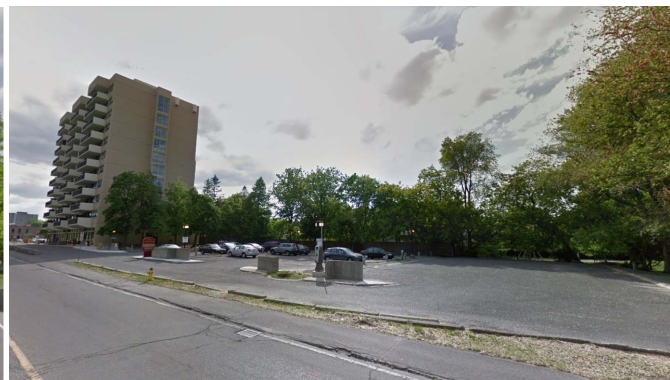




851 Richmond Road Transportation Brief



851 Richmond Road

Transportation Brief

prepared for:
Homestead Land Holdings Limited
80 Johnston Road
Kingston, ON K7L 1X7

prepared by:
PARSONS
1223 Michael Street
Suite 100
Ottawa, ON K1J 7T2

March 19, 2018

476418-01000

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Transportation Brief

1. INTRODUCTION

This study has been prepared in support of Site Plan Application (SPA) for the redevelopment of Homestead Land Holdings Limited's 851 Richmond Road. The proposed development will consist of two 11 storey towers, one existing and one new tower. The new tower, the primary subject of this application, is anticipated to include approximately 132 residential units. For the purposes of this study it has been assumed that the site will be occupied and operational in 2019.

The subject site, displayed in **Figure 1**, is located on Richmond Road, between the intersections of Woodroffe Road/Richmond Road and Cleary Avenue/Richmond Road. A two-way full movement driveway and one-way out driveway are provided directly on Richmond Road. This study will focus on the two-way access to the proposed new building, as well as the adjacent road network and signalized intersections.

1.1. CONTEXT

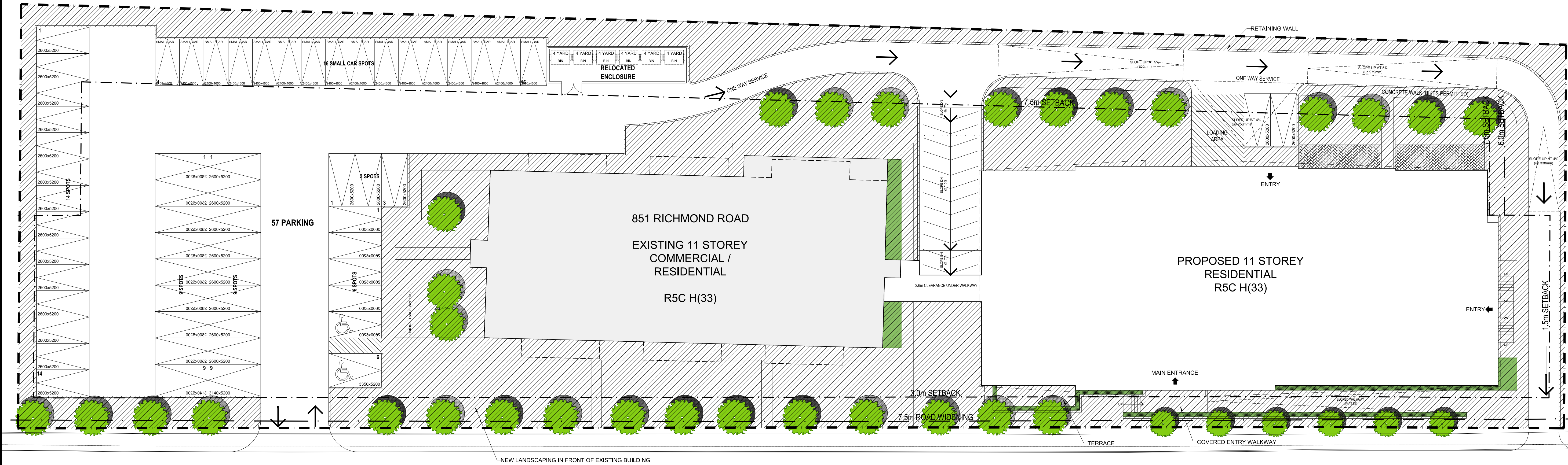
The proposed development is located at the municipal address 851 Richmond Road. The site is located within 300m walking distance of the future Cleary Avenue LRT station and therefore the development needs to be consistent with the Transit-Oriented Development (TOD) guidelines that the City approved in 2007. According to the guidelines, a TOD is "a mix of moderate to high-density transit-supportive land uses located within an easy walk of a rapid transit stop or station that is oriented and designed to facilitate transit use" (City of Ottawa, 2007). In addition, the site should be developed in conjunction with the policies of the Official Plan and all other applicable regulations (i.e. Zoning By-law, Private Approach By-law, Signs By-Law).

The proposed development, shown in **Figure 2** below, includes one new and one existing 11 storey tower, with associated vehicle and bicycle parking. These elements are considered transit-supportive land uses according to City of Ottawa TOD guidelines (2007).

Adjacent land uses along Richmond Road include an autobody shop, restaurants, commercial/retail space and south of the site is the Byron Avenue linear park. Neighbouring residential areas have a variety of dwelling types including apartment buildings, semi-detached homes, and single-family homes.

Figure 1: Site Context





IT IS THE RESPONSIBILITY OF THE APPROPRIATE CONTRACTOR TO CHECK AND VERIFY ALL DIMENSIONS ON SITE AND TO REPORT ALL ERRORS AND/OR OMISSIONS TO THE ARCHITECT.

ALL CONTRACTORS MUST COMPLY WITH ALL PERTINENT CODES AND BY-LAWS.

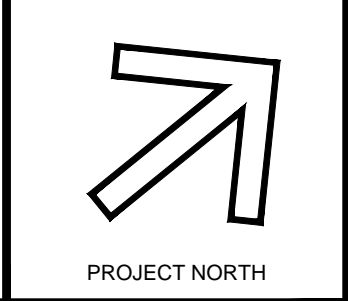
THIS DRAWING MAY NOT BE USED FOR CONSTRUCTION UNTIL SIGNED BY THE ARCHITECT.

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1	ISSUED FOR SITE PLAN APPLICATION	13/10/17
No.	DESCRIPTION	DATE

REVISIONS:	
ARCHITECT SEAL:	NORTH ARROW:



CLIENT:

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ARCHITECT:

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PROJECT TITLE:

851 RICHMOND RD

OTTAWA	ONTARIO
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SHEET TITLE:

SITE PLAN

DRAWN:	CHECKED:
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SCALE:	SHEET No.
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PROJECT No.	SP1
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2. EXISTING CONDITIONS

2.1. STUDY AREA ROAD NETWORK

Richmond Road is a two lane east-west arterial road in the City of Ottawa. The posted speed limit for Richmond Road within the Study Area is 50km/h.

Woodroffe Avenue is a north-south arterial road in the City of Ottawa. The posted speed limit for Woodroffe Avenue at the intersection with Richmond Road is 50km/h.

Cleary Avenue is a dead end local road that connects Richmond Road with several buildings including a church, a children's center, and a senior's assisted living facility. The posted speed limit is 25km/h.

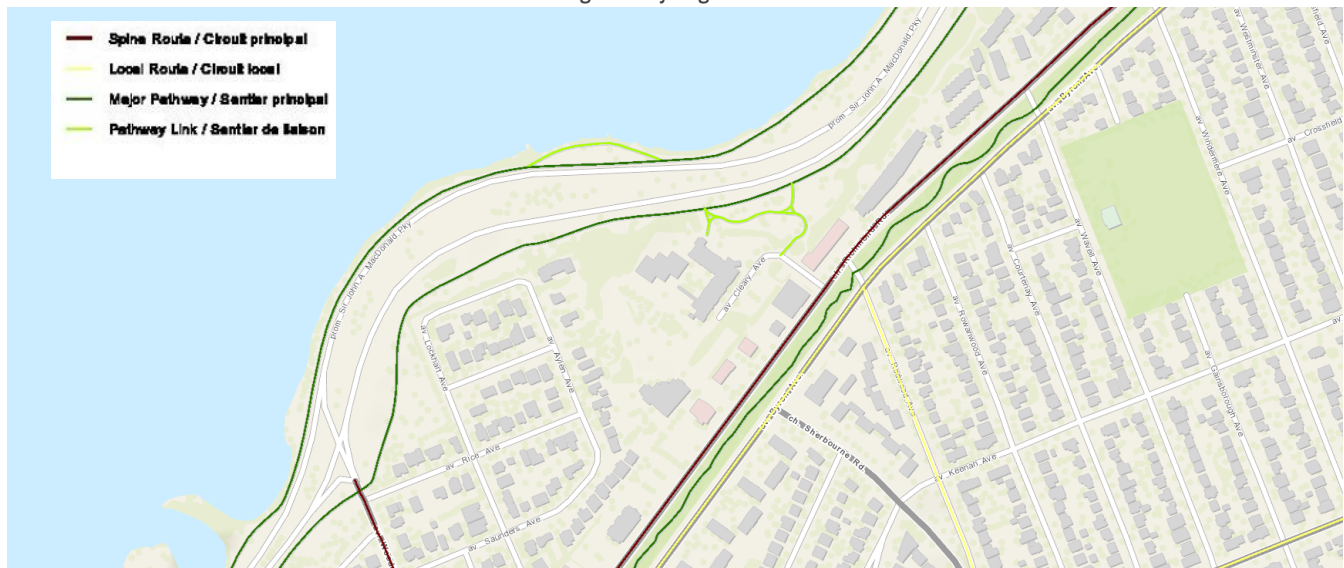
2.2. PEDESTRIAN/CYCLING NETWORK

Paved shoulders for cycling are provided on Richmond Road. The City of Ottawa's 2013 Cycling Plan identifies Richmond Road and Woodroffe Road as Spine or City-Wide cycling routes. There are no existing cycling facilities on Woodroffe Avenue. Cleary Avenue does not have any existing or future planned cycling infrastructure.

