]	F(F)	55.4(67.4)	SB(SB)	6.9(7.2)	-	-
Robert Grant Avenue/Cope Drive [3]	A(A)	5.9(5.5)	NB(NB)	5.7(5.3)	-	-
Rouncey Road/Cope Drive [3]	A(A)	8.9(6.8)	NB(NB)	8.5(6.1)	-	-
Note: *1- Signalized Intersection* *2- Unsignalized Intersection* *3- Roundabout Intersection*						

With the addition of traffic from the full build-out of the proposed site, the roundabout at Robert Grant Avenue and Cope Drive will continue to operate at LOS A during both peak hours. The signalized intersection at Robert Grant Avenue and Fernbank Road will operate at LOS C with the addition of the site traffic.

Similar to 2025 total future conditions the unsignalized intersection of Rouncey Road and Fernbank Road will operate with poor LOS, and high delays. This is caused by the high volume of east/west traffic on Fernbank Road causing delays to the minor, southbound approach of the intersection. The east/west legs of the intersection are projected to operate with LOS A. Additionally, a signal warrant was examined using OTM Book 12 methodology for a future intersection with future volumes. Using the methodology, a traffic control signal is not warranted at this location for the 2030 Total Future Conditions.

5. TRANSPORTATION DEMAND MANAGEMENT

Transportation Demand Management (TDM) strategies have the potential to be an integral part of a planned development. For this site, the proximity of dedicated on-road cycling facilities will contribute to maximizing the bicycle mode split. As well, several other TDM measures could be considered to reduce vehicle use, including:

- Improving the quality and safety of pedestrian facilities, such as enhanced sidewalks/lighting
- Ride-sharing programs (e.g. community forum where residents can register/arrange carpooling or on-site parking can be reserved for VRTUCAR cars)
- Provide a transit information to encourage residents to utilize transit
- Develop a program to encourage both residents to have transit passes

TDM strategies are important in encouraging active modes of transportation to/from the site, further lessening the reliance on the private automobile.

6. CONCLUSIONS

The conclusions of the Transportation Impact Study are as follows:

a) The existing study area intersections have been shown to operate with a good overall LOS (LOS A) and minimal delays. No mitigation measures were required to address existing deficiencies.

b) It is projected that the site will generate 1,349 and 876 net new auto trips in the AM and PM peak hours respectively (per Table 4: Site Trip Generation).

c) The analysis of 2025 and 2030 future background conditions (without site generated traffic) indicated that the roundabout intersection would operate with good LOS (LOS B or better) and minimal delays. No mitigation measures were required to address deficiencies as a result of the addition of background growth.

d) The analysis of 2025 and 2030 total future traffic forecasts (including site-generated traffic) showed that the roundabout at Robert Grant Avenue and Cope Drive would continue to operate with few delays and good LOS (LOS A), with the inclusion of the site-generated traffic. The signalized intersection at Robert Grant Avenue will continue to operate well, with some delays, and LOS B or better.

e) The internal intersection of Cope Drive at Rouncey Road is planned to be a roundabout. This intersection was analyzed as a single lane roundabout and was found to operate with good LOS (LOS A) with the proposed intersection configuration, and projected traffic volumes.

f) The new access intersection of Rouncey Road at Fernbank Road was analyzed as an unsignalized intersection with a stop control on the minor (southbound) leg. Left and right auxiliary turning lanes have been examined at this location. An eastbound right turn lane and a westbound left turn lane were found to be warranted. The access intersection was analyzed using the foregoing configuration. It was projected that the minor leg would operate with LOS F; however, this leg was shown to operate within theoretical capacity (i.e. v/c<1.0). A signal warrant was undertaken using the OTM Book 12 methodology. It was found that a traffic control signal was not warranted for either 2025 or 2030 total future conditions.

Upon approval of the traffic analysis contained herein, the following tasks will be undertaken:

- Functional design of the Cope Drive at Rouncey Road Roundabout
- Roadway Modification Approval for the intersection of Rouncey Road at Fernbank Road

It is anticipated that the study area intersections, with the noted mitigations measures, will operate acceptably. It is therefore recommended that, from a transportation perspective, the subject development be approved.

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Reviewed By

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Appendix A

Scope Email

Blackstone TIA TOR

Transportation Impact Study

Background Growth

- Please forward any available TIA's for nearby developments that should be considered in our analysis
- 2% background growth rate, due to the number of developments in the area.

Study Area

- Rouncey Road (Street 1) at Fernbank Road
- Rouncey Road (Street 1) at Cope Drive (Street 2)
- Cope Drive and Robert Grant Avenue

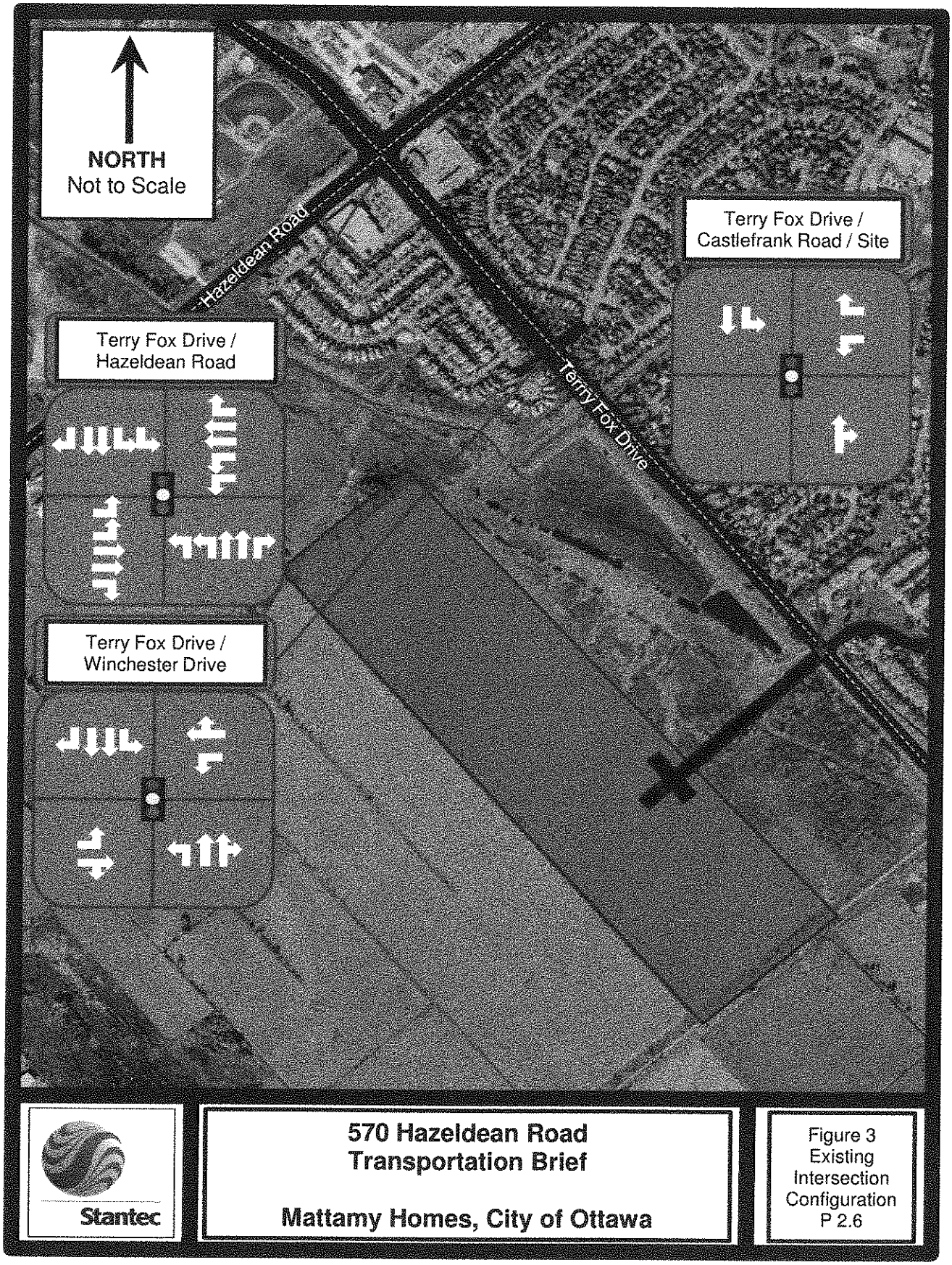
Horizons

- It is anticipated that all 5 Phases will be fully built-out by 2025. As a result, the following horizons will be examined:
    - 2017 Existing Conditions
    - 2025 Full Build-out
    - 2030 Full Build-out +5 years
- As this is a residential subdivision the AM / PM peak hours will be examined.

Transit and Active Modes should be included in the study.