Sidewalks are located on the north side of Richmond Road. A multi-use pathway runs east-west along the Byron Avenue linear park. The NCC's Ottawa River multi-use pathway network connects to Cleary Avenue. Woodroffe and Cleary Avenues have sidewalks located on both sides of the street.

Figure 3 illustrates the Study Area, and surrounding area, cycling network.

Figure 3: Cycling Network



2.3. TRANSIT NETWORK

Local OC Transpo Route 2 runs along Richmond Road. Local routes run seven days/week in most time periods. Richmond Road is an existing Rapid Transit Corridor.

Woodroffe Avenue is serviced by OC Transpo local routes 2, 87, and 153 in the vicinity of the Study Area. Transit stops are located only southbound within the Study Area. Woodroffe Avenue has no designation within the Rapid Transit Network. **Figure 4** shows the transit routes through the Study Area.

Figure 4: Existing Transit Network



Accessed July 18, 2017. <http://www.octranspo1.com/images/files/systemmap/systemmap.pdf>

The 2013 Transportation Master Plan identifies that Richmond Road will become a part of the Phase 2 Future Light Rail Transit (LRT) network in the City of Ottawa within the Transportation Master Plan's (TMP's) ultimate horizon (2031). A new LRT station is proposed at Cleary Avenue, approximately 300m northeast of the site. Both the station and the LRT line will be located underground in this area.

Figure 5 shows the LRT route through the Study Area and the proximity of the Cleary Station to the subject development.

Figure 5: Phase 2 Light Rail Transit Stations



2.4. EXISTING INTERSECTION OPERATIONS

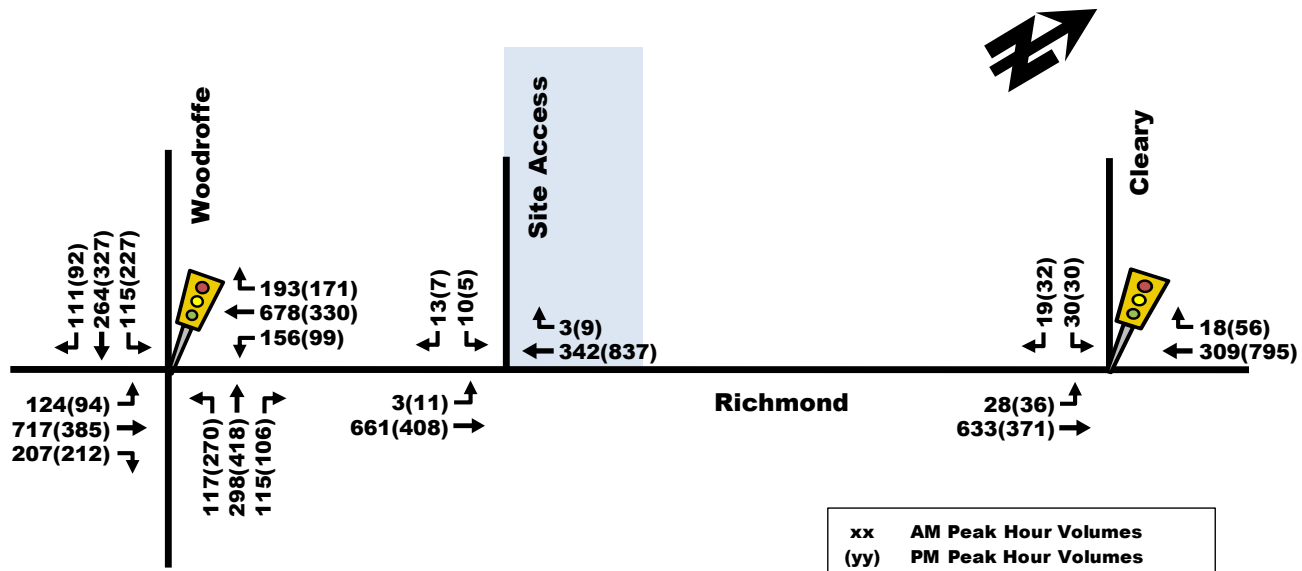
To establish the baseline intersection operations an operational analysis of the existing traffic conditions has been undertaken for the Study Area intersections. Recent turning movement counts have been obtained from the City of Ottawa. The counts were undertaken on the following dates:

- Cleary Avenue @ Richmond Road – Friday, June 12, 2015
- Woodroffe Avenue @ Richmond Road – Friday, May 23, 2014

The counts were adjusted to reflect 2017 conditions using a 1.5% annual background growth rate. **Figure 6** shows the resultant traffic volumes at the Study Area intersections.

As there are no existing counts at the site access, appropriate trip generation rates and mode shares were used to calculate the auto trips associated with the existing building. These are also included in **Figure 6** below.

Figure 6: 2017 Traffic Volumes



Appendix A contains the detailed traffic data sheets.

To assess the peak hour traffic conditions 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)
- Existing lane arrangements
- Existing signal timing (provided by the City of Ottawa)
- Peak hour factor (derived from the traffic count provided by the City of Ottawa)
- Heavy vehicle percentages (derived from the traffic count provided by the City of Ottawa)
- Heavy vehicle equivalent factor of 1.70 (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 existing signal timing information is included in **Appendix A**. The Synchro analysis outputs are provided in **Appendix B**.

Table 1: Capacity Analysis

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection 'as a Whole'		
	LOS	max. v/c or avg. delay (s)	Movement	Delay (s)	LOS	v/c
Woodroffe Avenue / Richmond Road (Signalized)	D(E)	0.90(0.98)	WBL(SBL)	32.6(37.1)	B(C)	0.67(0.72)
Cleary Avenue / Richmond Road (Signalized)	C(D)	0.77(0.87)	EBT(WBT)	14.3(19.4)	C(C)	0.73(0.75)
Notes: Analysis of signalized intersections assumes a PHF of 0.95 and a saturation flow rate of 1800 veh/h/lane.						

As shown in **Table 1**, the signalized Woodroffe Avenue/Richmond Road critical movements are currently operating at a LOS 'D' for the westbound left turn during the AM peak period and a LOS 'E' for the southbound left movement during the PM peak.

The Cleary Avenue/Richmond Road 'critical movements' are identified as the eastbound through during the AM peak (LOS 'C') and the westbound through during the PM peak (LOS 'D').

The overall intersection LOS at these locations is within the permissible operational thresholds.

3. DEMAND FORECASTING

3.1. PLANNED STUDY AREA TRANSPORTATION NETWORK CHANGES

The City of Ottawa is planning to expand the nearly completed Stage 1 LRT to include additional stops east and west of Stage 1. Stage 2 will extend westward along the existing Transitway. At Dominion Station the Transitway ends and the Stage 2 LRT West will diverge towards Richmond Road. In the Study Area, the Stage 2 LRT West will run beneath Richmond Road. The Cleary Station will be within 300m walking distance of the subject development. **Figure 7** illustrates the general Stage 2 LRT West alignment and the future stations, as well as the proposed site location relative to the Cleary Station. To account for this change in the transportation network an updated mode share estimate has been created for the post LRT scenario (2024). This will be further documented in **Section 3.4**.

Figure 7: Planned Transitway Map



3.2. OTHER AREA DEVELOPMENT

809 Richmond Road

Adjacent to the subject development is the former Kristy's Restaurant, located at 809 Richmond Road. 809 Richmond Road has recently been the subject of a development application. The development would consist of two towers with 11,000 sq. ft. of retail space, and 252 residential units. The traffic impacts of 809 Richmond Road have been documented in the 809 Richmond Road Transportation Impact Study, Parsons, 2016. The results of that study have been used herein to account for traffic growth within the Study Area. **Figure 8** illustrates the 809 Richmond Road Site Plan. **Figure 9** illustrates the 809 Richmond Road site generated traffic.