Appendix B

Dawson Transportation Brief and Abbott Fernbank Phase 4



Stantec

570 Hazeldean Road
Transportation Brief

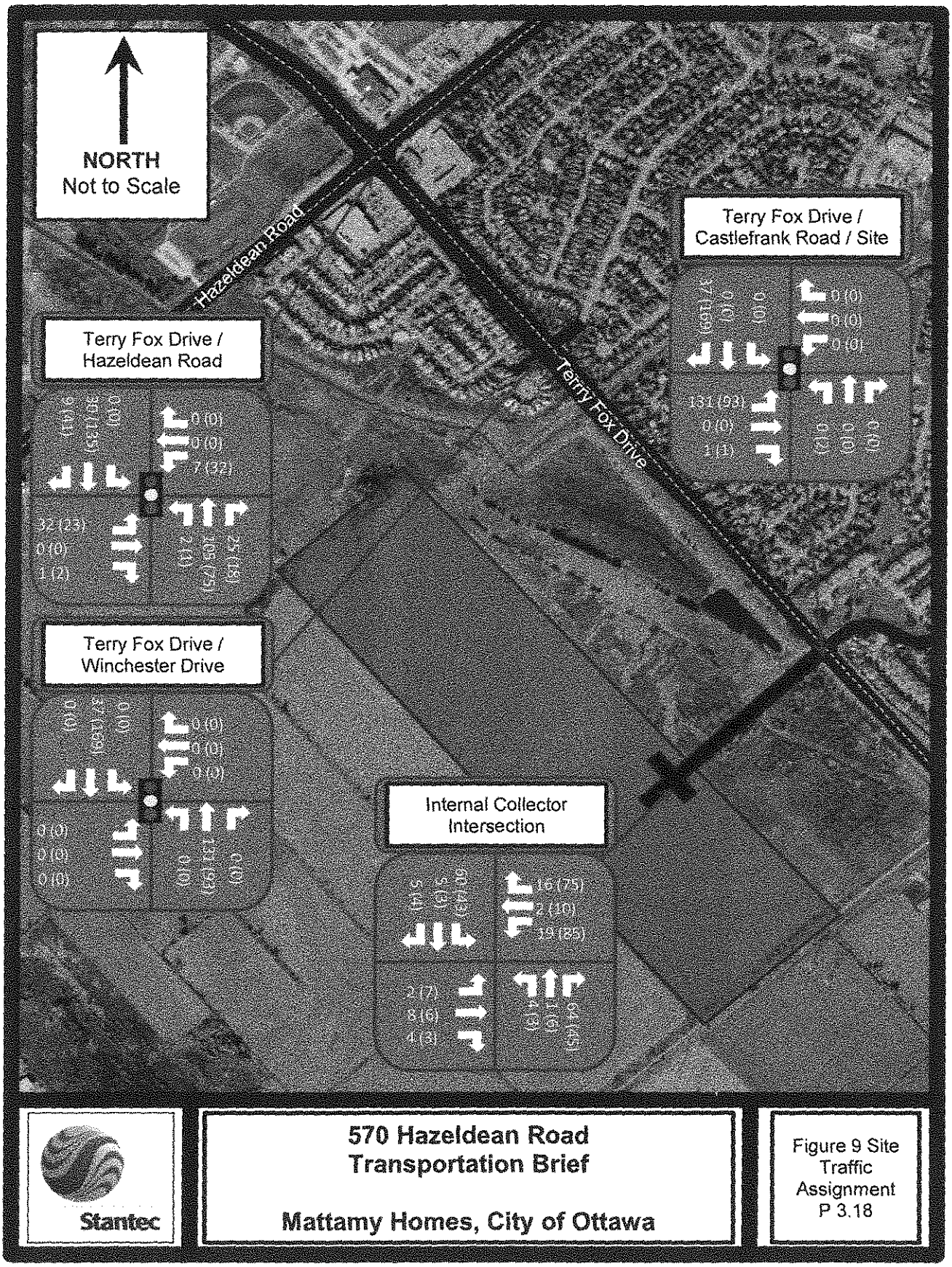
Mattamy Homes, City of Ottawa

Figure 3
Existing
Intersection
Configuration
P 2.6

570 Hazeldean Road
Transportation Brief

Mattamy Homes, City of Ottawa

Figure 7
Existing Traffic
P 2.11



Stantec

570 Hazeldean Road
Transportation Brief

Mattamy Homes, City of Ottawa

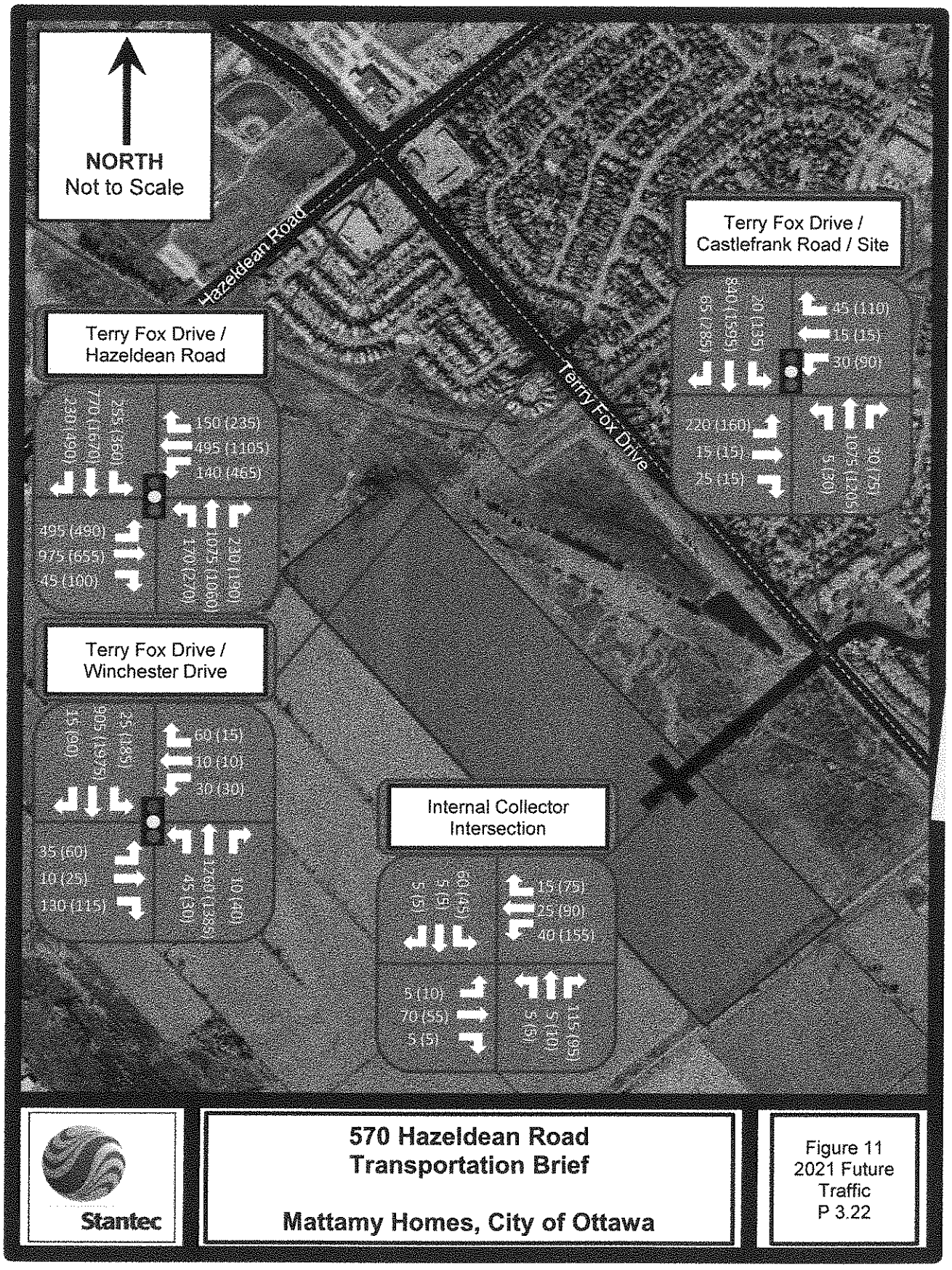
Figure 9 Site Traffic Assignment
P 3.18

Stantec

570 Hazeldean Road Transportation Brief

Mattamy Homes, City of Ottawa

Figure 10 2021 Future Background Traffic Volumes P 3.20

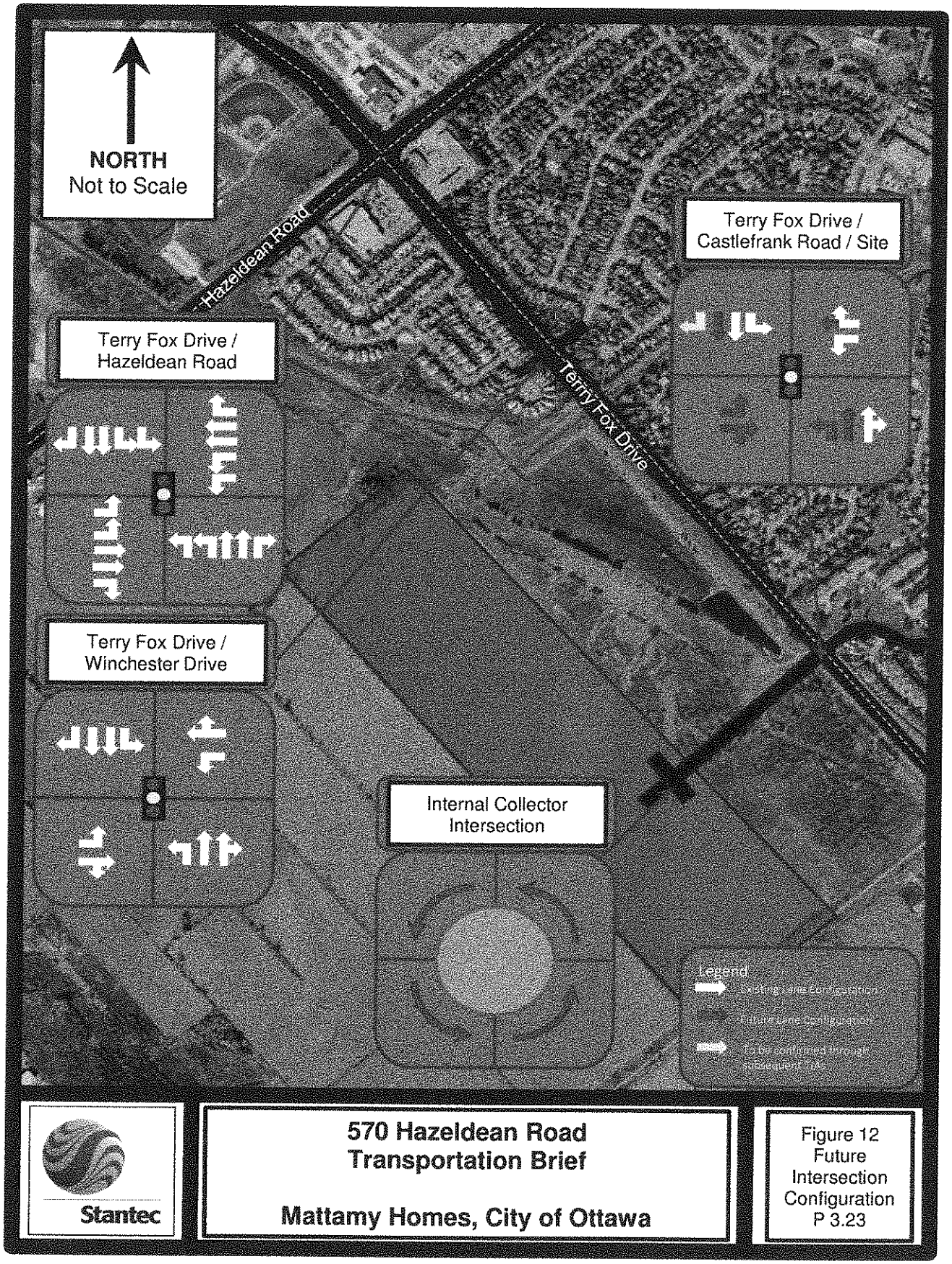


Stantec

570 Hazeldean Road
Transportation Brief

Mattamy Homes, City of Ottawa

Figure 11
2021 Future
Traffic
P 3.22



Stantec

570 Hazeldean Road
Transportation Brief

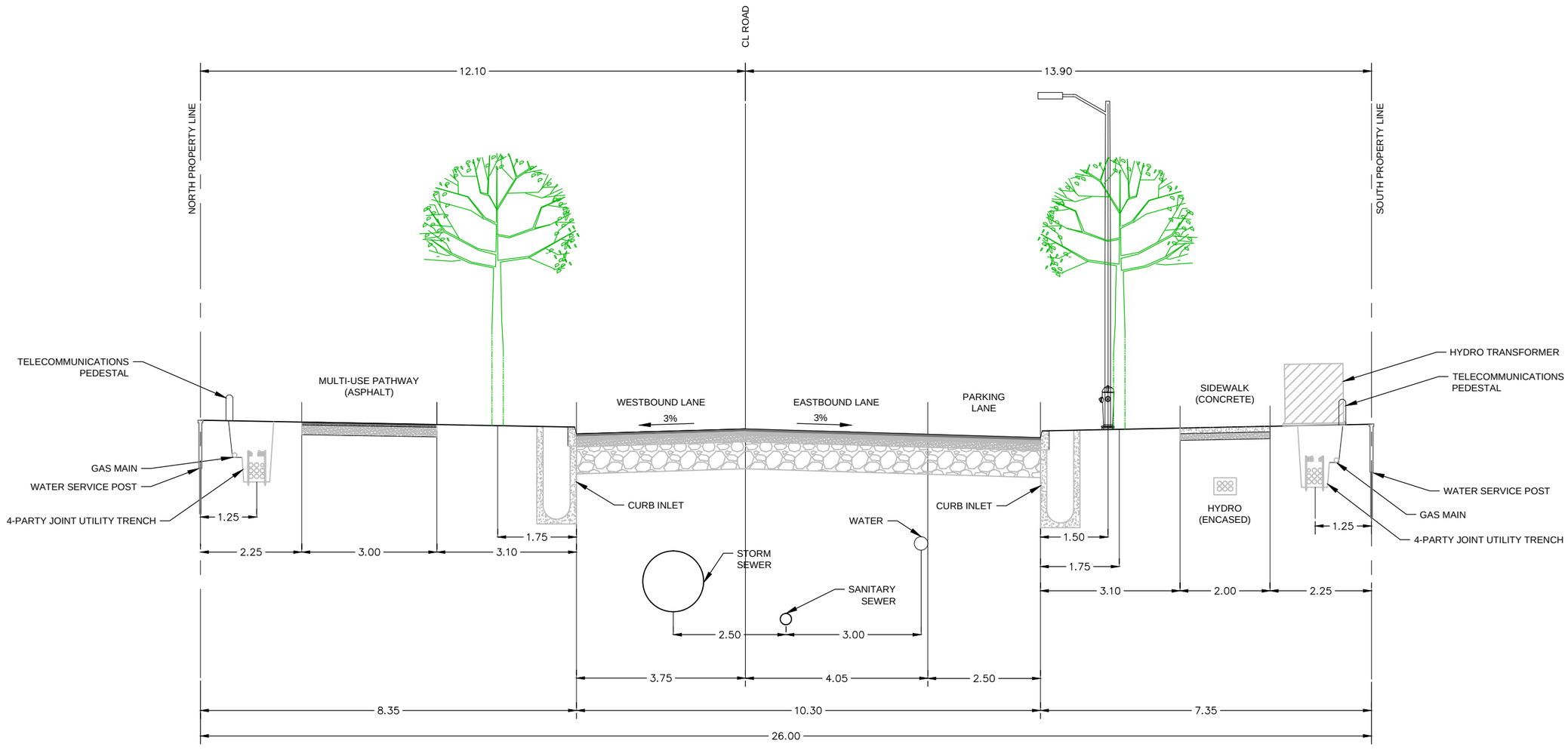
Mattamy Homes, City of Ottawa

Figure 12
Future
Intersection
Configuration
P 3.23

Appendix C

Cope Road Sample Cross-Section

COPE DRIVE - 26.0m ROW
CONCEPT 28A



NOVATECH ENGINEERING CONSULTANTS LTD.
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CITY of OTTAWA
FERNBANK CROSSING - COPE DRIVE

COPE DRIVE
CONCEPT SECTION 28A

SCALE	JOB	FIGURE
1 : 100	108180-10	DSK-28A
DATE: APRIL 17, 2015		

M:\2008\108180\CAD\figure\Design Sketch\DWG's\108180-DSK28A-Cope Drive Concept.dwg, DSK28A, Apr 17, 2015 - 4:31pm, dduflon

SHT11X17.DWG - 279mmX432mm

Appendix D

Traffic Data

Traffic Signal Timing

City of Ottawa, Transportation Services Department

Traffic Operations Unit

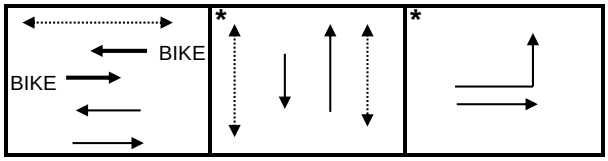
Intersection:	**Main:** Fernbank	**Side:** Robert Grant		
Controller:	**ATC 3**		**TSD:**	**6827**
Author:	Matthew Anderson		**Date:**	11-May-2017

Existing Timing Plans†

	Plan	**Ped Minimum Time**		
	All Day 2	***Walk***	***DW***	***A+R***
Cycle	Free			
Offset	X			
EB Thru	min = 52.2	-	-	4.6+1.6
WB Thru	min = 52.2	7	10	4.6+1.6
SB Thru	max = 20.0	7	17	3.3+2.7
WB Left	max = 26.2	-	-	4.6+1.6

Phasing Sequence‡

Plan: 2



Notes: 1) During the first 5 seconds of the westbound phase, vehicles receive a straight green arrow preventing them from turning right across the cycle track and crosswalk. After 5 seconds, westbound traffic receives a green ball display.

Schedule

All the time

Time	Plan
all	2

Notes

†: Time for each direction includes amber and all red intervals

‡: Start of first phase should be used as reference point for offset

Asterisk (*) Indicates actuated phase

(fp): Fully Protected Left Turn

◄·····► Pedestrian signal

Cost is $56.50 ($50 + HST)

Turning Movement Count
Summary, AM and PM Peak Hour Flow Diagrams

Automobiles, Taxis, Light Trucks, Vans, SUV's, Motorcycles, Heavy Trucks, Buses, and School Buses

Cope Drive & Robert Grant Avenue (Roundabout) — Stittsville, ON

All Vehicles
(Except Bicycles & Electric Scooters)

Ward:

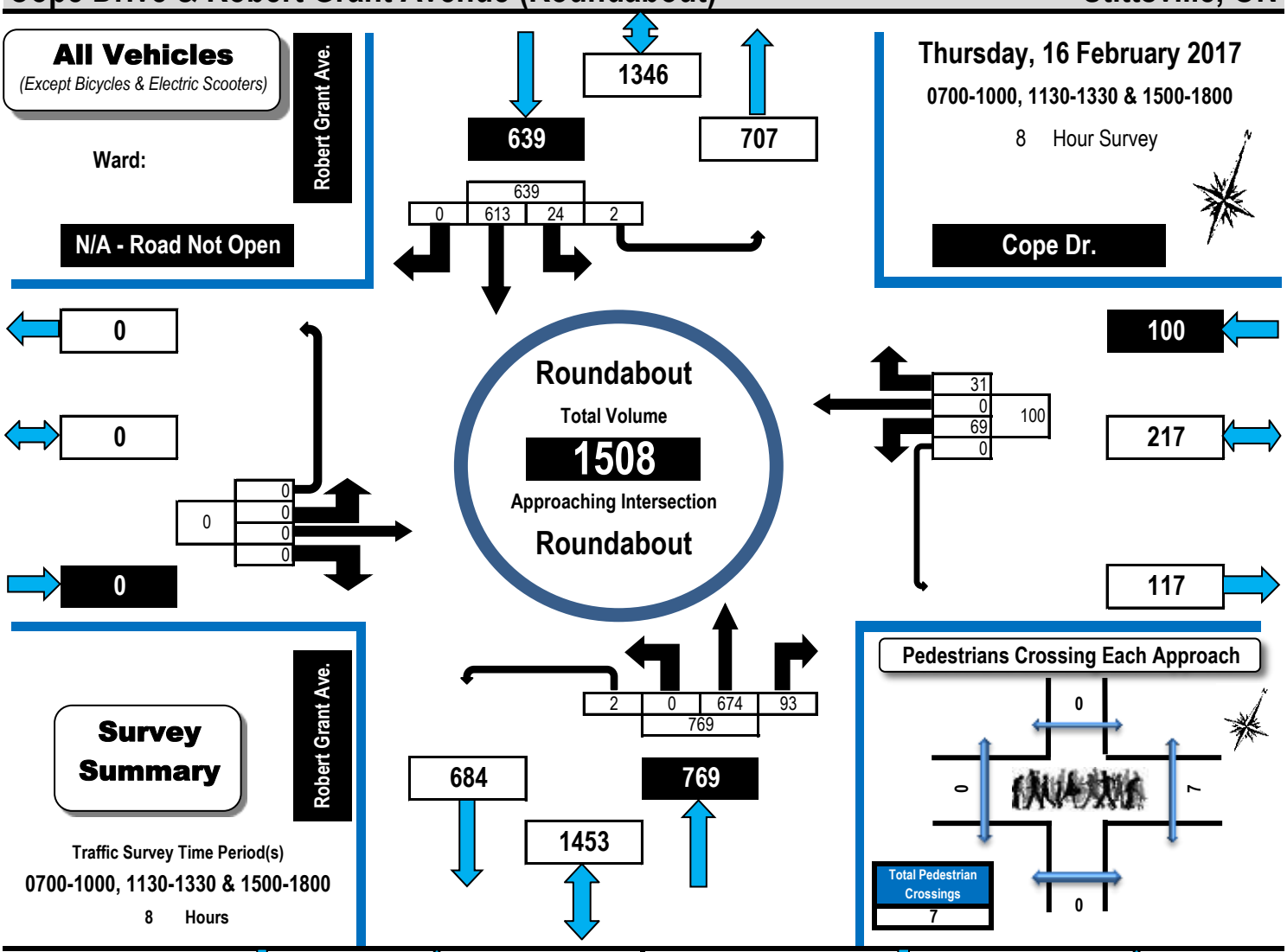
N/A - Road Not Open

Thursday, 16 February 2017

0700-1000, 1130-1330 & 1500-1800

8 Hour Survey

Cope Dr.



Survey Summary

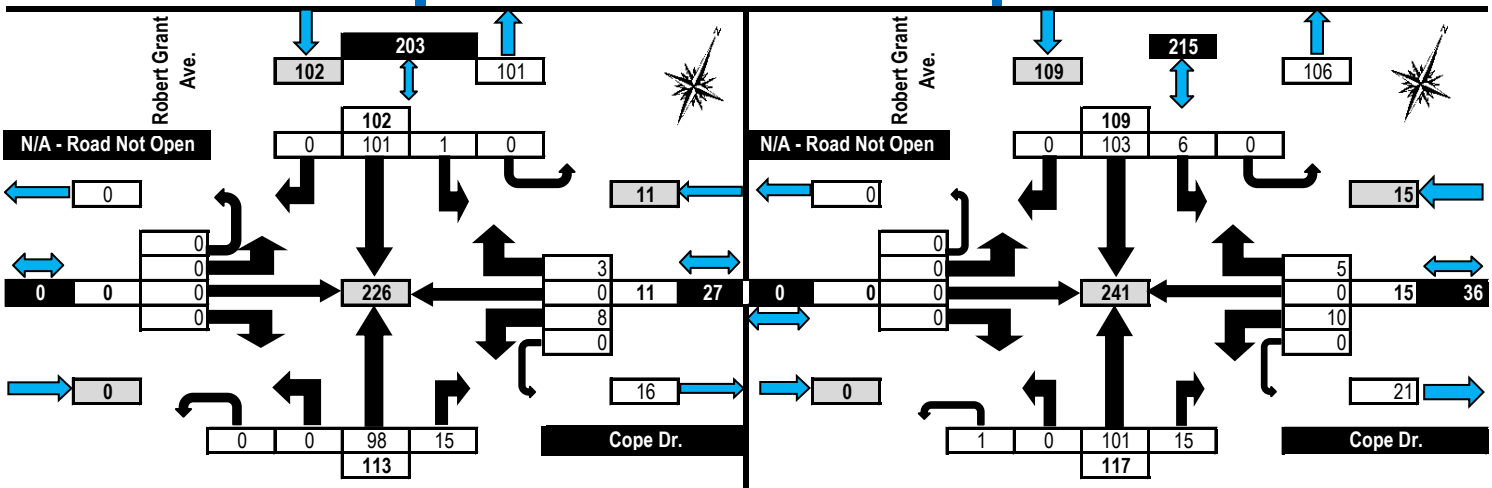
Traffic Survey Time Period(s)

0700-1000, 1130-1330 & 1500-1800

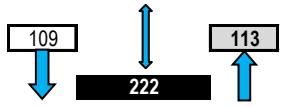
8 Hours

Pedestrians Crossing Each Approach

Total Pedestrian Crossings: 7



AM Peak Hour Summary



Robert Grant Ave.

Summary - AM Peak Hr.	
Peak Hr.	0815-0915
Volume	226
% of Total	15.0%
PHF	0.78

PM Peak Hour Summary

Robert Grant Ave.

Summary - PM Peak Hr.	
Peak Hr.	1630-1730
Volume	241
% of Total	16.0%
PHF	0.90

Turning Movement Count
Heavy Vehicle Summary
Flow Diagram

Heavy Trucks, Buses, and School Buses

Cope Drive & Robert Grant Avenue (Roundabout) — Stittsville, ON

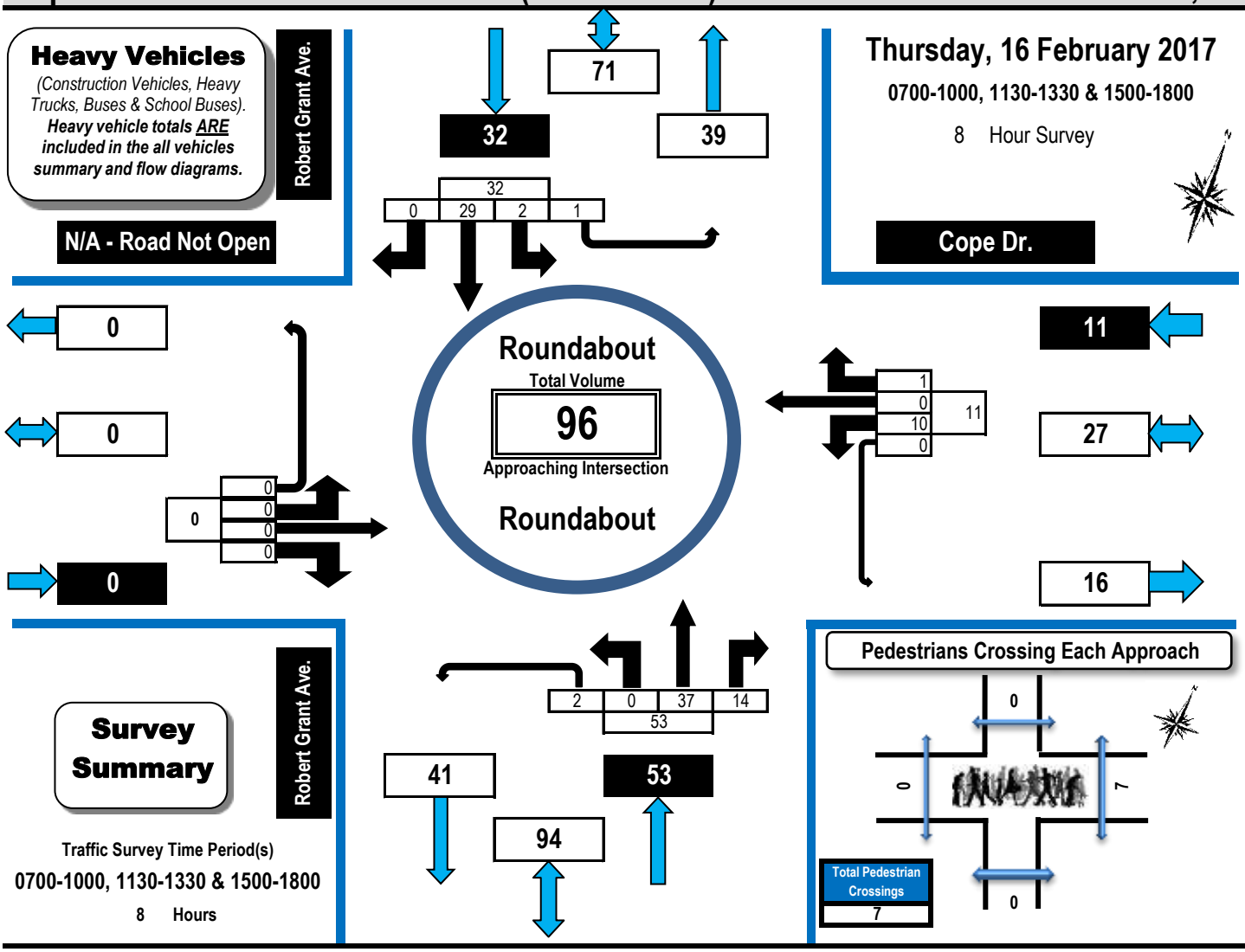
Heavy Vehicles
(Construction Vehicles, Heavy Trucks, Buses & School Buses).
Heavy vehicle totals ARE included in the all vehicles summary and flow diagrams.

Robert Grant Ave.

N/A - Road Not Open

Thursday, 16 February 2017
0700-1000, 1130-1330 & 1500-1800
8 Hour Survey

Cope Dr.



Robert Grant Ave.

Survey Summary

Traffic Survey Time Period(s)
0700-1000, 1130-1330 & 1500-1800
8 Hours

Pedestrians Crossing Each Approach

Total Pedestrian Crossings: 7

Cope Drive & Robert Grant Avenue (Roundabout) — Stittsville, ON

Survey Date: Thursday, 16 February 2017 **Start Time:** 0700
Weather: Overcast -9C am/-4C p **Survey Duration:** 8 Hrs. **Survey Hours:** 0700-1000, 1130-1330 & 1500-1800

	N/A - Road Not Open					Cope Dr.					Robert Grant Ave.					Robert Grant Ave.					
	Eastbound					Westbound					Northbound					Southbound					
Time Period	LT	ST	RT	UT	S. Tot	LT	ST	RT	UT	S. Tot	LT	ST	RT	UT	S. Tot	LT	ST	RT	UT	S. Tot	G.Tot.
0700-0800	0	0	0	0	0	3	0	0	0	3	0	1	2	0	3	0	3	0	0	3	9
0800-0900	0	0	0	0	0	1	0	0	0	1	0	3	3	0	6	0	3	0	1	4	11
0900-1000	0	0	0	0	0	0	0	0	0	0	0	11	1	0	12	2	9	0	0	11	23
1130-1230	0	0	0	0	0	2	0	0	0	2	0	5	1	0	6	0	3	0	0	3	11
1230-1330	0	0	0	0	0	0	0	1	0	1	0	2	2	1	5	0	2	0	0	2	8
1500-1600	0	0	0	0	0	0	0	0	0	0	0	7	0	0	7	0	6	0	0	6	13
1600-1700	0	0	0	0	0	1	0	0	0	1	0	7	3	0	10	0	3	0	0	3	14
1700-1800	0	0	0	0	0	3	0	0	0	3	0	1	2	1	4	0	0	0	0	0	7
Totals	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**1**	**0**	**11**	**0**	**37**	**14**	**2**	**53**	**2**	**29**	**0**	**1**	**32**	**96**

Turning Movement Count

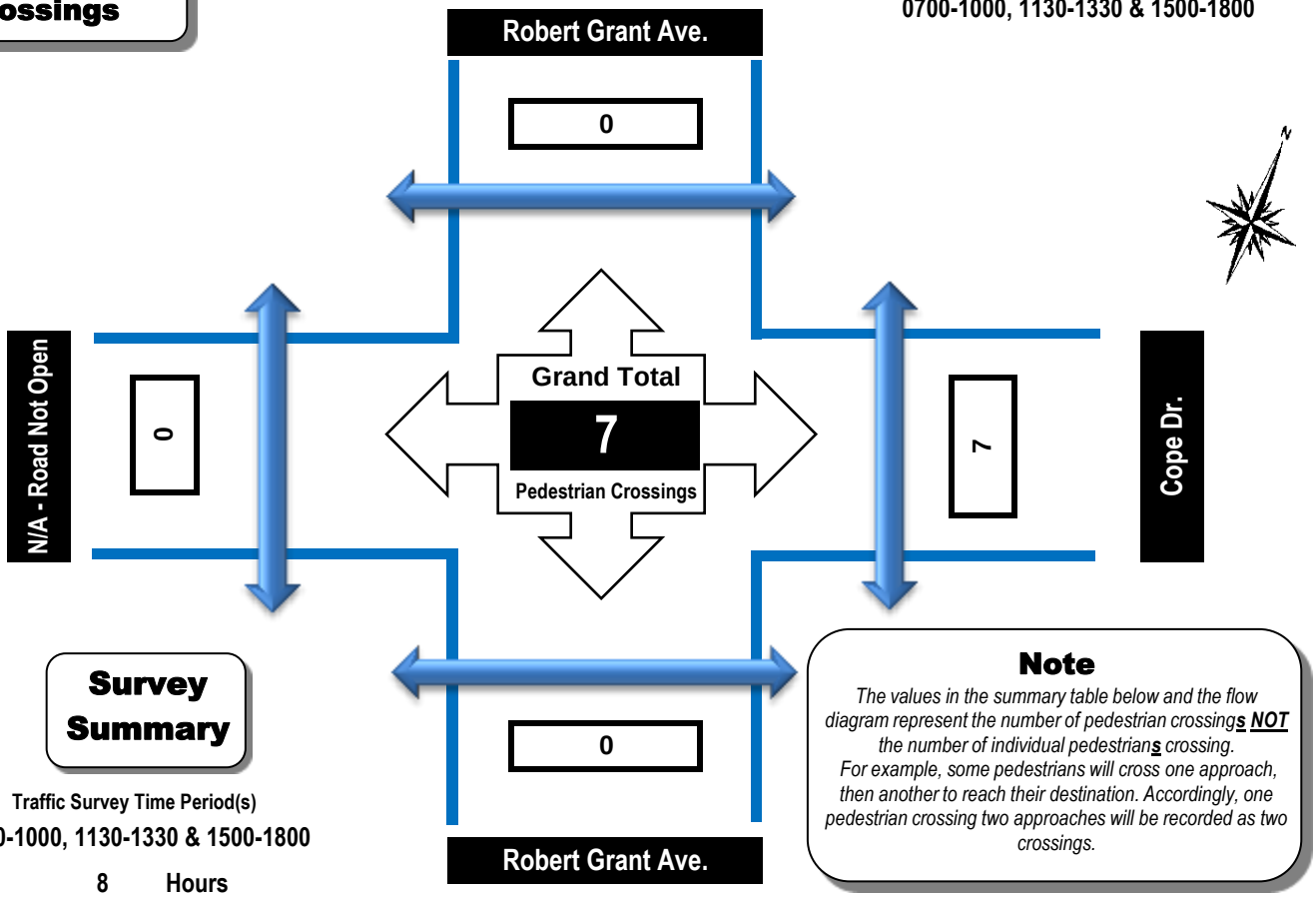
Pedestrian Crossings Summary and Flow Diagram

Cope Drive & Robert Grant Avenue (Roundabout) — Stittsville, ON

Pedestrian Crossings

Thursday, 16 February 2017

0700-1000, 1130-1330 & 1500-1800



Survey Summary

Traffic Survey Time Period(s)

0700-1000, 1130-1330 & 1500-1800

8 Hours

Note

*The values in the summary table below and the flow diagram represent the number of pedestrian crossing**s** **NOT** the number of individual pedestrian**s** crossing. For example, some pedestrians will cross one approach, then another to reach their destination. Accordingly, one pedestrian crossing two approaches will be recorded as two crossings.*

Cope Drive & Robert Grant Avenue (Roundabout) — Stittsville, ON

Survey Date: Thursday, 16 February 2017 **Start Time:** 0700

Weather: Overcast -9C am/-4C p **Survey Duration:** 8 Hrs. **Survey Hours:** 0700-1000, 1130-1330 & 1500-1800

Time Period	West Side Crossing N/A - Road Not Open	East Side Crossing Cope Dr.	Street Total	South Side Crossing Robert Grant Ave.	North Side Crossing Robert Grant Ave.	Street Total	Grand Total
0700-0800	0	0	0	0	0	0	0
0800-0900	0	0	0	0	0	0	0
0900-1000	0	0	0	0	0	0	0
1130-1230	0	0	0	0	0	0	0
1230-1330	0	1	1	0	0	0	1
1500-1600	0	4	4	0	0	0	4
1600-1700	0	2	2	0	0	0	2
1700-1800	0	0	0	0	0	0	0
Totals	0	7	7	0	0	0	7

Turning Movement Count

Summary Report Including AM/PM Peak Hours, PHF, AADT and Expansion Factors

Automobiles, Taxis, Light Trucks, Vans, SUV's, Motorcycles, Heavy Trucks, Buses, and School Buses

Cope Drive & Robert Grant Avenue (Roundabout) — Stittsville, ON

Survey Date: Thursday, 16 February 2017 **Start Time:** 0700 **AADT Factor:** 0.9

Weather: Overcast -9C am/-4C pm **Survey Duration:** 8 Hrs. **Survey Hours:** 0700-1000, 1130-1330 & 1500-1800

	N/A - Road Not Open					Cope Dr.						Robert Grant Ave.					Robert Grant Ave.						
	Eastbound					Westbound						Northbound					Southbound						
Time Period	LT	ST	RT	UT	E/B Tot	LT	ST	RT	UT	W/B Tot	Street Total	LT	ST	RT	UT	N/B Tot	LT	ST	RT	UT	S/B Tot	Street Total	Grand Total
0700-0800	0	0	0	0	**0**	8	0	3	0	**11**	**11**	0	83	8	0	**91**	2	67	0	1	**70**	**161**	**172**
0800-0900	0	0	0	0	**0**	5	0	3	0	**8**	**8**	0	99	19	0	**118**	0	90	0	0	**90**	**208**	**216**
0900-1000	0	0	0	0	**0**	14	0	4	0	**18**	**18**	0	86	13	0	**99**	3	54	0	0	**57**	**156**	**174**
1130-1230	0	0	0	0	**0**	8	0	7	0	**15**	**15**	0	65	8	0	**73**	5	59	0	0	**64**	**137**	**152**
1230-1330	0	0	0	0	**0**	11	0	3	0	**14**	**14**	0	56	10	1	**67**	3	46	0	0	**49**	**116**	**130**
1500-1600	0	0	0	0	**0**	10	0	4	0	**14**	**14**	0	92	7	0	**99**	3	105	0	1	**109**	**208**	**222**
1600-1700	0	0	0	0	**0**	4	0	5	0	**9**	**9**	0	104	13	0	**117**	6	99	0	0	**105**	**222**	**231**
1700-1800	0	0	0	0	**0**	9	0	2	0	**11**	**11**	0	89	15	1	**105**	2	93	0	0	**95**	**200**	**211**
Totals	**0**	**0**	**0**	**0**	**0**	**69**	**0**	**31**	**0**	**100**	**100**	**0**	**674**	**93**	**2**	**769**	**24**	**613**	**0**	**2**	**639**	**1408**	**1508**