Figure 8: 809 Richmond Road Site Plan

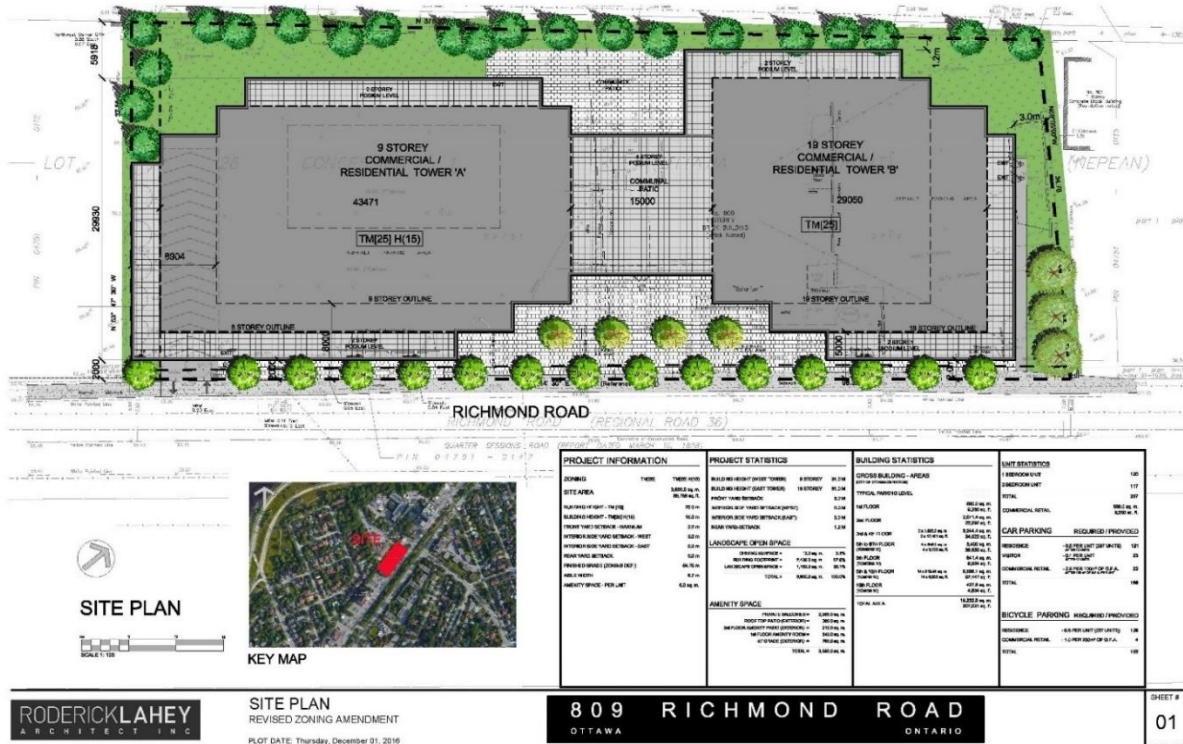
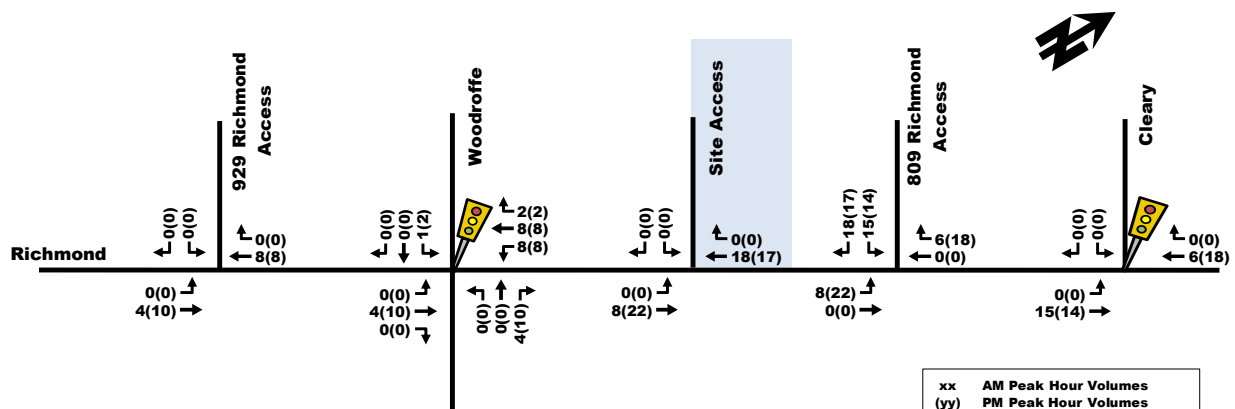


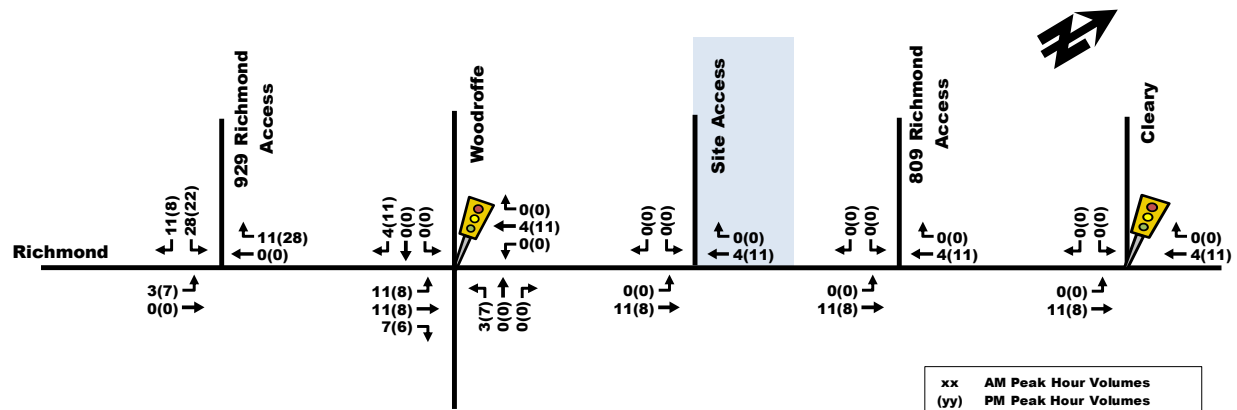
Figure 9: 809 Richmond Site Generated Traffic



929 Richmond Road

929 Richmond Road has recently been the subject of a development application. The development 19-storey residential building would consist of approximately 176 residential units and 3,812 ft² (355 m²) of ground floor retail. The traffic impacts of 929 Richmond Road have been documented in the 929 Richmond Road Transportation Impact Study, Parsons, 2016. The results of that study have been used herein to account for traffic growth within the Study Area. **Figure 10** illustrates the 929 Richmond Road site generated traffic.

Figure 10: 929 Richmond Site Generated Traffic



3.3. BACKGROUND TRAFFIC GROWTH

To estimate traffic growth beyond the Study Area a background growth rate of 1.5% has been applied to the turning movement counts along both Richmond Road and Woodroffe Road. **Figure 11** and **Figure 12** show the future background traffic volumes for the 2019 and 2024 future background traffic volumes, respectively.

Figure 11: 2019 Future Background Traffic

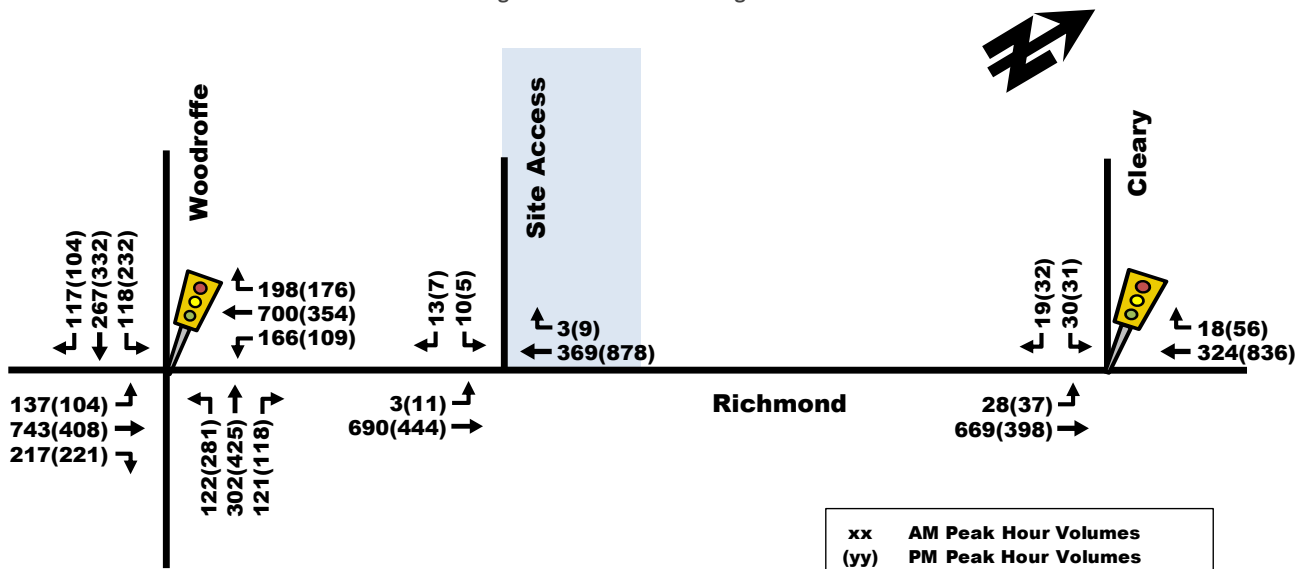
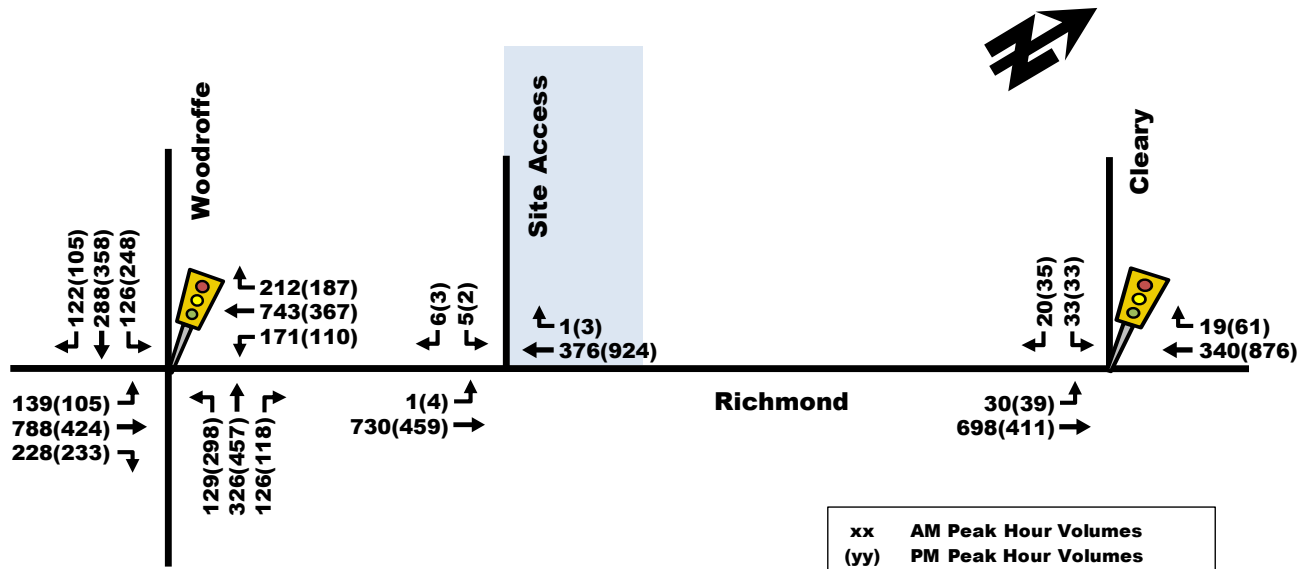


Figure 12: 2024 Future Background Traffic



3.4. SITE TRIP GENERATION

Appropriate trip generation rates for the proposed development consisting of approximately 132 units was obtained from the City's 2009 TRANS Trip Generation – Residential Trip Rates. These rates are summarized in **Table 2**.