Equivalent 12 & 24-hour Vehicle Volumes Including the Annual Average Daily Traffic (AADT) Factor Applicable to the Day and Month of the Turning Movement Count

➡ **Expansion factors are applied exclusively to standard weekday 8-hour turning movement counts** ⬅

Equivalent 12-hour vehicle volumes. These volumes are calculated by multiplying the 8-hour totals by the 8 ➡12 expansion factor of 1.39

Equ. 12 Hr	0	0	0	0	**0**	96	0	43	0	**139**	**139**	0	937	129	3	**1069**	33	852	0	3	**888**	**1957**	**2096**

Average daily 12-hour vehicle volumes. These volumes are calculated by multiplying the equivalent 12-hour totals by the AADT factor of: 0.9

AADT 12-hr	0	0	0	0	**0**	86	0	39	0	**125**	**125**	0	843	116	3	**962**	30	767	0	3	**799**	**1761**	**1887**

24-Hour AADT. These volumes are calculated by multiplying the average daily 12-hour vehicle volumes by the 12 ➡24 expansion factor of 1.31

AADT 24 Hr	0	0	0	0	**0**	113	0	51	0	**164**	**164**	0	1105	152	3	**1260**	39	1005	0	3	**1047**	**2307**	**2471**

AM Peak Hour Factor ➡ 0.78

AM Peak Hr	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	G.TOT
0815-0915	0	0	0	0	**0**	8	0	3	0	**11**	**11**	0	98	15	0	**113**	1	101	0	0	**102**	**215**	**226**

PM Peak Hour Factor ➡ 0.90

PM Peak Hr	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	G.TOT
1630-1730	0	0	0	0	**0**	10	0	5	0	**15**	**15**	0	101	15	1	**117**	6	103	0	0	**109**	**226**	**241**

Comments

Robert Grant Avenue is open between Fernbank Road and Abbott Street (East). Cope Drive and Bobolink Ridge are not open west of Robert Grant Avenue and Abbott Street (East) is not open east of Robert Grant Avenue. Additionally, Robert Grant Avenue is not open north of Abbott Street (East).

Notes:

1. Includes all vehicle types except bicycles and electric scooters.
2. Expansion factors are not applied to turning movement counts if they are less than 8-hours in duration.
3. When expansion and AADT factors are applied, the results will differ slightly due to rounding.

Disclaimer:

ACCURATE TRUSTED TRAFFIC DATA

Turning Movement Count
Summary, AM and PM Peak Hour Flow Diagrams

Automobiles, Taxis, Light Trucks, Vans, SUV's, Motorcycles, Heavy Trucks, Buses, and School Buses

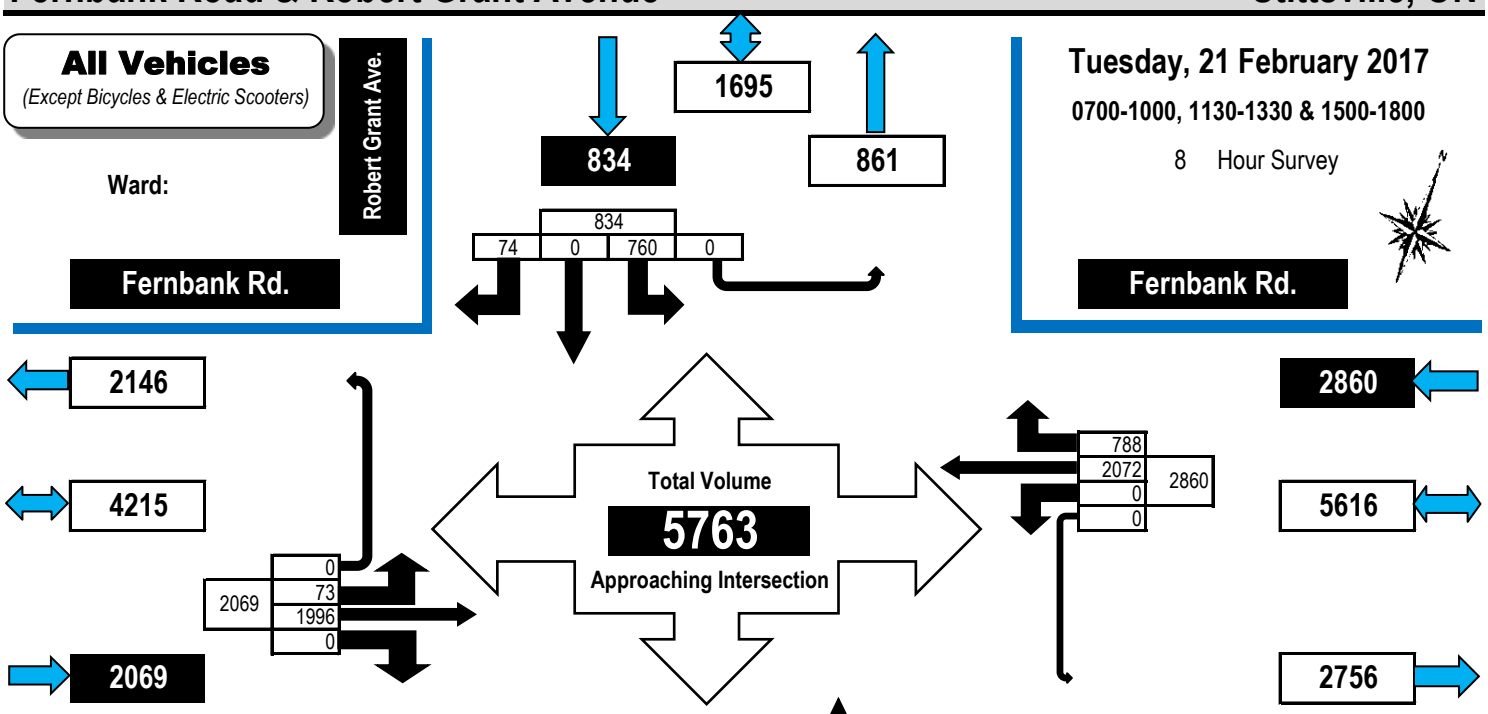
Fernbank Road & Robert Grant Avenue — Stittsville, ON

All Vehicles
(Except Bicycles & Electric Scooters)

Ward:

Robert Grant Ave.

Fernbank Rd.



Tuesday, 21 February 2017

0700-1000, 1130-1330 & 1500-1800

8 Hour Survey

Fernbank Rd.

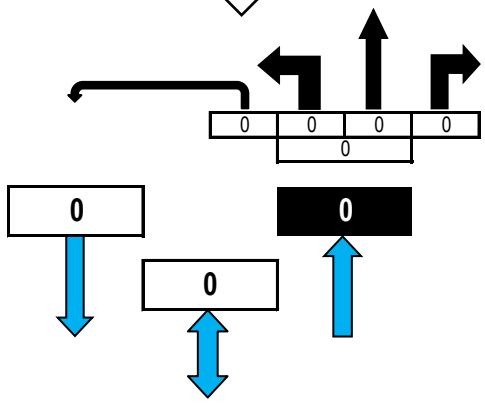
Survey Summary

N/A

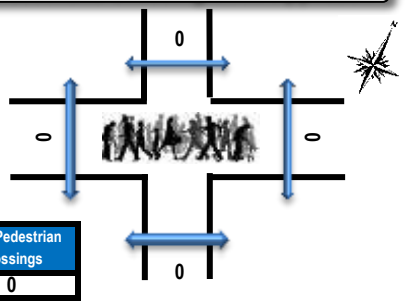
Traffic Survey Time Period(s)

0700-1000, 1130-1330 & 1500-1800

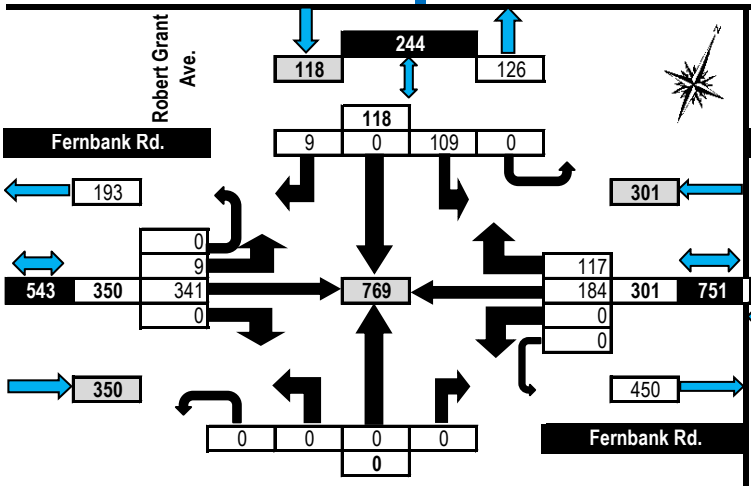
8 Hours

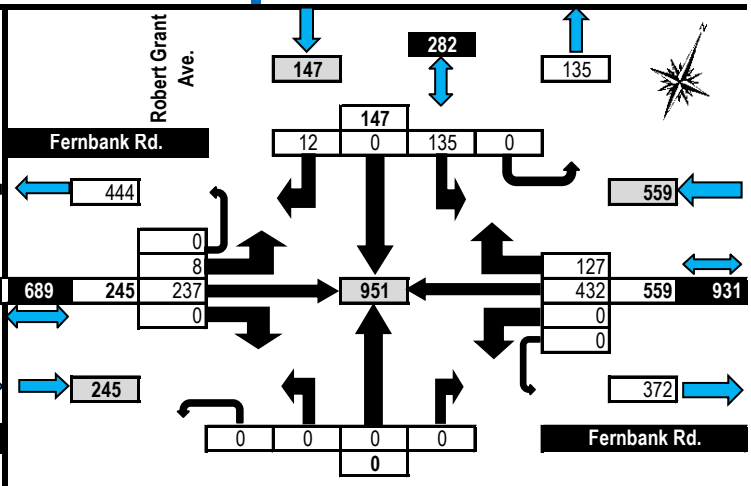


Pedestrians Crossing Each Approach



Total Pedestrian Crossings: 0





AM Peak Hour Summary

Summary - AM Peak Hr.	
Peak Hr.	0800-0900
Volume	769
% of Total	13.3%
PHF	0.89

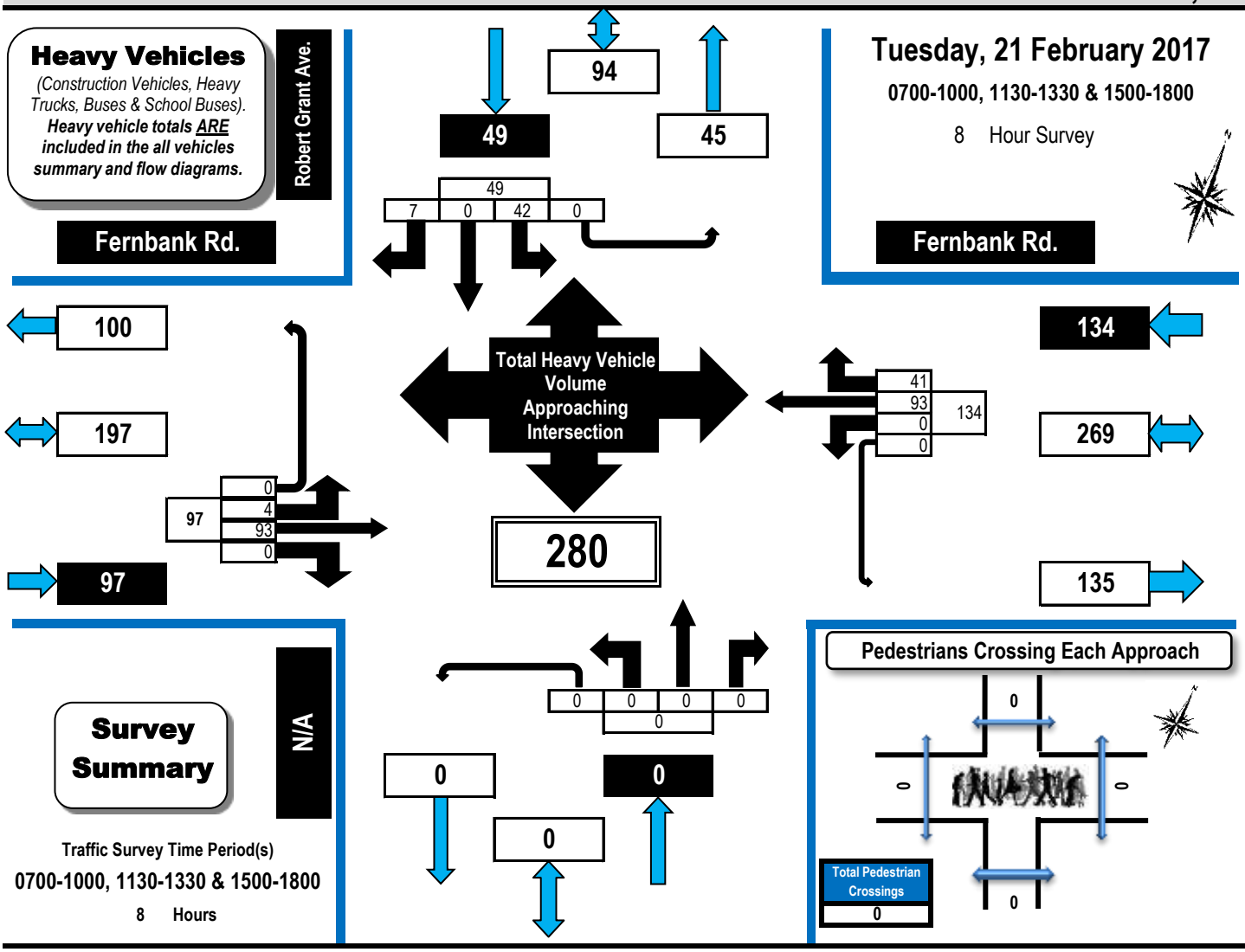
PM Peak Hour Summary

Summary - PM Peak Hr.	
Peak Hr.	1600-1700
Volume	951
% of Total	16.5%
PHF	0.94

Turning Movement Count
Heavy Vehicle Summary
Flow Diagram

Heavy Trucks, Buses, and School Buses

Fernbank Road & Robert Grant Avenue — Stittsville, ON



Fernbank Road & Robert Grant Avenue — Stittsville, ON

Survey Date: Tuesday, 21 February 2017 **Start Time:** 0700
Weather: Partly Cloudy/Overcast **Survey Duration:** 8 Hrs. **Survey Hours:** 0700-1000, 1130-1330 & 1500-1800