Table 2: ITE Vehicle Trip Generation Rates

Land Use	Data Source	Trip Rates	
		AM Peak	PM Peak
High-Rise Apartment	ITE 233	T = 0.24(du)	T = 0.27(du)
Notes: T = Average Vehicle Trip Ends du = Dwelling units			

Using the TRANS Trip Generation rates for the residential component of the site, the total amount of vehicle trips generated by the proposed development was projected. The results are summarized in **Table 3**.

Table 3: Projected Vehicle Trip Generation – TRANS Model

Land Use	Area	AM Peak (Veh/h)			PM Peak (Veh/h)		
		In	Out	Total	In	Out	Total
Single-detached Dwellings	119 units	7	25	32	22	14	36
Total Vehicle Trips		7	25	32	32	22	14

As shown in **Table 3**, a total of approximately 32 veh/h and 14 veh/h are projected to travel to/from the proposed development during the weekday morning and afternoon commuter peak hours, respectively. Using the TRANS Auto Trips projected in **Table 3** and the mode share percentages outline in Table 3.13 of the TRANS Trip Generation Study, the modal shares for the high-rise apartment land use within the proposed development are summarized in **Table 4**.

Table 4: Total Site Trip Generation (Pre-OLRT)

Travel Mode	Mode Share	AM Peak (Person Trips/h)			Mode Share	PM Peak (Person Trips/h)		
		In	Out	Total		In	Out	Total
Auto Driver	37%	7	25	32	40%	22	14	36
Auto Passenger	8%	1	5	6	9%	5	3	8
Transit	41%	8	28	36	37%	21	13	34
Non-motorized	14%	3	10	13	14%	7	5	12
Total Person Trips	100%	19	68	86	100%	55	35	90

As shown in **Table 4**, based on the TRANS Trip Generation method, the proposed site is projected to generate approximately 86 to 90 person-trips per hour during the weekday commuter peak hours. The increase in two-way transit trips is estimated to be 34 to 36 persons per hour, and the increase in bike/walk trips is approximately 12 to 13 persons per hour. The total amount of 'new' vehicle traffic to the study area is projected to be 32 to 36 veh/h during the peak hours.

To reflect that the proposed development is in a TOD, the following mode shares and total site-generated vehicle traffic were forecasted and summarized in **Table 5**.

Table 5: Total Site Trip Generation (Post-OLRT)

Travel Mode	Mode Share	AM Peak (Person Trips/h)			Mode Share	PM Peak (Person Trips/h)		
		In	Out	Total		In	Out	Total
Auto Driver	15%	3	10	13	15%	8	5	13
Auto Passenger	5%	1	3	4	5%	2	2	4
Transit	65%	13	42	55	65%	36	23	59
Non-motorized	15%	3	10	13	15%	8	6	14
Total Person Trips	100%	19	68	86	100%	55	35	90

As shown in **Table 5**, the resulting number of potential 'new' two-way vehicle trips for the proposed development is approximately 11 and 15 veh/h during the weekday morning and afternoon peak hours, respectively. The future vehicle trip generation is expected to decrease over time as a result of access to the Stage 2 LRT at Cleary Station.

3.5. VEHICLE 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 6**.

Table 6: Traffic Distribution

To/From	AM Peak Hour
North	5%
South	5%
East	65%
West	25%
Total	100%

New site generated trips were assigned to the Study Area intersections using the above distribution, turning movement splits, proximity / connectivity to major transportation infrastructure (i.e. Highway 417), and the proposed access configuration. **Figure 13** and **Figure 14** show the 2019 and 2024 site generated traffic volumes, respectively.

Figure 13: 2019 Site Generated Traffic Volumes

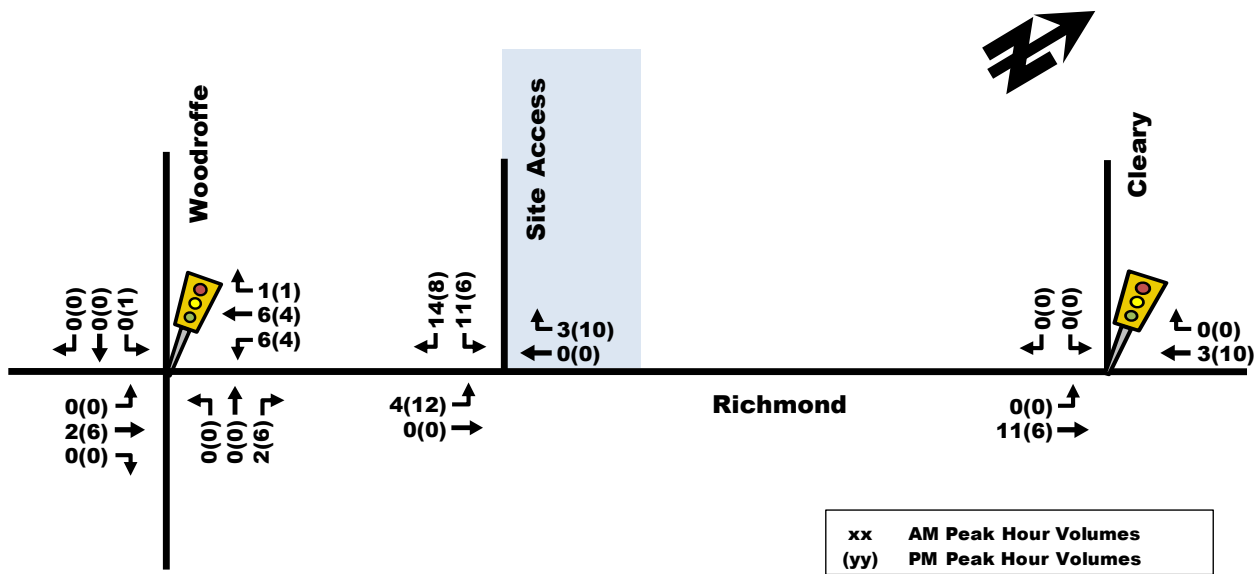
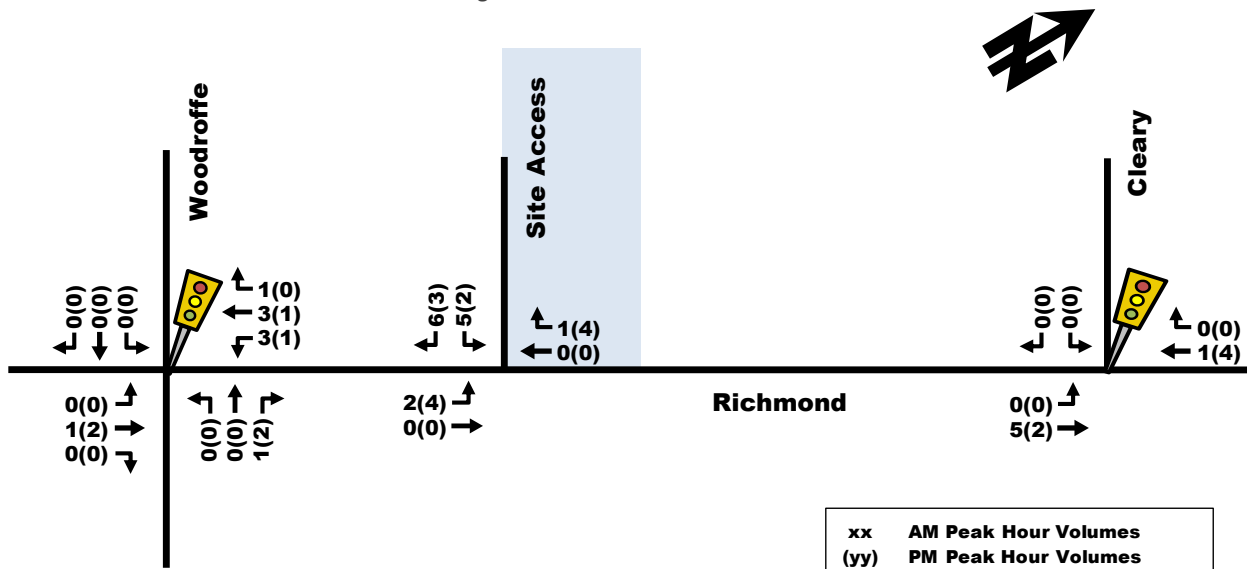


Figure 14: 2024 Site Generated Traffic Volumes



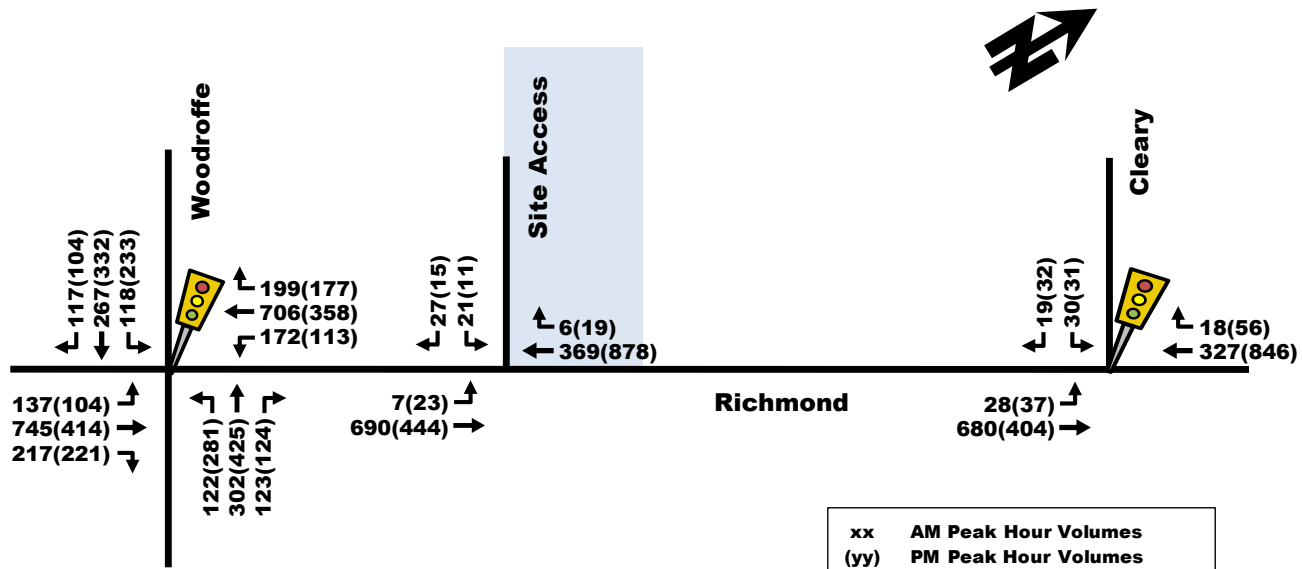
3.6. LEFT-TURN LANE WARRANT

Based on the heavy volumes on Richmond Road, a left-turn lane is warranted into the site access off Richmond using the MTO nomographs. However, given the context of the road, the lack of left-turn lanes into adjacent development driveways and the low left-turning vehicles in the site (less than 10 left turning vehicles in the 2024 ultimate scenario), a left-turn lane would not be appropriate in this situation. The left-turn warrant analysis is included in **Appendix G**. The future Phase 2 LRT will also modify the streetscape along Richmond Road, given the low turning volumes, the Phase 2 LRT streetscape design should supersede the left turn lane warrant. Additionally, this warrant is driven by the through traffic in each direction. As a result of the Phase 2 LRT the traffic volumes along Richmond Road could be reasonable assumed to decrease and therefore the need for the left turn lane will be further reduced.

3.7. PROJECTED 2019 CONDITIONS AT FULL SITE DEVELOPMENT

The total projected 2019 volumes associated with the proposed development were derived by superimposing 'new' site-generated traffic volumes (Figure 13) onto projected 2019 background traffic volumes (Figure 11). The resulting total projected 2019 volumes are illustrated as Figure 15.

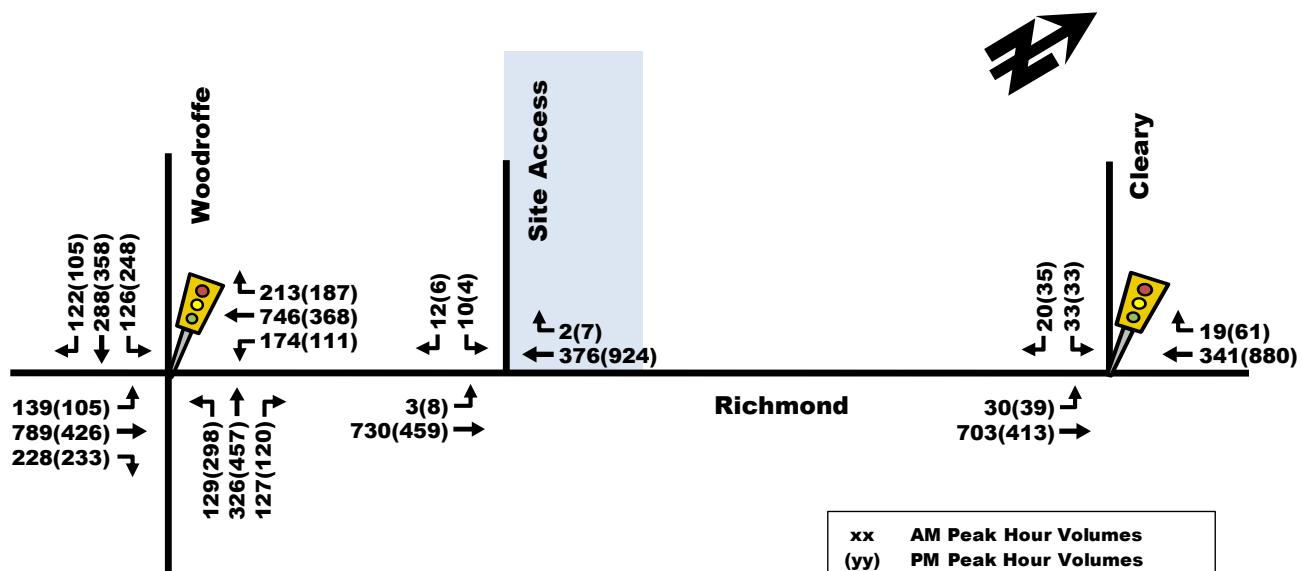
Figure 15: 2019 Total Future Traffic Volumes



3.8. PROJECTED 2024 CONDITIONS AT FULL SITE DEVELOPMENT PLUS FIVE YEARS

The total projected 2024 volumes associated with the proposed development were derived by superimposing 'new' site-generated traffic volumes (Figure 14) onto projected 2024 background traffic volumes (Figure 12). The resulting total projected 2024 volumes are illustrated as Figure 16.

Figure 16: 2024 Total Future Traffic Volumes



4. FUTURE TRAFFIC OPERATIONS

4.1. 2019 FUTURE BACKGROUND CONDITIONS

The operational analysis of the 2019 background conditions is summarized in **Table 7** below. The detailed Synchro analysis sheets are provided as **Appendix C**.

Table 7: 2019 Future Background Capacity Analysis

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection 'as a Whole'		
	LOS	max. v/c or avg. delay (s)	Movement	Delay (s)	LOS	v/c
Woodroffe Avenue / Richmond Road (Signalized)	E(E)	0.97(0.98)	WBL(SBL)	33.9(38.7)	B(C)	0.69(0.73)
Cleary Avenue / Richmond Road (Signalized)	C(D)	0.79(0.89)	EBT(WBT)	15.1(21.0)	C(C)	0.75(0.78)
Notes: Analysis of signalized intersections assumes a PHF of 0.95 and a saturation flow rate of 1800 veh/h/lane.						

As shown in **Table 7**, the signalized Woodroffe Avenue/Richmond Road critical movements are projected to operate at a LOS 'E' for the westbound left turn during the AM peak period and a LOS 'E' for the southbound left movement during the PM peak.

For the intersection at the signalized intersection at Cleary Avenue/Richmond Road, the critical movements are projected to operate at LOS 'C' for the eastbound through movement during the AM peak period and LOS 'D' for the westbound through movement during the PM peak.

The overall intersection LOS at these locations is within the permissible operational thresholds.

4.2. 2019 TOTAL FUTURE CONDITIONS

The operational analysis of the 2019 background conditions is summarized in **Table 8** below. The detailed Synchro analysis sheets are provided as **Appendix D**.

Table 8: 2019 Total Future Capacity Analysis

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection 'as a Whole'		
	LOS	max. v/c or avg. delay (s)	Movement	Delay (s)	LOS	v/c
Woodroffe Avenue / Richmond Road (Signalized)	F(E)	1.01(1.00)	WBL(SBL)	34.7(39.4)	B(C)	0.69(0.74)
Cleary Avenue / Richmond Road (Signalized)	D(D)	0.81(0.90)	EBT(WBT)	15.6(21.9)	C(C)	0.77(0.79)
Richmond Road / Site Access (Unsignalized)	C(C)	16.9(26.7)	SB(SB)	0.8(0.9)	-	-
Notes: Analysis of signalized intersections assumes a PHF of 0.95 and a saturation flow rate of 1800 veh/h/lane.						

As shown in **Table 8**, the signalized Woodroffe Avenue/Richmond Road critical movements are projected to operate at a LOS 'F' for the westbound left turn during the AM peak period and a LOS 'E' for the southbound left movement during the PM peak.

For the intersection at the signalized intersection at Cleary Avenue/Richmond Road, the critical movements are projected to operate at LOS 'D' for the eastbound through movement during the AM peak period and LOS 'D' for the westbound through movement during the PM peak.

The proposed unsignalized access at Richmond Road/West Site Access has projected critical movements operating at LOS 'C' for both AM and PM peaks.

The overall intersection LOS at these locations is within the permissible operational thresholds.

4.3. 2024 FUTURE BACKGROUND CONDITIONS

The operational analysis of the 2019 background conditions is summarized in **Table 9** below. The detailed Synchro analysis sheets are provided as **Appendix E**.

Table 9: 2024 Future Background Capacity Analysis

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection 'as a Whole'		
	LOS	max. v/c or avg. delay (s)	Movement	Delay (s)	LOS	v/c
Woodroffe Avenue / Richmond Road (Signalized)	F(F)	1.11(1.16)	WBL(SBL)	38.5(47.6)	C(C)	0.74(0.79)
Cleary Avenue / Richmond Road (Signalized)	D(E)	0.83(0.93)	EBT(WBT)	16.6(27.0)	C(D)	0.78(0.84)
Notes: Analysis of signalized intersections assumes a PHF of 0.95 and a saturation flow rate of 1800 veh/h/lane.						