	Fernbank Rd. Eastbound					Fernbank Rd. Westbound					N/A Northbound					Robert Grant Ave. Southbound					
Time Period	LT	ST	RT	UT	S. Tot	LT	ST	RT	UT	S. Tot	LT	ST	RT	UT	S. Tot	LT	ST	RT	UT	S. Tot	G.Tot.
0700-0800	1	2	0	0	3	0	5	4	0	9	0	0	0	0	0	10	0	0	0	10	22
0800-0900	1	5	0	0	6	0	6	8	0	14	0	0	0	0	0	3	0	2	0	5	25
0900-1000	0	11	0	0	11	0	6	6	0	12	0	0	0	0	0	9	0	1	0	10	33
1130-1230	0	15	0	0	15	0	17	2	0	19	0	0	0	0	0	4	0	1	0	5	39
1230-1330	0	18	0	0	18	0	16	5	0	21	0	0	0	0	0	2	0	0	0	2	41
1500-1600	1	15	0	0	16	0	20	8	0	28	0	0	0	0	0	9	0	2	0	11	55
1600-1700	1	15	0	0	16	0	12	6	0	18	0	0	0	0	0	3	0	1	0	4	38
1700-1800	0	12	0	0	12	0	11	2	0	13	0	0	0	0	0	2	0	0	0	2	27
Totals	4	93	0	0	97	0	93	41	0	134	0	0	0	0	0	42	0	7	0	49	280

Turning Movement Count

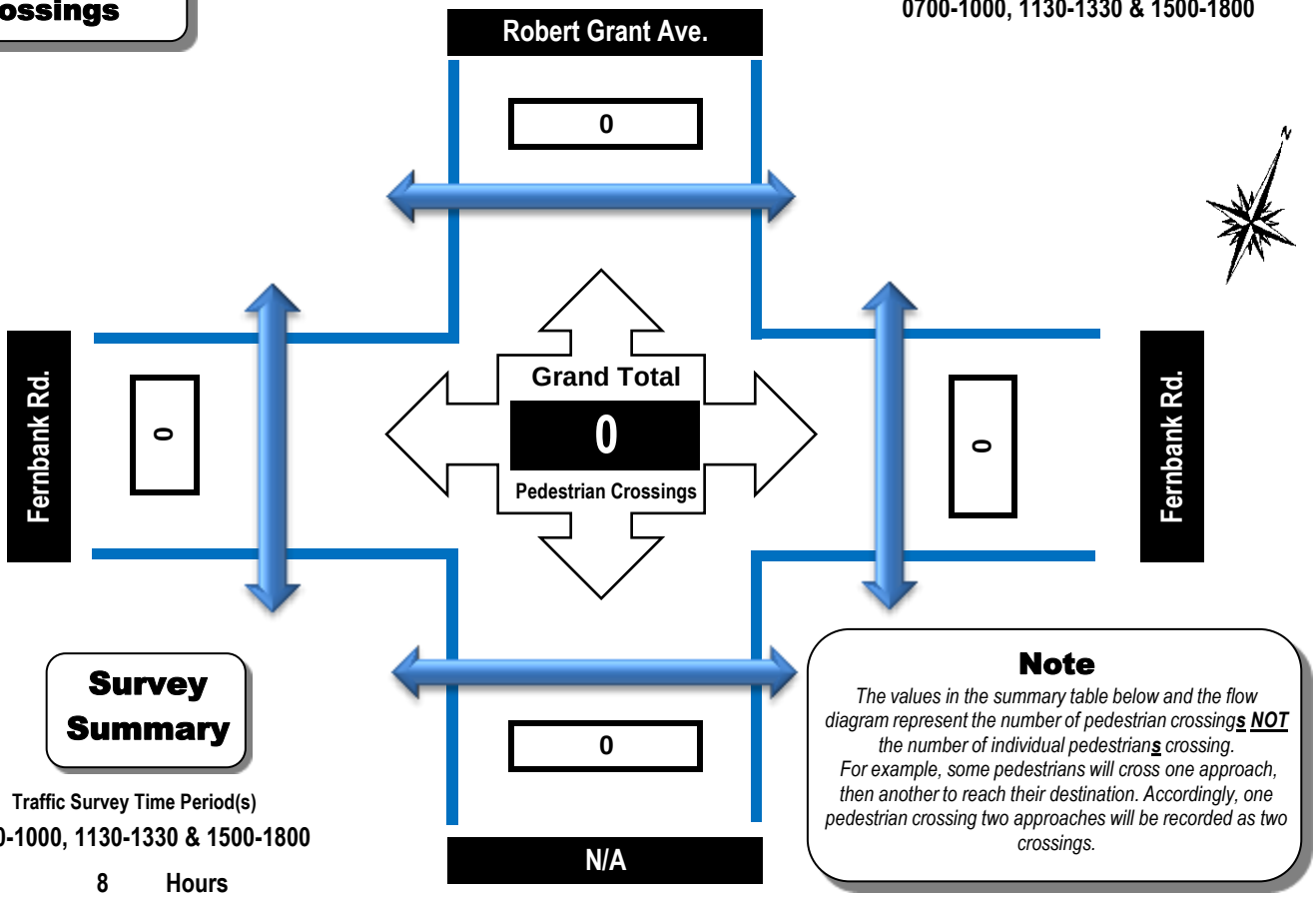
Pedestrian Crossings Summary and Flow Diagram

Fernbank Road & Robert Grant Avenue — Stittsville, ON

Pedestrian Crossings

Tuesday, 21 February 2017

0700-1000, 1130-1330 & 1500-1800



Survey Summary

Traffic Survey Time Period(s)

0700-1000, 1130-1330 & 1500-1800

8 Hours

Note

*The values in the summary table below and the flow diagram represent the number of pedestrian crossing**s** **NOT** the number of individual pedestrian**s** crossing. For example, some pedestrians will cross one approach, then another to reach their destination. Accordingly, one pedestrian crossing two approaches will be recorded as two crossings.*

Fernbank Road & Robert Grant Avenue — Stittsville, ON

Survey Date: Tuesday, 21 February 2017 **Start Time:** 0700

Weather: Partly Cloudy/Overcast **Survey Duration:** 8 Hrs. **Survey Hours:** 0700-1000, 1130-1330 & 1500-1800

Time Period	West Side Crossing Fernbank Rd.	East Side Crossing Fernbank Rd.	Street Total	South Side Crossing N/A	North Side Crossing Robert Grant Ave.	Street Total	Grand Total
0700-0800	0	0	0	0	0	0	0
0800-0900	0	0	0	0	0	0	0
0900-1000	0	0	0	0	0	0	0
1130-1230	0	0	0	0	0	0	0
1230-1330	0	0	0	0	0	0	0
1500-1600	0	0	0	0	0	0	0
1600-1700	0	0	0	0	0	0	0
1700-1800	0	0	0	0	0	0	0
Totals	0	0	0	0	0	0	0

No Pedestrians Observed

Turning Movement Count

Summary Report Including AM/PM Peak Hours, PHF, AADT and Expansion Factors

Automobiles, Taxis, Light Trucks, Vans, SUV's, Motorcycles, Heavy Trucks, Buses, and School Buses

Fernbank Road & Robert Grant Avenue — Stittsville, ON

Survey Date: Tuesday, 21 February 2017 **Start Time:** 0700 **AADT Factor:** 1.0

Weather: Partly Cloudy/Overcast **Survey Duration:** 8 Hrs. **Survey Hours:** 0700-1000, 1130-1330 & 1500-1800

	Fernbank Rd.					Fernbank Rd.						N/A					Robert Grant Ave.						
	Eastbound					Westbound						Northbound					Southbound						
Time Period	LT	ST	RT	UT	E/B Tot	LT	ST	RT	UT	W/B Tot	Street Total	LT	ST	RT	UT	N/B Tot	LT	ST	RT	UT	S/B Tot	Street Total	Grand Total
0700-0800	16	366	0	0	**382**	0	133	106	0	**239**	**621**	0	0	0	0	**0**	85	0	8	0	**93**	**93**	**714**
0800-0900	9	341	0	0	**350**	0	184	117	0	**301**	**651**	0	0	0	0	**0**	109	0	9	0	**118**	**118**	**769**
0900-1000	8	283	0	0	**291**	0	153	71	0	**224**	**515**	0	0	0	0	**0**	73	0	10	0	**83**	**83**	**598**
1130-1230	4	192	0	0	**196**	0	184	63	0	**247**	**443**	0	0	0	0	**0**	73	0	9	0	**82**	**82**	**525**
1230-1330	13	191	0	0	**204**	0	197	67	0	**264**	**468**	0	0	0	0	**0**	54	0	8	0	**62**	**62**	**530**
1500-1600	11	187	0	0	**198**	0	388	119	0	**507**	**705**	0	0	0	0	**0**	109	0	16	0	**125**	**125**	**830**
1600-1700	8	237	0	0	**245**	0	432	127	0	**559**	**804**	0	0	0	0	**0**	135	0	12	0	**147**	**147**	**951**
1700-1800	4	199	0	0	**203**	0	401	118	0	**519**	**722**	0	0	0	0	**0**	122	0	2	0	**124**	**124**	**846**
Totals	**73**	**1996**	**0**	**0**	**2069**	**0**	**2072**	**788**	**0**	**2860**	**4929**	**0**	**0**	**0**	**0**	**0**	**760**	**0**	**74**	**0**	**834**	**834**	**5763**

Equivalent 12 & 24-hour Vehicle Volumes Including the Annual Average Daily Traffic (AADT) Factor Applicable to the Day and Month of the Turning Movement Count

➡ **Expansion factors are applied exclusively to standard weekday 8-hour turning movement counts** ⬅

Equivalent 12-hour vehicle volumes. These volumes are calculated by multiplying the 8-hour totals by the 8 ➡12 expansion factor of 1.39

Equ. 12 Hr	101	2774	0	0	**2876**	0	2880	1095	0	**3975**	**6851**	0	0	0	0	**0**	1056	0	103	0	**1159**	**1159**	**8011**

Average daily 12-hour vehicle volumes. These volumes are calculated by multiplying the equivalent 12-hour totals by the AADT factor of: 1.0

AADT 12-hr	101	2774	0	0	**2876**	0	2880	1095	0	**3975**	**6851**	0	0	0	0	**0**	1056	0	103	0	**1159**	**1159**	**8011**

24-Hour AADT. These volumes are calculated by multiplying the average daily 12-hour vehicle volumes by the 12 ➡24 expansion factor of 1.31

AADT 24 Hr	133	3635	0	0	**3767**	0	3773	1435	0	**5208**	**8975**	0	0	0	0	**0**	1384	0	135	0	**1519**	**1519**	**10494**

AM Peak Hour Factor ➡ 0.89

AM Peak Hr	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	G.TOT
0800-0900	9	341	0	0	**350**	0	184	117	0	**301**	**651**	0	0	0	0	**0**	109	0	9	0	**118**	**118**	**769**

PM Peak Hour Factor ➡ 0.94

PM Peak Hr	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	LT	ST	RT	UT	TOT	LT	ST	RT	UT	TOT	S.TOT	G.TOT
1600-1700	8	237	0	0	**245**	0	432	127	0	**559**	**804**	0	0	0	0	**0**	135	0	12	0	**147**	**147**	**951**

Comments

Many of the heavy vehicles travelling eastbound and westbound on Fernbank Road are dump trucks involved in snow removal activity.

Notes:

1. Includes all vehicle types except bicycles and electric scooters.
2. Expansion factors are not applied to turning movement counts if they are less than 8-hours in duration.
3. When expansion and AADT factors are applied, the results will differ slightly due to rounding.

Disclaimer:

Appendix E

Existing Conditions Analysis

MOVEMENT SUMMARY

Site: Robert Grant at Cope - Existing AM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

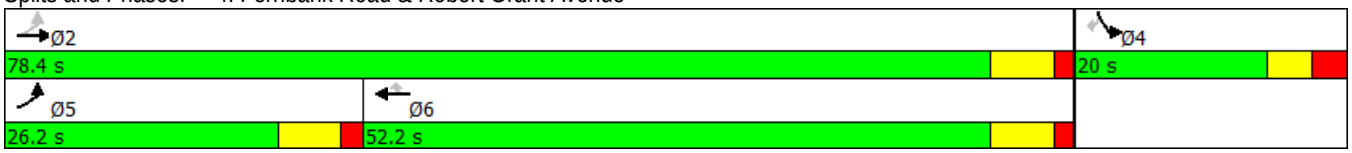
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3u	U	109	2.0	0.211	5.2	LOS A	0.9	6.7	0.02	0.00	52.9
8	T1	107	2.0	0.211	5.2	LOS A	0.9	6.7	0.02	0.00	47.4
18	R2	16	2.0	0.211	5.2	LOS A	0.9	6.7	0.02	0.00	46.2
Approach		232	2.0	0.211	5.2	LOS A	0.9	6.7	0.02	0.00	49.7
East: Cope Drive											
1	L2	9	2.0	0.016	4.2	LOS A	0.1	0.4	0.31	0.18	46.2
16	R2	5	2.0	0.016	4.2	LOS A	0.1	0.4	0.31	0.18	44.6
Approach		14	2.0	0.016	4.2	LOS A	0.1	0.4	0.31	0.18	45.6
North: Robert Grant Avenue											
7	L2	1	2.0	0.114	4.7	LOS A	0.4	3.2	0.24	0.14	48.0
4	T1	110	2.0	0.114	4.7	LOS A	0.4	3.2	0.24	0.14	47.5
Approach		111	2.0	0.114	4.7	LOS A	0.4	3.2	0.24	0.14	47.5
All Vehicles		357	2.0	0.211	5.0	LOS A	0.9	6.7	0.10	0.05	48.8

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	9	341	184	117	109	9
Future Volume (vph)	9	341	184	117	109	9
Lane Group Flow (vph)	9	359	194	123	115	9
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.2	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	20.3	22.2	21.7	21.7	9.8	9.8
Actuated g/C Ratio	0.50	0.55	0.54	0.54	0.24	0.24
v/c Ratio	0.02	0.37	0.20	0.14	0.28	0.02
Control Delay	6.7	9.2	9.9	3.5	16.0	9.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.7	9.2	9.9	3.5	16.0	9.1
LOS	A	A	A	A	B	A
Approach Delay		9.1	7.4		15.5	
Approach LOS		A	A		B	
Queue Length 50th (m)	0.3	16.3	7.0	0.0	5.6	0.0
Queue Length 95th (m)	1.8	31.9	26.4	8.4	19.4	2.7
Internal Link Dist (m)		162.8	354.5		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	892	1784	1766	1503	577	523
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.20	0.11	0.08	0.20	0.02

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 40.2	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.37	
Intersection Signal Delay: 9.4	Intersection LOS: A
Intersection Capacity Utilization 38.8%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue



MOVEMENT SUMMARY

Site: Robert Grant at Cope - Existing PM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
8	T1	110	2.0	0.115	4.3	LOS A	0.4	3.3	0.05	0.01	47.7
18	R2	16	2.0	0.115	4.3	LOS A	0.4	3.3	0.05	0.01	46.4
Approach		126	2.0	0.115	4.3	LOS A	0.4	3.3	0.05	0.01	47.6
East: Cope Drive											
1	L2	9	2.0	0.020	3.8	LOS A	0.1	0.5	0.22	0.10	46.9
16	R2	11	2.0	0.020	3.8	LOS A	0.1	0.5	0.22	0.10	45.2
Approach		20	2.0	0.020	3.8	LOS A	0.1	0.5	0.22	0.10	46.0
North: Robert Grant Avenue											
7	L2	7	2.0	0.109	4.2	LOS A	0.4	3.1	0.05	0.01	48.2
4	T1	112	2.0	0.109	4.2	LOS A	0.4	3.1	0.05	0.01	47.6
Approach		118	2.0	0.109	4.2	LOS A	0.4	3.1	0.05	0.01	47.6
All Vehicles		264	2.0	0.115	4.2	LOS A	0.4	3.3	0.06	0.02	47.5

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	8	237	432	127	135	12
Future Volume (vph)	8	237	432	127	135	12
Lane Group Flow (vph)	8	249	455	134	142	13
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	10.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.6	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	24.2	26.3	25.9	25.9	10.7	10.7
Actuated g/C Ratio	0.53	0.58	0.57	0.57	0.24	0.24
v/c Ratio	0.01	0.24	0.45	0.15	0.35	0.04
Control Delay	6.0	7.6	11.5	2.9	21.3	11.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.0	7.6	11.5	2.9	21.3	11.8
LOS	A	A	B	A	C	B
Approach Delay		7.6	9.5		20.5	
Approach LOS		A	A		C	
Queue Length 50th (m)	0.3	10.5	19.6	0.0	7.6	0.0
Queue Length 95th (m)	1.7	22.0	72.7	8.5	33.9	4.3
Internal Link Dist (m)		162.8	354.5		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	834	1772	1655	1417	539	491
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.14	0.27	0.09	0.26	0.03

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 45.3	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.45	
Intersection Signal Delay: 10.7	Intersection LOS: B
Intersection Capacity Utilization 42.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Appendix F

Site Trip Generation

Trip Generation

Total Site Vehicle Trip Generation

Travel Mode	AM Peak (veh/hr)			PM Peak (veh/hr)		
	In	Out	Total	In	Out	Total
Single-Family Detached Housing (NE) Trip Generation	17	53	70	57	34	91
Residential Condominium / Townhouse (NE) Trip Generation	6	32	38	29	15	44
High School (SE) Trip Generation	437	206	643	92	104	196
Elementary School (SW) Trip Generation	126	103	229	38	39	77
Single-Family Detached Housing (NW) Trip Generation	12	35	47	38	23	61
Residential Condominium / Townhouse (NW) Trip Generation	5	24	29	22	12	34
Single-Family Detached Housing (SE) Trip Generation	12	35	47	38	23	61
Residential Condominium / Townhouse (SE) Trip Generation	2	9	11	8	5	13
Single-Family Detached Housing (SW) Trip Generation	25	76	101	83	50	133
Residential Condominium / Townhouse (SW) Trip Generation	12	59	71	56	28	84
Residential Condominium Block (SE) Trip Generation	12	51	63	53	29	82
Single-Family Detached Housing (NE) Pass-by (0%)	0	0	0	0	0	0
Residential Condominium / Townhouse (NE) Pass-by (0%)	0	0	0	0	0	0
High School (SE) Pass-by (0%)	0	0	0	0	0	0
Elementary School (SW) Pass-by (0%)	0	0	0	0	0	0
Single-Family Detached Housing (NW) Pass-by (0%)	0	0	0	0	0	0
Residential Condominium / Townhouse (NW) Pass-by (0%)	0	0	0	0	0	0
Single-Family Detached Housing (SE) Pass-by (0%)	0	0	0	0	0	0
Residential Condominium / Townhouse (SE) Pass-by (0%)	0	0	0	0	0	0
Single-Family Detached Housing (SW) Pass-by (0%)	0	0	0	0	0	0
Residential Condominium / Townhouse (SW) Pass-by (0%)	0	0	0	0	0	0
Residential Condominium Block (SE) Pass-by (0%)	0	0	0	0	0	0
Multi-purpose Trips (0%)	0	0	0	0	0	0
Total 'New' Auto Trips	**666**	**683**	**1,349**	**514**	**362**	**876**

Appendix G

2025 Future Background Analysis

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	11	400	216	137	128	11
Future Volume (vph)	11	400	216	137	128	11
Lane Group Flow (vph)	12	421	227	144	135	12
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	15.6	23.2	16.2	16.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.0	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	6.5	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	20.7	22.0	21.7	21.7	10.0	10.0
Actuated g/C Ratio	0.51	0.55	0.54	0.54	0.25	0.25
v/c Ratio	0.02	0.43	0.24	0.16	0.32	0.03
Control Delay	6.5	10.0	10.0	3.3	16.7	8.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.5	10.0	10.0	3.3	16.7	8.9
LOS	A	A	A	A	B	A
Approach Delay		9.9	7.4		16.1	
Approach LOS		A	A		B	
Queue Length 50th (m)	0.4	20.0	8.3	0.0	6.5	0.0
Queue Length 95th (m)	2.2	40.4	31.0	9.0	23.0	3.1
Internal Link Dist (m)		162.8	354.5		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	908	1784	1746	1488	578	525
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.24	0.13	0.10	0.23	0.02

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 40.2	
Natural Cycle: 65	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.43	
Intersection Signal Delay: 9.9	Intersection LOS: A
Intersection Capacity Utilization 42.1%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	9	278	506	149	158	14
Future Volume (vph)	9	278	506	149	158	14
Lane Group Flow (vph)	9	293	533	157	166	15
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.2	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	25.2	25.2	25.5	25.5	11.2	11.2
Actuated g/C Ratio	0.50	0.50	0.50	0.50	0.22	0.22
v/c Ratio	0.03	0.33	0.60	0.19	0.45	0.04
Control Delay	6.2	8.6	13.3	2.5	23.6	11.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.2	8.6	13.3	2.5	23.6	11.7
LOS	A	A	B	A	C	B
Approach Delay		8.6	10.9		22.6	
Approach LOS		A	B		C	
Queue Length 50th (m)	0.4	13.3	25.7	0.0	10.0	0.0
Queue Length 95th (m)	1.8	26.0	81.1	8.3	39.6	4.6
Internal Link Dist (m)		162.8	354.5		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	716	1767	1636	1404	464	426
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.17	0.33	0.11	0.36	0.04

Intersection Summary			
Cycle Length: 98.4			
Actuated Cycle Length: 50.8			
Natural Cycle: 100			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.60			
Intersection Signal Delay: 12.1		Intersection LOS: B	
Intersection Capacity Utilization 47.2%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2025 FB AM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.177	5.3	LOS A	0.7	5.3	0.25	0.14	47.4
8	T1	143	2.0	0.177	5.3	LOS A	0.7	5.3	0.25	0.14	46.9
18	R2	20	2.0	0.177	5.3	LOS A	0.7	5.3	0.25	0.14	45.7
Approach		174	2.0	0.177	5.3	LOS A	0.7	5.3	0.25	0.14	46.8
East: Cope Drive											
1	L2	10	2.0	0.122	5.0	LOS A	0.4	3.4	0.30	0.19	47.4
6	T1	26	2.0	0.122	5.0	LOS A	0.4	3.4	0.30	0.19	46.8
16	R2	77	2.0	0.122	5.0	LOS A	0.4	3.4	0.30	0.19	45.6
Approach		113	2.0	0.122	5.0	LOS A	0.4	3.4	0.30	0.19	46.0
North: Robert Grant Avenue											
7	L2	68	2.0	0.203	5.3	LOS A	0.8	6.3	0.16	0.07	46.6
4	T1	134	2.0	0.203	5.3	LOS A	0.8	6.3	0.16	0.07	46.1
14	R2	11	2.0	0.203	5.3	LOS A	0.8	6.3	0.16	0.07	44.9
Approach		213	2.0	0.203	5.3	LOS A	0.8	6.3	0.16	0.07	46.2
West: Cope Drive											
5	L2	11	2.0	0.059	4.6	LOS A	0.2	1.5	0.32	0.21	47.4
2	T1	30	2.0	0.059	4.6	LOS A	0.2	1.5	0.32	0.21	46.8
12	R2	11	2.0	0.059	4.6	LOS A	0.2	1.5	0.32	0.21	45.6
Approach		52	2.0	0.059	4.6	LOS A	0.2	1.5	0.32	0.21	46.7
All Vehicles		552	2.0	0.203	5.2	LOS A	0.8	6.3	0.23	0.13	46.4

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2025 FB PM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.164	5.0	LOS A	0.6	4.9	0.18	0.08	47.6
8	T1	139	2.0	0.164	5.0	LOS A	0.6	4.9	0.18	0.08	47.1
18	R2	20	2.0	0.164	5.0	LOS A	0.6	4.9	0.18	0.08	45.9
Approach		170	2.0	0.164	5.0	LOS A	0.6	4.9	0.18	0.08	47.0
East: Cope Drive											
1	L2	13	2.0	0.071	4.5	LOS A	0.2	1.9	0.28	0.17	47.3
6	T1	10	2.0	0.071	4.5	LOS A	0.2	1.9	0.28	0.17	46.8
16	R2	43	2.0	0.071	4.5	LOS A	0.2	1.9	0.28	0.17	45.5
Approach		66	2.0	0.071	4.5	LOS A	0.2	1.9	0.28	0.17	46.1
North: Robert Grant Avenue											
7	L2	43	2.0	0.192	5.2	LOS A	0.8	5.9	0.13	0.05	47.1
4	T1	150	2.0	0.192	5.2	LOS A	0.8	5.9	0.13	0.05	46.6
14	R2	11	2.0	0.192	5.2	LOS A	0.8	5.9	0.13	0.05	45.4
Approach		204	2.0	0.192	5.2	LOS A	0.8	5.9	0.13	0.05	46.6
West: Cope Drive											
5	L2	11	2.0	0.034	4.4	LOS A	0.1	0.9	0.31	0.19	47.0
2	T1	9	2.0	0.034	4.4	LOS A	0.1	0.9	0.31	0.19	46.5
12	R2	11	2.0	0.034	4.4	LOS A	0.1	0.9	0.31	0.19	45.3
Approach		30	2.0	0.034	4.4	LOS A	0.1	0.9	0.31	0.19	46.2
All Vehicles		471	2.0	0.192	5.0	LOS A	0.8	5.9	0.18	0.09	46.6

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Appendix H

2025 Total Future Analysis

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2025 FT AM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.185	5.6	LOS A	0.7	5.5	0.29	0.18	47.3
8	T1	143	2.0	0.185	5.6	LOS A	0.7	5.5	0.29	0.18	46.8
18	R2	22	2.0	0.185	5.6	LOS A	0.7	5.5	0.29	0.18	45.5
Approach		176	2.0	0.185	5.6	LOS A	0.7	5.5	0.29	0.18	46.6
East: Cope Drive											
1	L2	17	2.0	0.164	5.5	LOS A	0.6	4.7	0.31	0.20	47.0
6	T1	26	2.0	0.164	5.5	LOS A	0.6	4.7	0.31	0.20	46.5
16	R2	109	2.0	0.164	5.5	LOS A	0.6	4.7	0.31	0.20	45.2
Approach		152	2.0	0.164	5.5	LOS A	0.6	4.7	0.31	0.20	45.6
North: Robert Grant Avenue											
7	L2	102	2.0	0.237	5.7	LOS A	1.0	7.7	0.18	0.08	46.1
4	T1	134	2.0	0.237	5.7	LOS A	1.0	7.7	0.18	0.08	45.6
14	R2	11	2.0	0.237	5.7	LOS A	1.0	7.7	0.18	0.08	44.5
Approach		247	2.0	0.237	5.7	LOS A	1.0	7.7	0.18	0.08	45.8
West: Cope Drive											
5	L2	11	2.0	0.061	4.8	LOS A	0.2	1.6	0.35	0.24	47.2
2	T1	30	2.0	0.061	4.8	LOS A	0.2	1.6	0.35	0.24	46.7
12	R2	11	2.0	0.061	4.8	LOS A	0.2	1.6	0.35	0.24	45.5
Approach		52	2.0	0.061	4.8	LOS A	0.2	1.6	0.35	0.24	46.6
All Vehicles		627	2.0	0.237	5.5	LOS A	1.0	7.7	0.26	0.15	46.0

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Rouncey at Cope - 2025 FT AM

New intersection at Rouncey Road and Cope Road
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Rouncey Road											
3	L2	14	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	45.5
8	T1	248	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	45.0
18	R2	62	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	43.9
Approach		324	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	44.8
East: Cope Drive											
1	L2	70	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	45.4
6	T1	64	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	44.9
16	R2	61	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	43.7
Approach		195	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	44.7
North: Rouncey Road											
7	L2	105	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	44.8
4	T1	272	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	44.3
14	R2	38	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	43.2
Approach		415	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	44.4
West: Cope Drive											
5	L2	59	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	45.0
2	T1	91	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	44.5
12	R2	26	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	43.4
Approach		176	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	44.5
All Vehicles		1110	2.0	0.439	8.5	LOS A	2.3	17.4	0.45	0.37	44.6

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	13	479	279	137	132	14
Future Volume (vph)	13	479	279	137	132	14
Lane Group Flow (vph)	14	504	294	144	139	15
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.2	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.0	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	6.5	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	23.0	24.2	24.0	24.0	10.1	10.1
Actuated g/C Ratio	0.54	0.57	0.56	0.56	0.24	0.24
v/c Ratio	0.03	0.50	0.29	0.16	0.35	0.04
Control Delay	6.2	10.4	9.9	3.1	18.5	9.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.2	10.4	9.9	3.1	18.5	9.4
LOS	A	B	A	A	B	A
Approach Delay		10.3	7.7		17.6	
Approach LOS		B	A		B	
Queue Length 50th (m)	0.5	25.4	11.2	0.0	7.5	0.0
Queue Length 95th (m)	2.5	51.8	40.7	8.9	25.3	3.7
Internal Link Dist (m)		162.8	732.9		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	875	1784	1723	1470	547	500
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.28	0.17	0.10	0.25	0.03

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 42.5	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.50	
Intersection Signal Delay: 10.3	Intersection LOS: B
Intersection Capacity Utilization 46.4%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	70	560	376	150	114	50
Future Volume (Veh/h)	70	560	376	150	114	50
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	74	589	396	158	120	53
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	554				1133	396
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	554				1133	396
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	93				42	92
cM capacity (veh/h)	1016				208	653

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	74	589	396	158	173
Volume Left	74	0	0	0	120
Volume Right	0	0	0	158	53
cSH	1016	1700	1700	1700	263
Volume to Capacity	0.07	0.35	0.23	0.09	0.66
Queue Length 95th (m)	1.8	0.0	0.0	0.0	31.9
Control Delay (s)	8.8	0.0	0.0	0.0	41.6
Lane LOS	A				E
Approach Delay (s)	1.0		0.0		41.6
Approach LOS					E

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2025 FT PM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.176	5.2	LOS A	0.7	5.3	0.22	0.11	47.5
8	T1	139	2.0	0.176	5.2	LOS A	0.7	5.3	0.22	0.11	47.0
18	R2	27	2.0	0.176	5.2	LOS A	0.7	5.3	0.22	0.11	45.7
Approach		177	2.0	0.176	5.2	LOS A	0.7	5.3	0.22	0.11	46.8
East: Cope Drive											
1	L2	16	2.0	0.091	4.7	LOS A	0.3	2.5	0.28	0.17	47.2
6	T1	10	2.0	0.091	4.7	LOS A	0.3	2.5	0.28	0.17	46.7
16	R2	59	2.0	0.091	4.7	LOS A	0.3	2.5	0.28	0.17	45.4
Approach		85	2.0	0.091	4.7	LOS A	0.3	2.5	0.28	0.17	45.9
North: Robert Grant Avenue											
7	L2	66	2.0	0.215	5.4	LOS A	0.9	6.8	0.14	0.05	46.7
4	T1	150	2.0	0.215	5.4	LOS A	0.9	6.8	0.14	0.05	46.2
14	R2	11	2.0	0.215	5.4	LOS A	0.9	6.8	0.14	0.05	45.0
Approach		227	2.0	0.215	5.4	LOS A	0.9	6.8	0.14	0.05	46.3
West: Cope Drive											
5	L2	11	2.0	0.035	4.5	LOS A	0.1	0.9	0.33	0.21	46.9
2	T1	9	2.0	0.035	4.5	LOS A	0.1	0.9	0.33	0.21	46.4
12	R2	11	2.0	0.035	4.5	LOS A	0.1	0.9	0.33	0.21	45.2
Approach		30	2.0	0.035	4.5	LOS A	0.1	0.9	0.33	0.21	46.1
All Vehicles		520	2.0	0.215	5.2	LOS A	0.9	6.8	0.20	0.10	46.4

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Rouncey at Cope - 2025 FT PM

New intersection at Rouncey Road and Cope Road
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Rouncey Road											
3	L2	21	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	56.2
8	T1	165	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	56.1
18	R2	26	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	54.5
Approach		212	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	55.9
East: Cope Drive											
1	L2	30	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	55.7
6	T1	55	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	55.6
16	R2	38	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	54.0
Approach		124	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	55.1
North: Rouncey Road											
7	L2	34	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	55.2
4	T1	217	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	55.2
14	R2	50	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	53.6
Approach		301	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	54.9
West: Cope Drive											
5	L2	36	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	55.0
2	T1	43	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	55.0
12	R2	13	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	53.5
Approach		92	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	54.8
All Vehicles		729	2.0	0.305	6.1	LOS A	1.4	10.5	0.30	0.19	55.2