As shown in **Table 9**, the signalized Woodroffe Avenue/Richmond Road critical movements are projected to operate at a LOS 'F' for the westbound left turn during the AM peak period and a LOS 'F' for the southbound left movement during the PM peak.

For the intersection at the signalized intersection at Cleary Avenue/Richmond Road, the critical movements are projected to operate at LOS 'D' for the eastbound through movement during the AM peak period and LOS 'E' for the westbound through movement during the PM peak.

4.4. 2024 TOTAL FUTURE CONDITIONS

The operational analysis of the 2019 background conditions is summarized in **Table 10** below. The detailed Synchro analysis sheets are provided as **Appendix F**.

Table 10: 2024 Total Future Capacity Analysis

Intersection	Weekday AM Peak (PM Peak)					
	Critical Movement			Intersection 'as a Whole'		
	LOS	max. v/c or avg. delay (s)	Movement	Delay (s)	LOS	v/c
Woodroffe Avenue / Richmond Road (Signalized)	F(F)	1.13(1.17)	WBL(SBL)	39.1(48.0)	C(C)	0.75(0.79)
Cleary Avenue / Richmond Road (Signalized)	D(E)	0.84(0.94)	EBT(WBT)	16.9(27.6)	C(D)	0.79(0.85)
Richmond Road / Site Access (Unsignalized)	C(D)	16.3(25.2)	SB(SB)	0.4(0.4)	-	-
Notes: Analysis of signalized intersections assumes a PHF of 0.95 and a saturation flow rate of 1800 veh/h/lane.						

As shown in **Table 10**, the signalized Woodroffe Avenue/Richmond Road critical movements are projected to operate at a LOS 'F' for the westbound left turn during the AM peak period and a LOS 'F' for the southbound left movement during the PM peak.

For the intersection at the signalized intersection at Cleary Avenue/Richmond Road, the critical movements are projected to operate at LOS 'D' for the eastbound through movement during the AM peak period and LOS 'E' for the westbound through movement during the PM peak.

The proposed unsignalized access at Richmond Road/West Site Access has projected critical movements operating at LOS 'C' for the AM peak and LOS 'D' for the PM peak period.

5. FINDINGS AND RECOMMENDATIONS

851 Richmond Road, located on Richmond Road, between the intersections of Woodroffe Road / Richmond Road and Cleary Avenue / Richmond Road, is a residential development that will consist of approximately 132 new High-Rise Apartment units.

Based on the foregoing analysis of the proposed development, the following transportation-related conclusions are offered:

EXISTING CONDITIONS

- The intersection north of the site within the study area at Cleary Avenue / Richmond Road is currently operating 'as a whole' with an overall LOS 'C' or better during the weekday morning and afternoon peak hours.
- The intersection south of the site within the study area at Woodroffe Avenue / Richmond Road is currently operating 'as a whole' with an overall LOS 'C' or better during the weekday morning and afternoon peak hours.
- No safety issues were noted at the signalized study area intersections adjacent to the proposed site.

PROJECTED CONDITIONS

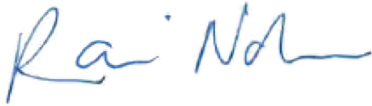
- To account for background growth beyond that Study Area, a 1.5% traffic growth rate per annum was assumed for the 2019 and 2024 horizon years.
- It is projected that the proposed development, for the 2019 horizon, would generate 'new' two-way vehicle volumes of approximately 32 and 36 veh/h during the weekday morning and afternoon peak hours, respectively.
- As a result of the anticipated shift in mode share, it is projected that the proposed development, for the 2024 horizon, would generate 'new' two-way vehicle volumes of approximately 13 veh/h during both the weekday morning and afternoon peak hours.
- At full occupancy (year 2019), study area intersections 'as a whole' are projected to operate at an acceptable LOS 'C' or better and the 'critical movements' are projected to operate at acceptable levels of service during both peak hours.
- At 5-years beyond site build-out, study area intersections 'as a whole' are projected to operate at an acceptable LOS 'D' or better.
- A left turn lane warrant analysis has been conducted for the proposed access point. While the warrant does show that a left turn lane is warranted, the context of this development and the adjacent developments along Richmond Road should be considered, including the lack of left-turn lanes into adjacent development driveways and the low left-turning vehicles in the site (less than 10 left turning vehicles in the 2024 ultimate scenario). Based on those factors, a left turn lane is not appropriate at the entrance to this development. Additionally, the Phase 2 LRT will redesign the streetscape along Richmond Road and the streetscape design should supersede the left turn lane warrant.

Based on the foregoing, the proposed development fits well into the context of the surrounding area, and its location and design serves to promote use of walking, cycling, and transit modes, thus supporting City of Ottawa policies, goals and objectives with respect to redevelopment, intensification and modal share.

PARSONS

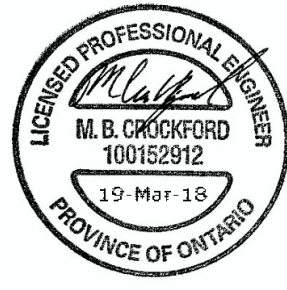
Therefore, Homestead's proposed development at 851 Richmond Road is recommended from a transportation perspective.

Prepared By:



Rani Nahas, E.I.T.
Transportation Analyst

Reviewed By:



Mark Crockford, P.Eng.
Transportation Engineer

14 June 2018

City of Ottawa
Development Review Services
110 Laurier Avenue West
Ottawa, ON K1P 1J1

Attention: Rosanna Baggs

Dear Rosanna:

**Re: 891 Richmond Road
Transportation Impact Study – Addendum #2**

This Addendum has been prepared to address the comments received from the City of Ottawa, dated May 16, 2018, with corresponding responses from Parsons.

1. SITE PLAN

1.1. TRANSPORTATION ENGINEERING SERVICES

***Comment 1:** This section of Richmond Road will need to be rebuilt as per the Stage 2 LRT Byron Avenue /Richmond Road concept plan. Cycle tracks and sidewalks will be required along the site frontage following construction of Stage 2 Richmond Road design. Ensure that site landscaping is coordinated with this design.*

Please contact Mike Schmidt (mike.schmidt@ottawa.ca or 613-580-2424 x13431) to obtain a CAD version of the functional design for Richmond Road. Please note that prior to providing the CAD file the attached Confidentially Agreement must be signed. It is standard practice that anyone who may receive information that is not currently publicly available related to the Stage 2 LRT project must sign this agreement.

Response 1: The proponent has had multiple discussions with the Stage 2 LRT group and understands that these plans are not yet finalized. The proposed landscaping has been designed to complement preliminary designs for Richmond Road and the appropriate road widening area has been set aside.

***Comment 2:** Ensure that accesses meet by-law requirements.*

Response 2: The main, two-way access, meets the private approach by-law. The easterly access does not meet the full by-law for the distance from the adjacent property line. However, the access does meet the reduced off-set of 0.3m. Additionally, the access would meet the three qualifying statements for a reduced offset (below) and therefore would be appropriate as shown.

The offset may be reduced provided that the access is:

- (i) a safe distance from the access serving the adjacent property, the proposed easterly access is approximately 60m west of the nearest access serving the adjacent property, according to the proposed site plan found on Ottawa's Devapps webtool.
- (ii) in such a manner that there are adequate sight lines for vehicles exiting from the property, Richmond Road along the frontage of the subject site is flat and straight and no sight line issues are anticipated at the entrance, and

- (iii) in such a manner that it does not create a traffic hazard. The proposed site is anticipated to generate a minimal number of trips, additionally, the easterly access will be a minor, exit only driveway, that will primarily be used for vehicles leaving the move-in area behind the proposed new building.

1.2. DEVELOPMENT REVIEW – TRANSPORTATION ENGINEERING SERVICES

Comment 3: Clear throat length required on an arterial for an apartment with 100-200 units is a minimum of 25m. This should take into consideration the widening.

Response 3: The clear throat length has been increased, compared to the original submission. However, on this site, providing the full 25m throat length is not appropriate. This site has been shown to generate an extremely low number of vehicle trips. The throat length is to accommodate vehicles turning into the site, without interference on site from vehicles making parking maneuvers or stopping. This will prevent vehicles from queuing back on to the adjacent street. This situation only occurs where a high volume of trips is anticipated at the access point. The 25m standard has been developed based on a standard apartment building with 100-200 units. The proposed apartment building is within a TOD zone and will therefore have significantly different trip generation characteristics and should be treated in a unique manner. To determine an appropriate throat length an MSU truck has been placed on the property (and completely within the property) at the access point. A clear throat length has been provided that would allow this truck to enter the site and stop on-site without interfering with the sidewalk or the adjacent street. As the most typical vehicle accessing the site will be a passenger vehicle, this design is considered appropriate. A throat length of approximately 11m has been provided for the main access to 851 Richmond Road.

Comment 4: List the width of the following on the site plan:

- a. garage ramp/access
- b. move-in area

Response 4: The garage/ramp access is 6m wide and the move-in area is 5.2m wide.

Comment 5: Provide a subsurface melting device for the garage access ramp as the grade is greater than 12%.

Response 5: Noted, it has been indicated that this will be provided.

Comment 6: Note depressed curb locations where pedestrian facilities are broken by drive aisles.

Response 6: -The site plan has been modified accordingly.

Comment 7: Side walk along Richmond to be continuous as per SC7.1 detail 1.

Response 7: See attached.

Comment 8: Show road details of Richmond road on site plan; i.e. line painting.

Response 8: Existing centreline and edge of pavement line painting have been shown on the site plan.

Comment 9: Most western surface parking aisle does not conform to Table 107 – Minimum Required Aisle Width of Part 4 – Parking, Queuing and Loading Provisions of the Zoning By-law; lane width for 90-degree parking space is 6.7m.

Response 9: The surface parking lot has been reviewed and revised accordingly.

Comment 10: "Exit Only" signage will be required for the one-way out access.

Response 10: Noted, a note has been added to the site plan indicating this.

Comment 11: *Provide truck turning templates for both access for the large vehicle to use the site (both entering and exiting from both direction on/off Richmond), as well as along the one-way drive aisle.*

Response 11: Turning templates have been completed and curb modifications have been made to accommodate the trucks. Several drawings have been included as part of this addendum to document the turning templates.

Comment 12: *Provide turning templates for the garage ramps within the garage. Traffic control may be required at the garage entrance if two cars cannot pass each other at the same time.*

Response 12: Turning templates have been completed. The car turning paths would overlap at the ramps. We would recommend convex mirrors to provide assistance to drivers entering and exiting.

2. TRANSPORTATION BRIEF

2.1. TRAFFIC SIGNALS

Comment 13: *No comments for this circulation and this TB.*

Response 13: -Noted.

Comment 14: *Future considerations:*

- *If there are any future proposed changes in the existing roadway geometry for the purpose of construction of a new TCS(s) or modifications to existing TCS(s) the City of Ottawa Traffic Signal Design and Specification Unit is required to complete a review for traffic signal plant re-design and provide the actual re-design.*

Response 14: -Noted.

2.2. TRAFFIC ENGINEERING

Comment 15: *The PM volumes do not seem to reflect existing conditions given that the outbound would be the peak direction. Also, the volumes do not balance with the adjacent intersections. More up to date counts should be used for the analysis at Richmond Road and Woodroffe Avenue.*

Response 15: The counts used were the same counts that were used for the approved CTS for the adjacent 809 Richmond Road. Additionally, the subject development has been shown to produce a minimal number of site trips. With the construction of the Future Phase 2 LRT the context of the entire development, and the subject intersection, will be drastically altered. This will influence the future operations and therefore the configuration, of the Richmond Road and Woodroffe Avenue intersection to a greater degree than the subject development, which will have no impact on the noted intersection.

2.3. STREET LIGHTING

Comment 16: *No comments for Traffic Brief.*

Response 16: -Noted.

Comment 17: Future Considerations:

- Site plan does not show any proposed water/sewer connections into ROW. If there are future utilities being installed:
- Streetlights and street light plant must be maintained and protected at all times. Locates required.
- If there are any road geometry changes, Street Lighting will need to review any impact/changes to street lighting.
- If conflict arises please contact Isak Wall (City of Ottawa) 613-580-2424 ext. 32593.

Response 17: -Noted.

2.4. TRANSPORTATION ENGINEERING SERVICES

Comment 18: Table 3 in the trip generation section is incorrectly written- there are 132 apartment units and the TRANS land code is 222. Ensure that this error has not affected other tables/calculations.

Response 18: This is a small typo that does not impact the development or trip generation analysis. The corrected tables are below.

Table 1: ITE Vehicle Trip Generation Rates

Land Use	Data Source	Trip Rates	
		AM Peak	PM Peak
High-Rise Apartment	ITE 222	T = 0.24(du)	T = 0.27(du)
Notes: T = Average Vehicle Trip Ends du = Dwelling units			

Using the TRANS Trip Generation rates for the residential component of the site, the total amount of vehicle trips generated by the proposed development was projected. The results are summarized in **Table 3**.

Table 2: Projected Vehicle Trip Generation - TRANS Model

Land Use	Area	AM Peak (Veh/h)			PM Peak (Veh/h)		
		In	Out	Total	In	Out	Total
High-Rise Apartments	132 units	7	25	32	22	14	36
Total Vehicle Trips		7	25	32	22	14	36

2.5. DEVELOPMENTS REVIEW - TRANSPORTATION ENGINEERING SERVICES

Comment 19: Is an occupancy date of 2019 still reasonable/achievable?

Response 19: The first occupancies are currently targeted for the later part of 2019, with fully occupancy being completed very early in 2020. This date was selected at the outset of the study, in mid-2018, and was reasonable at that time. Subsequent delays during the approval process have delayed the fully occupancy slightly. Regardless, the study date is appropriate. Any change to the study date would not have a significant impact on the overall results of the TIA, and therefore no revisions to the study have been undertaken.

Comment 20: Section 1 second paragraph – the site plan has been revised to only have one full movement access and one one-way. This still lists two FMAs.

Response 20: The study submitted in March 2018 correctly refers to one full movement access and one one-way access.

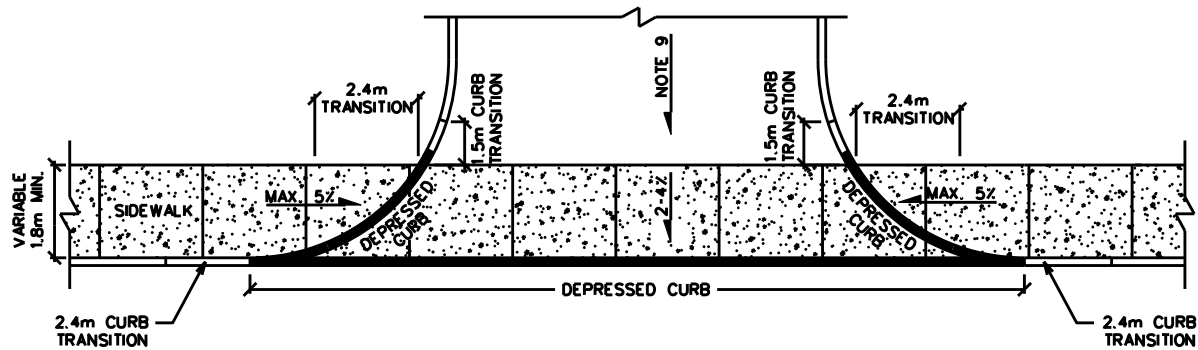
Sincerely,

A handwritten signature in blue ink, appearing to read "Rani Nahas".

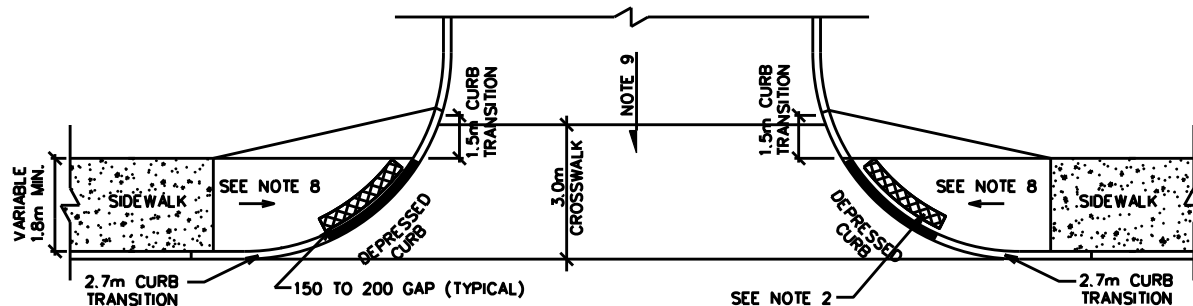
Rani Nahas, EIT
Traffic Analyst

A handwritten signature in blue ink, appearing to read "Mark Crockford".

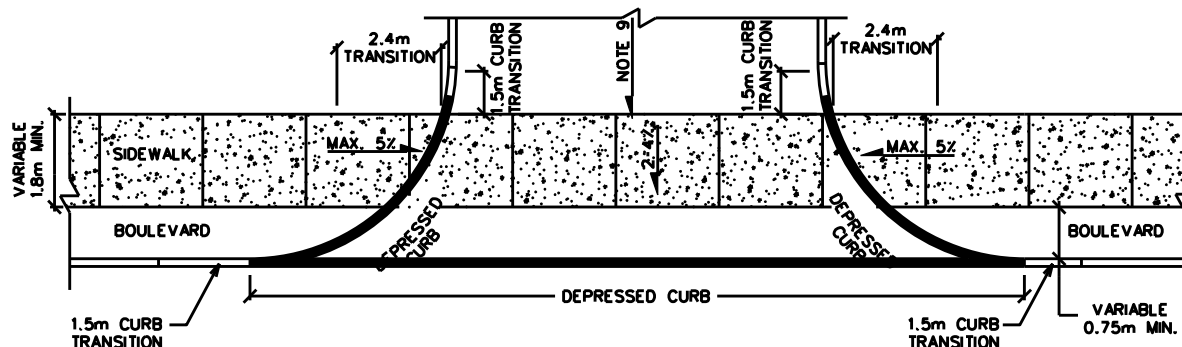
Mark Crockford, P. Eng.
Transportation Engineer