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	16	324	589	149	160	15
Future Volume (vph)	16	324	589	149	160	15
Lane Group Flow (vph)	17	341	620	157	168	16
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.2	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	29.2	29.2	29.5	29.5	11.6	11.6
Actuated g/C Ratio	0.53	0.53	0.53	0.53	0.21	0.21
v/c Ratio	0.05	0.36	0.65	0.18	0.47	0.05
Control Delay	6.0	8.5	14.0	2.3	27.3	13.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.0	8.5	14.0	2.3	27.3	13.3
LOS	A	A	B	A	C	B
Approach Delay		8.4	11.7		26.1	
Approach LOS		A	B		C	
Queue Length 50th (m)	0.7	16.7	33.7	0.0	11.7	0.0
Queue Length 95th (m)	2.6	29.8	100.3	7.9	#48.1	5.2
Internal Link Dist (m)		162.8	732.9		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	676	1731	1564	1349	429	396
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.03	0.20	0.40	0.12	0.39	0.04

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 55.4	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.65	
Intersection Signal Delay: 12.8	Intersection LOS: B
Intersection Capacity Utilization 51.9%	ICU Level of Service A
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	36	454	680	115	85	76
Future Volume (Veh/h)	36	454	680	115	85	76
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	38	478	716	121	89	80
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	837				1270	716
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	837				1270	716
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				50	81
cM capacity (veh/h)	797				177	430

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	38	478	716	121	169
Volume Left	38	0	0	0	89
Volume Right	0	0	0	121	80
cSH	797	1700	1700	1700	245
Volume to Capacity	0.05	0.28	0.42	0.07	0.69
Queue Length 95th (m)	1.1	0.0	0.0	0.0	34.4
Control Delay (s)	9.7	0.0	0.0	0.0	47.0
Lane LOS	A				E
Approach Delay (s)	0.7		0.0		47.0
Approach LOS					E

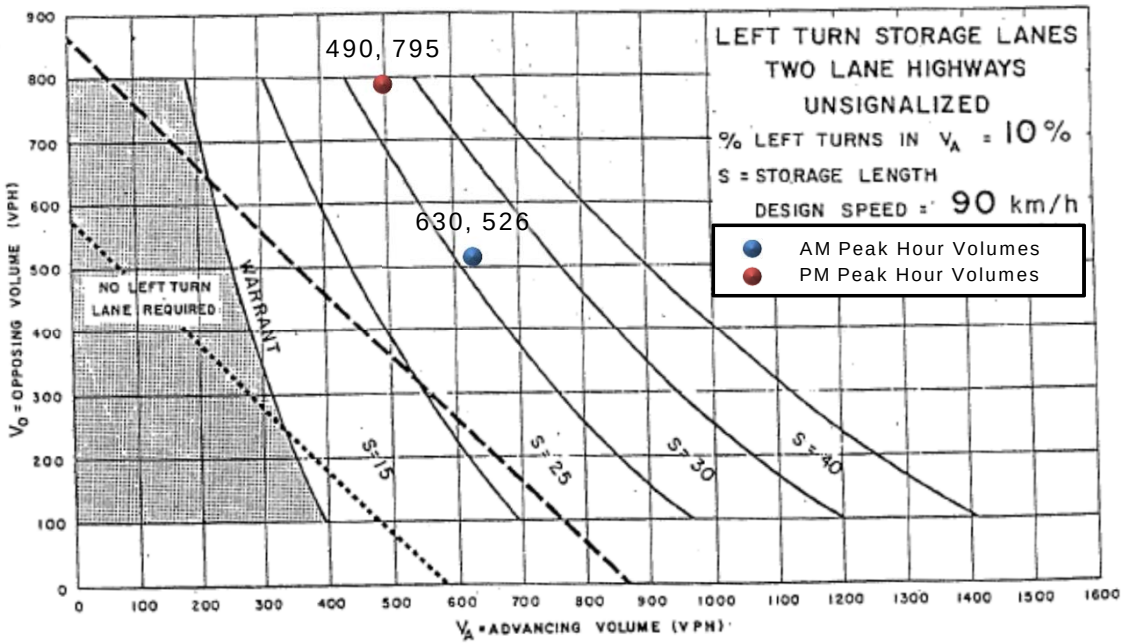
Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	54.3%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix I

Left-turn Lane Warrant and Traffic Signal Warrant Analysis

	Design Speed	Advancing Traffic Volume (V_A)		Opposing Traffic Volume (V_O)		Left Turn Traffic Volume (V_L)		% of Left Turning Traffic		Warrant Left Turn Lane
		AM	PM	AM	PM	AM	PM	AM	PM	
Existing										
Fernbank/Rouncey	90	630	490	526	795	70	36	11%	7%	Yes

Peak	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
							Warrant?					
AM	0	0	0	114	0	50	70	560	0	0	376	150
PM	0	0	0	85	0	76	36	454	0	0	680	115



Fernbank Road/Rouncey Road - (peak hour signal warrant)

Signal Warrant			Description	Minimum Requirement for Two Lane Roadways	Compliance		
				Restricted Flow - Operating Speed Less Than 70 km/h	Sectional %	Entire %	Warrant
Intersection	1. Minimum Vehicular Volume	(1) A	Vehicle Volume, All Approaches for Each of the Heaviest 8 Hours of on Average Day, and	720	93%	32%	**67% No**
		(4) B	Vehicle Volume, Along Minor Streets for Each of the Same 8 Hours	255	32%		
	2. Delay to Cross Traffic	(1) A	Vehicle Volume, Along Major Street for Each of the Heaviest 8 Hours of an Average Day, and	720	81%	67%	
		(2) B	Combined Vehicle and Pedestrian Volume Crossing the Major Street for Each of the Same 8 Hours	75	67%		

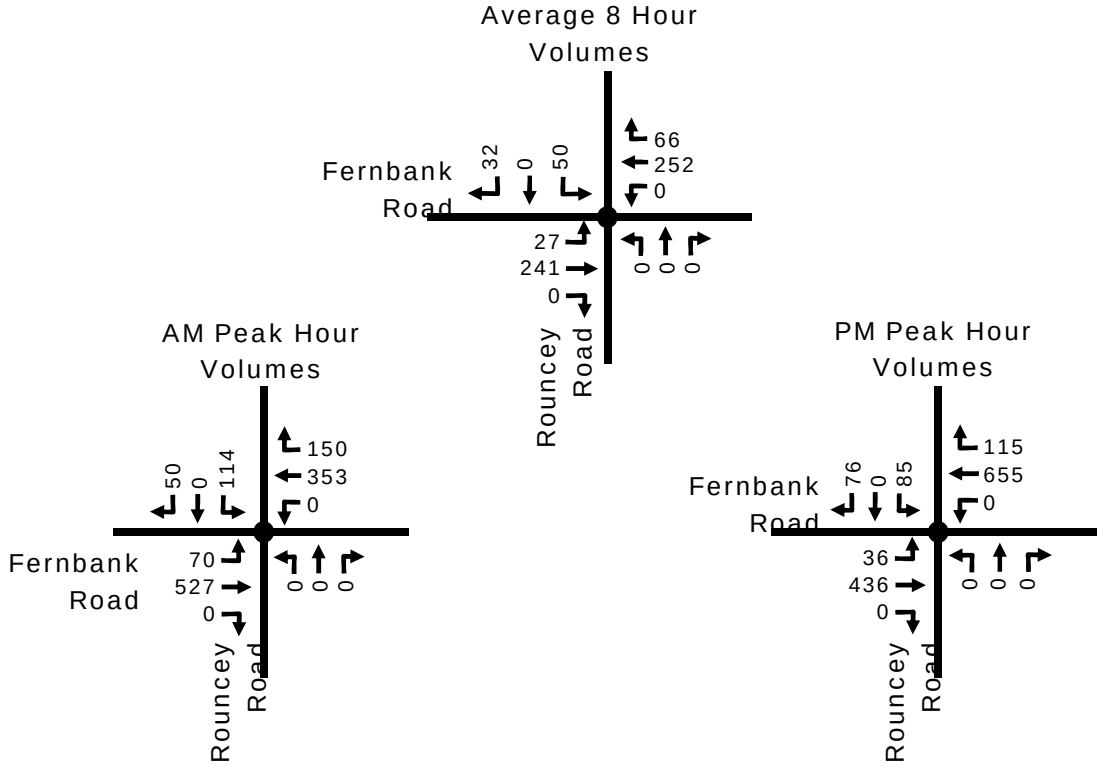
Notes

1 *Vehicle Volume Warrants (1A), (2A) and (5B) for Roadways Having Two or More Moving Lanes in one Direction Should Be 25% Higher Than Values Given Above* **No**

2 *For Definition of Crossing Volume Refer to Note 4 on the Signal Warrant Analysis Form B2.03.08*

3 *The Lowest Sectional Percentage Governs the Entire Warrant*

4 *For "T" Intersections the Warrant Values for Minor Street Should be Increased by 50% (Warrant 1B only)* **Yes**



Fernbank Road/Rouncey Road - (peak hour signal warrant)

Signal Warrant			Description	Minimum Requirement for Two Lane Roadways	Compliance		
				Restricted Flow - Operating Speed Less Than 70 km/h	Sectional %	Entire %	Warrant
Intersection	1. Minimum Vehicular Volume	(1) A	Vehicle Volume, All Approaches for Each of the Heaviest 8 Hours of on Average Day, and	720	103%	32%	**67% No**
		(4) B	Vehicle Volume, Along Minor Streets for Each of the Same 8 Hours	255	32%		
	2. Delay to Cross Traffic	(1) A	Vehicle Volume, Along Major Street for Each of the Heaviest 8 Hours of an Average Day, and	720	92%	67%	
		(2) B	Combined Vehicle and Pedestrian Volume Crossing the Major Street for Each of the Same 8 Hours	75	67%		

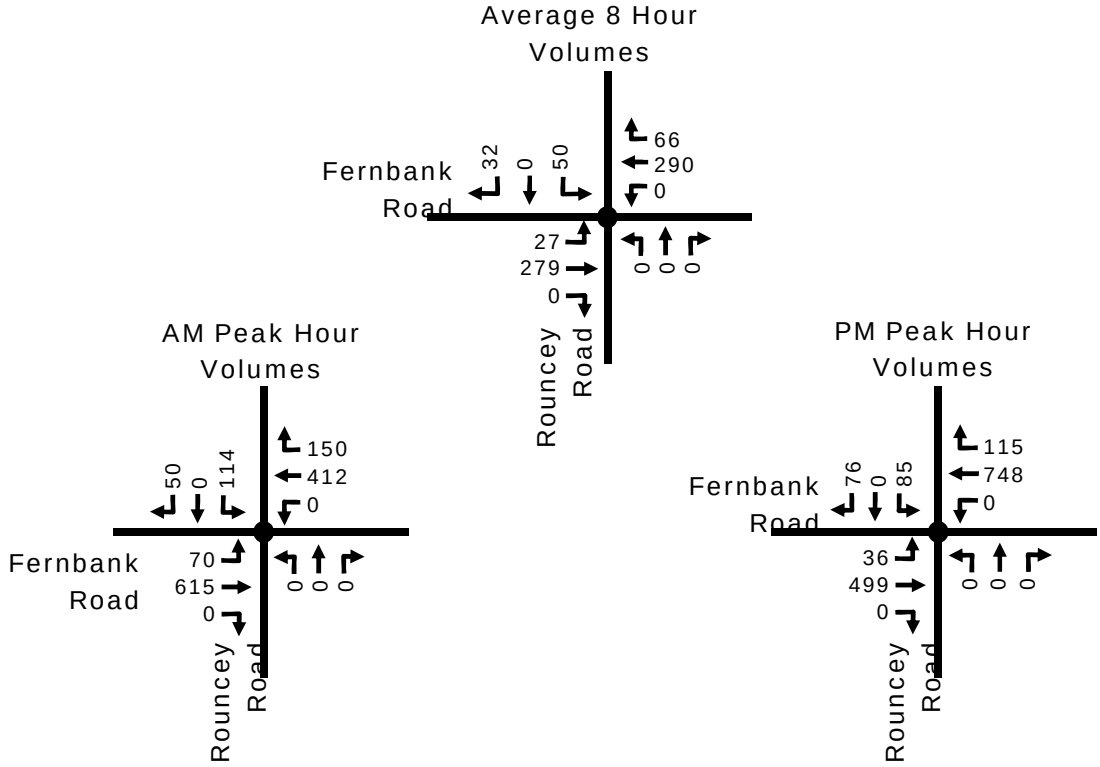
Notes

1 *Vehicle Volume Warrants (1A), (2A) and (5B) for Roadways Having Two or More Moving Lanes in one Direction Should Be 25% Higher Than Values Given Above* **No**

2 *For Definition of Crossing Volume Refer to Note 4 on the Signal Warrant Analysis Form B2.03.08*

3 *The Lowest Sectional Percentage Governs the Entire Warrant*

4 *For "T" Intersections the Warrant Values for Minor Street Should be Increased by 50% (Warrant 1B only)* **Yes**



Appendix J

2030 Future Background Analysis

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2030 FB AM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.191	5.5	LOS A	0.7	5.8	0.25	0.14	47.4
8	T1	157	2.0	0.191	5.5	LOS A	0.7	5.8	0.25	0.14	46.8
18	R2	21	2.0	0.191	5.5	LOS A	0.7	5.8	0.25	0.14	45.6
Approach		188	2.0	0.191	5.5	LOS A	0.7	5.8	0.25	0.14	46.7
East: Cope Drive											
1	L2	11	2.0	0.124	5.1	LOS A	0.4	3.5	0.31	0.20	47.3
6	T1	26	2.0	0.124	5.1	LOS A	0.4	3.5	0.31	0.20	46.7
16	R2	77	2.0	0.124	5.1	LOS A	0.4	3.5	0.31	0.20	45.5
Approach		114	2.0	0.124	5.1	LOS A	0.4	3.5	0.31	0.20	45.9
North: Robert Grant Avenue											
7	L2	68	2.0	0.217	5.5	LOS A	0.9	6.9	0.16	0.07	46.6
4	T1	148	2.0	0.217	5.5	LOS A	0.9	6.9	0.16	0.07	46.1
14	R2	11	2.0	0.217	5.5	LOS A	0.9	6.9	0.16	0.07	44.9
Approach		227	2.0	0.217	5.5	LOS A	0.9	6.9	0.16	0.07	46.2
West: Cope Drive											
5	L2	11	2.0	0.060	4.7	LOS A	0.2	1.6	0.33	0.22	47.3
2	T1	30	2.0	0.060	4.7	LOS A	0.2	1.6	0.33	0.22	46.8
12	R2	11	2.0	0.060	4.7	LOS A	0.2	1.6	0.33	0.22	45.6
Approach		52	2.0	0.060	4.7	LOS A	0.2	1.6	0.33	0.22	46.6
All Vehicles		582	2.0	0.217	5.3	LOS A	0.9	6.9	0.24	0.13	46.4

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	12	491	262	151	141	12
Future Volume (vph)	12	491	262	151	141	12
Lane Group Flow (vph)	13	517	276	159	148	13
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	16.2	10.0	10.0	10.0	10.0
Minimum Split (s)	16.6	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	21.9	21.9	21.9	21.9	10.1	10.1
Actuated g/C Ratio	0.47	0.47	0.47	0.47	0.22	0.22
v/c Ratio	0.03	0.61	0.33	0.20	0.40	0.04
Control Delay	6.6	12.7	10.6	3.2	19.3	9.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.6	12.7	10.6	3.2	19.3	9.6
LOS	A	B	B	A	B	A
Approach Delay		12.6	7.9		18.5	
Approach LOS		B	A		B	
Queue Length 50th (m)	0.5	26.4	10.4	0.0	8.3	0.0
Queue Length 95th (m)	2.4	54.7	39.2	9.7	26.5	3.4
Internal Link Dist (m)		162.8	732.9		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	783	1784	1680	1438	500	457
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.29	0.16	0.11	0.30	0.03

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 46.2	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.61	
Intersection Signal Delay: 11.6	Intersection LOS: B
Intersection Capacity Utilization 47.1%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	41	615	412	28	17	11
Future Volume (Veh/h)	41	615	412	28	17	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	43	647	434	29	18	12
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	463				1167	434
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	463				1167	434
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	96				91	98
cM capacity (veh/h)	1098				206	622

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	43	647	434	29	30
Volume Left	43	0	0	0	18
Volume Right	0	0	0	29	12
cSH	1098	1700	1700	1700	281
Volume to Capacity	0.04	0.38	0.26	0.02	0.11
Queue Length 95th (m)	0.9	0.0	0.0	0.0	2.7
Control Delay (s)	8.4	0.0	0.0	0.0	19.3
Lane LOS	A				C
Approach Delay (s)	0.5		0.0		19.3
Approach LOS					C

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	44.2%	ICU Level of Service	A
Analysis Period (min)	15		

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2030 FB PM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.179	5.2	LOS A	0.7	5.4	0.19	0.09	47.6
8	T1	153	2.0	0.179	5.2	LOS A	0.7	5.4	0.19	0.09	47.0
18	R2	21	2.0	0.179	5.2	LOS A	0.7	5.4	0.19	0.09	45.8
Approach		185	2.0	0.179	5.2	LOS A	0.7	5.4	0.19	0.09	46.9
East: Cope Drive											
1	L2	14	2.0	0.074	4.6	LOS A	0.3	2.0	0.29	0.18	47.2
6	T1	10	2.0	0.074	4.6	LOS A	0.3	2.0	0.29	0.18	46.7
16	R2	45	2.0	0.074	4.6	LOS A	0.3	2.0	0.29	0.18	45.5
Approach		68	2.0	0.074	4.6	LOS A	0.3	2.0	0.29	0.18	46.0
North: Robert Grant Avenue											
7	L2	45	2.0	0.206	5.3	LOS A	0.8	6.5	0.14	0.05	47.0
4	T1	163	2.0	0.206	5.3	LOS A	0.8	6.5	0.14	0.05	46.5
14	R2	11	2.0	0.206	5.3	LOS A	0.8	6.5	0.14	0.05	45.3
Approach		218	2.0	0.206	5.3	LOS A	0.8	6.5	0.14	0.05	46.5
West: Cope Drive											
5	L2	11	2.0	0.035	4.4	LOS A	0.1	0.9	0.32	0.20	46.9
2	T1	9	2.0	0.035	4.4	LOS A	0.1	0.9	0.32	0.20	46.4
12	R2	11	2.0	0.035	4.4	LOS A	0.1	0.9	0.32	0.20	45.2
Approach		30	2.0	0.035	4.4	LOS A	0.1	0.9	0.32	0.20	46.2
All Vehicles		502	2.0	0.206	5.1	LOS A	0.8	6.5	0.19	0.09	46.6

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	10	339	621	164	175	16
Future Volume (vph)	10	339	621	164	175	16
Lane Group Flow (vph)	11	357	654	173	184	17
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.2	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	30.7	30.7	31.1	31.1	12.2	12.2
Actuated g/C Ratio	0.53	0.53	0.54	0.54	0.21	0.21
v/c Ratio	0.04	0.37	0.68	0.19	0.51	0.05
Control Delay	5.8	8.6	14.6	2.1	29.2	13.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.8	8.6	14.6	2.1	29.2	13.3
LOS	A	A	B	A	C	B
Approach Delay		8.6	12.0		27.9	
Approach LOS		A	B		C	
Queue Length 50th (m)	0.5	19.3	40.3	0.0	13.5	0.0
Queue Length 95th (m)	1.9	31.3	107.0	8.0	#56.4	5.4
Internal Link Dist (m)		162.8	732.9		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	654	1725	1519	1318	412	381
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.21	0.43	0.13	0.45	0.04

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 57.4	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.68	
Intersection Signal Delay: 13.4	Intersection LOS: B
Intersection Capacity Utilization 54.6%	ICU Level of Service A
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	22	499	748	32	36	55
Future Volume (Veh/h)	22	499	748	32	36	55
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	23	525	787	34	38	58
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	821				1358	787
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	821				1358	787
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				76	85
cM capacity (veh/h)	808				159	392

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	23	525	787	34	96
Volume Left	23	0	0	0	38
Volume Right	0	0	0	34	58
cSH	808	1700	1700	1700	248
Volume to Capacity	0.03	0.31	0.46	0.02	0.39
Queue Length 95th (m)	0.7	0.0	0.0	0.0	13.2
Control Delay (s)	9.6	0.0	0.0	0.0	28.3
Lane LOS	A				D
Approach Delay (s)	0.4		0.0		28.3
Approach LOS					D

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix K

2030 Total Future Analysis

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	14	520	301	151	145	15
Future Volume (vph)	14	520	301	151	145	15
Lane Group Flow (vph)	15	547	317	159	153	16
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.2	23.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	23.1	23.1	23.2	23.2	10.2	10.2
Actuated g/C Ratio	0.49	0.49	0.49	0.49	0.22	0.22
v/c Ratio	0.03	0.63	0.36	0.19	0.42	0.05
Control Delay	6.4	12.9	10.7	3.0	20.7	9.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.4	12.9	10.7	3.0	20.7	9.7
LOS	A	B	B	A	C	A
Approach Delay		12.7	8.1		19.7	
Approach LOS		B	A		B	
Queue Length 50th (m)	0.5	28.6	12.3	0.0	9.2	0.0
Queue Length 95th (m)	2.7	59.1	45.3	9.4	29.0	3.9
Internal Link Dist (m)		162.8	732.9		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	756	1784	1691	1446	485	445
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.31	0.19	0.11	0.32	0.04

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 47.4	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.63	
Intersection Signal Delay: 11.9	Intersection LOS: B
Intersection Capacity Utilization 48.9%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	70	615	412	150	114	50
Future Volume (Veh/h)	70	615	412	150	114	50
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	74	647	434	158	120	53
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	592				1229	434
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	592				1229	434
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	92				34	91
cM capacity (veh/h)	984				182	622

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	74	647	434	158	173
Volume Left	74	0	0	0	120
Volume Right	0	0	0	158	53
cSH	984	1700	1700	1700	232
Volume to Capacity	0.08	0.38	0.26	0.09	0.75
Queue Length 95th (m)	1.9	0.0	0.0	0.0	39.3
Control Delay (s)	9.0	0.0	0.0	0.0	55.4
Lane LOS	A				F
Approach Delay (s)	0.9		0.0		55.4
Approach LOS					F

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	50.7%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	17	353	642	164	177	17
Future Volume (vph)	17	353	642	164	177	17
Lane Group Flow (vph)	18	372	676	173	186	18
Turn Type	pm+pt	NA	NA	Perm	Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases	2			6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	16.6	52.2	52.2	52.2	30.0	30.0
Total Split (s)	26.2	78.4	52.2	52.2	20.0	20.0
Total Split (%)	26.6%	79.7%	53.0%	53.0%	20.3%	20.3%
Yellow Time (s)	4.6	4.6	4.6	4.6	3.3	3.3
All-Red Time (s)	1.6	1.6	1.6	1.6	2.7	2.7
Lost Time Adjust (s)	0.9	0.9	-1.1	-1.1	0.7	0.7
Total Lost Time (s)	7.1	7.1	5.1	5.1	6.7	6.7
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	Min	Min	Min	None	None
Act Effct Green (s)	31.8	31.8	32.0	32.0	12.3	12.3
Actuated g/C Ratio	0.54	0.54	0.55	0.55	0.21	0.21
v/c Ratio	0.06	0.38	0.69	0.19	0.52	0.05
Control Delay	6.0	8.7	15.1	2.1	30.0	13.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.0	8.7	15.1	2.1	30.0	13.4
LOS	A	A	B	A	C	B
Approach Delay		8.5	12.5		28.5	
Approach LOS		A	B		C	
Queue Length 50th (m)	0.8	20.6	43.3	0.0	14.3	0.0
Queue Length 95th (m)	2.6	32.7	114.6	8.1	#57.7	5.6
Internal Link Dist (m)		162.8	732.9		570.9	
Turn Bay Length (m)	100.0			100.0	75.0	
Base Capacity (vph)	642	1723	1494	1298	403	374
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.03	0.22	0.45	0.13	0.46	0.05

Intersection Summary	
Cycle Length: 98.4	
Actuated Cycle Length: 58.5	
Natural Cycle: 100	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.69	
Intersection Signal Delay: 13.7	Intersection LOS: B
Intersection Capacity Utilization 55.9%	ICU Level of Service B
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 4: Fernbank Road & Robert Grant Avenue

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	36	499	748	115	85	76
Future Volume (Veh/h)	36	499	748	115	85	76
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	38	525	787	121	89	80
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	908				1388	787
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	908				1388	787
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				40	80
cM capacity (veh/h)	750				149	392

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	38	525	787	121	169
Volume Left	38	0	0	0	89
Volume Right	0	0	0	121	80
cSH	750	1700	1700	1700	211
Volume to Capacity	0.05	0.31	0.46	0.07	0.80
Queue Length 95th (m)	1.2	0.0	0.0	0.0	43.7
Control Delay (s)	10.1	0.0	0.0	0.0	67.4
Lane LOS	B				F
Approach Delay (s)	0.7		0.0		67.4
Approach LOS					F

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	58.1%	ICU Level of Service	B
Analysis Period (min)	15		

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2030 FT AM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.200	5.7	LOS A	0.8	6.0	0.30	0.19	47.2
8	T1	157	2.0	0.200	5.7	LOS A	0.8	6.0	0.30	0.19	46.7
18	R2	23	2.0	0.200	5.7	LOS A	0.8	6.0	0.30	0.19	45.5
Approach		190	2.0	0.200	5.7	LOS A	0.8	6.0	0.30	0.19	46.6
East: Cope Drive											
1	L2	18	2.0	0.167	5.5	LOS A	0.6	4.8	0.32	0.22	46.9
6	T1	26	2.0	0.167	5.5	LOS A	0.6	4.8	0.32	0.22	46.4
16	R2	109	2.0	0.167	5.5	LOS A	0.6	4.8	0.32	0.22	45.2
Approach		153	2.0	0.167	5.5	LOS A	0.6	4.8	0.32	0.22	45.6
North: Robert Grant Avenue											
7	L2	102	2.0	0.251	5.9	LOS A	1.1	8.2	0.19	0.08	46.1
4	T1	148	2.0	0.251	5.9	LOS A	1.1	8.2	0.19	0.08	45.6
14	R2	11	2.0	0.251	5.9	LOS A	1.1	8.2	0.19	0.08	44.5
Approach		261	2.0	0.251	5.9	LOS A	1.1	8.2	0.19	0.08	45.8
West: Cope Drive											
5	L2	11	2.0	0.062	4.9	LOS A	0.2	1.6	0.36	0.26	47.2
2	T1	30	2.0	0.062	4.9	LOS A	0.2	1.6	0.36	0.26	46.7
12	R2	11	2.0	0.062	4.9	LOS A	0.2	1.6	0.36	0.26	45.4
Approach		52	2.0	0.062	4.9	LOS A	0.2	1.6	0.36	0.26	46.5
All Vehicles		657	2.0	0.251	5.7	LOS A	1.1	8.2	0.26	0.16	46.0

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Robert Grant at Cope - 2030 FT PM

Roundabout with 1-lane approaches and circulating road, and an extra turn lane
MUTCD (FHWA 2009) example number: 3C-3
Roundabout Guide (TRB 2010) example number: A-2
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Robert Grant Avenue											
3	L2	11	2.0	0.191	5.4	LOS A	0.8	5.8	0.22	0.12	47.4
8	T1	153	2.0	0.191	5.4	LOS A	0.8	5.8	0.22	0.12	46.9
18	R2	28	2.0	0.191	5.4	LOS A	0.8	5.8	0.22	0.12	45.7
Approach		192	2.0	0.191	5.4	LOS A	0.8	5.8	0.22	0.12	46.7
East: Cope Drive											
1	L2	17	2.0	0.095	4.8	LOS A	0.3	2.6	0.30	0.19	47.1
6	T1	10	2.0	0.095	4.8	LOS A	0.3	2.6	0.30	0.19	46.6
16	R2	60	2.0	0.095	4.8	LOS A	0.3	2.6	0.30	0.19	45.4
Approach		87	2.0	0.095	4.8	LOS A	0.3	2.6	0.30	0.19	45.8
North: Robert Grant Avenue											
7	L2	67	2.0	0.228	5.5	LOS A	0.9	7.3	0.15	0.06	46.6
4	T1	163	2.0	0.228	5.5	LOS A	0.9	7.3	0.15	0.06	46.1
14	R2	11	2.0	0.228	5.5	LOS A	0.9	7.3	0.15	0.06	44.9
Approach		241	2.0	0.228	5.5	LOS A	0.9	7.3	0.15	0.06	46.2
West: Cope Drive											
5	L2	11	2.0	0.036	4.5	LOS A	0.1	0.9	0.34	0.22	46.9
2	T1	9	2.0	0.036	4.5	LOS A	0.1	0.9	0.34	0.22	46.3
12	R2	11	2.0	0.036	4.5	LOS A	0.1	0.9	0.34	0.22	45.1
Approach		30	2.0	0.036	4.5	LOS A	0.1	0.9	0.34	0.22	46.1
All Vehicles		551	2.0	0.228	5.3	LOS A	0.9	7.3	0.21	0.11	46.3

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Rouncey at Cope - 2030 FT AM

New intersection at Rouncey Road and Cope Road
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Rouncey Road											
3	L2	14	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	45.5
8	T1	248	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	45.0
18	R2	62	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	43.9
Approach		324	2.0	0.382	8.8	LOS A	1.7	13.3	0.47	0.39	44.8
East: Cope Drive											
1	L2	70	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	45.4
6	T1	64	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	44.9
16	R2	61	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	43.7
Approach		195	2.0	0.245	7.2	LOS A	0.9	7.3	0.46	0.39	44.7
North: Rouncey Road											
7	L2	105	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	44.8
4	T1	272	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	44.3
14	R2	38	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	43.2
Approach		415	2.0	0.439	8.9	LOS A	2.3	17.4	0.40	0.27	44.4
West: Cope Drive											
5	L2	59	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	45.0
2	T1	91	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	44.5
12	R2	26	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	43.4
Approach		176	2.0	0.253	8.2	LOS A	0.9	7.3	0.52	0.51	44.5
All Vehicles		1110	2.0	0.439	8.5	LOS A	2.3	17.4	0.45	0.37	44.6

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Rouncey at Cope - 2030 FT PM

New intersection at Rouncey Road and Cope Road
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Rouncey Road											
3	L2	21	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	47.1
8	T1	165	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	46.5
18	R2	26	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	45.3
Approach		212	2.0	0.216	5.8	LOS A	0.9	6.7	0.27	0.15	46.4
East: Cope Drive											
1	L2	30	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	46.7
6	T1	55	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	46.2
16	R2	38	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	45.0
Approach		124	2.0	0.141	5.5	LOS A	0.5	4.0	0.35	0.25	45.9
North: Rouncey Road											
7	L2	34	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	46.4
4	T1	217	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	45.9
14	R2	50	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	44.7
Approach		301	2.0	0.305	6.8	LOS A	1.4	10.5	0.28	0.17	45.8
West: Cope Drive											
5	L2	36	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	46.3
2	T1	43	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	45.8
12	R2	13	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	44.6
Approach		92	2.0	0.112	5.5	LOS A	0.4	3.0	0.38	0.29	45.8
All Vehicles		729	2.0	0.305	6.1	LOS A	1.4	10.5	0.30	0.19	46.0

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.