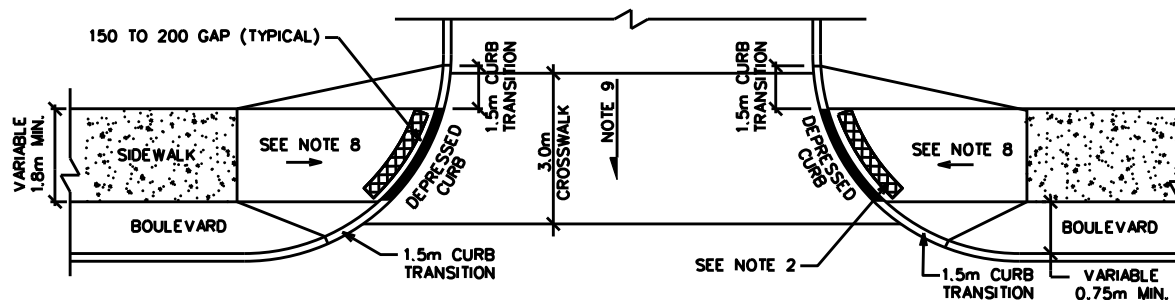
CURB RETURN AT A PRIVATE OR COMMERCIAL ENTRANCE - UNSIGNALIZED INTERSECTION



COMMERCIAL ENTRANCE OR CURB RETURN PRIVATE ENTRANCE AT A CONTROLLED INTERSECTION



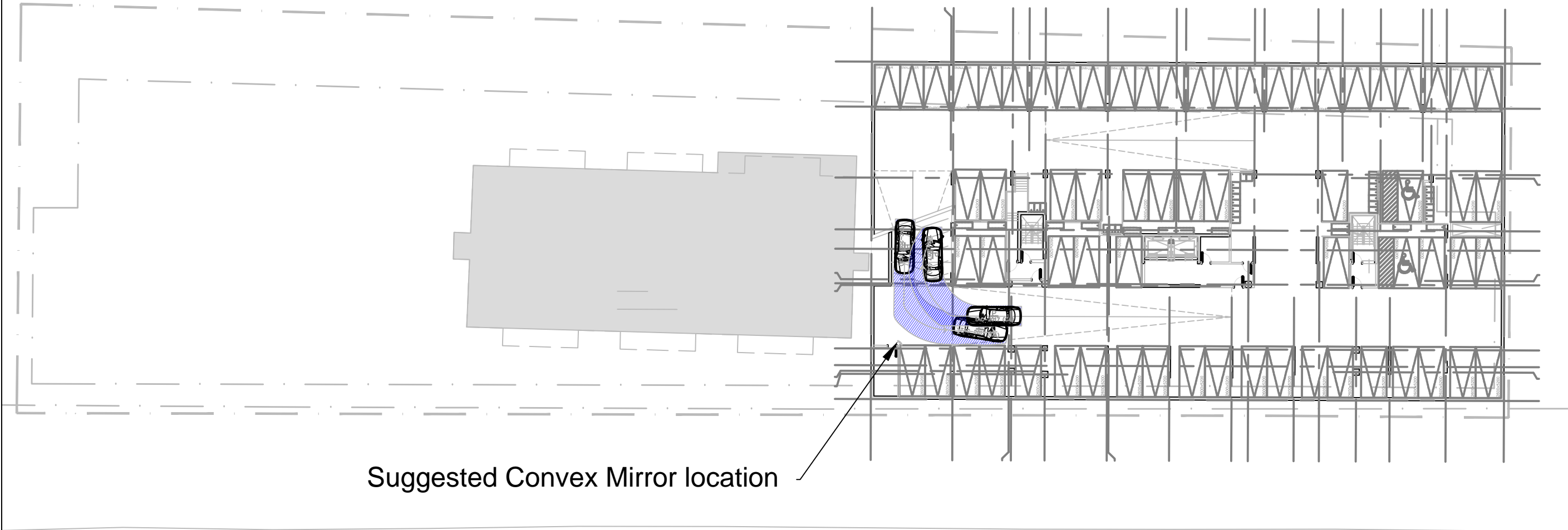
CURB RETURN AT A PRIVATE OR COMMERCIAL ENTRANCE WITH BOULEVARD - UNSIGNALIZED INTERSECTION



COMMERCIAL ENTRANCE OR CURB RETURN PRIVATE ENTRANCE WITH BOULEVARD AT A CONTROLLED INTERSECTION

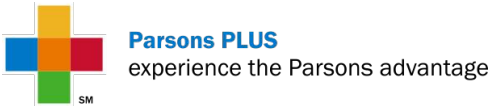
NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SHOWN OTHERWISE.
2. APPROVED 610 X WIDTH OF CURB RAMP (1500MIN) TACTILE WALKING SURFACE INDICATOR, RADIUS TO MATCH CURB. DRAIN GROOVES AS PER SC7.
3. CURB DETAILS SEE SC1.1, SC1.2 AND SC1.3.
4. SIDEWALK DETAILS SEE SC2 AND SC3.
5. CURB RAMPS AS PER SC6 AND SC7.
6. CONTROLLED MEANS SIGNALIZED OR A 4-WAY STOP INTERSECTION.
7. SUBJECT TO AVOIDANCE OF MEDIANS, CROSSWALK LINES TO BE CENTRED ON THE CURB RAMP.
8. FOR CURB RAMPS, SLOPE OF 2% TO 5%, MAXIMUM 8%.
9. MAXIMUM SLOPE VARIES, SEE PRIVATE APPROACH BYLAW



Suggested Convex Mirror location

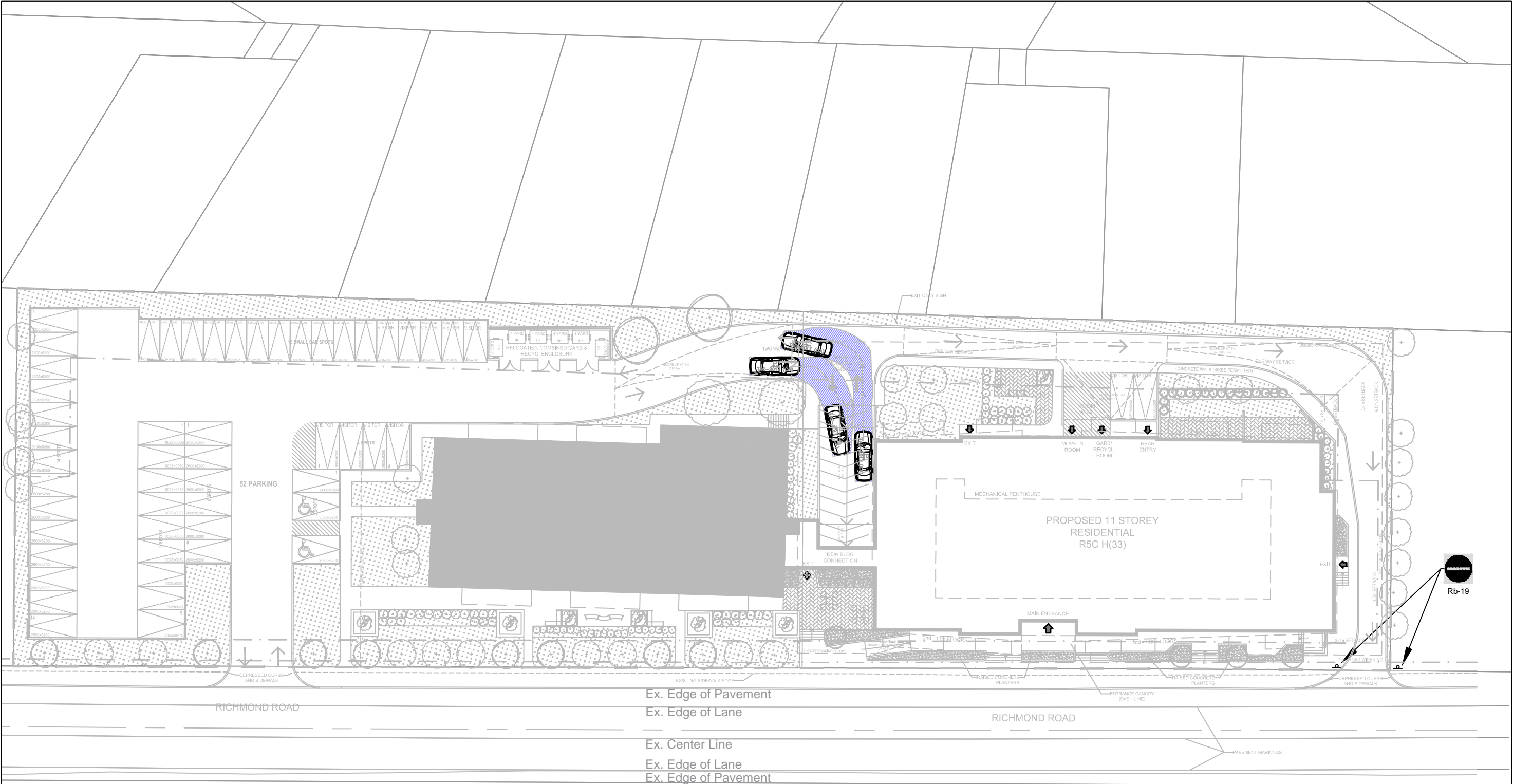
Not to Scale



Legend	
	5.80
P	1.10 3.20
Width	2.00
Track	2.00
Lock to Lock Time	6.0
Steering Angle	36.2

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

Drawing Description Modified Accesses - Underground Parking Passenger Vehicle Movements		
Client Homestead Land Holdings	Date June 14, 2018	Figure Number 004
Project Number 476418	Project Description 851 Richmond Road	

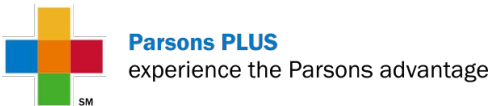


Ex. Edge of Pavement
Ex. Edge of Lane
Ex. Center Line
Ex. Edge of Lane
Ex. Edge of Pavement

RICHMOND ROAD

PAVEMENT MARKINGS

Rb-19

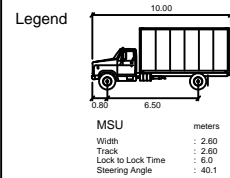
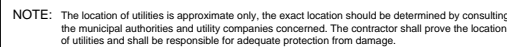
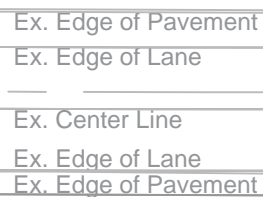


Legend

P	1.10	3.20	5.80
Width	: 2.00		
Track	: 2.00		
Lock to Lock Time	: 6.0		
Steering Angle	: 36.2		

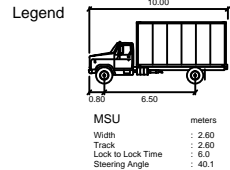
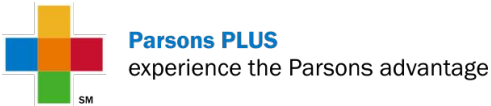
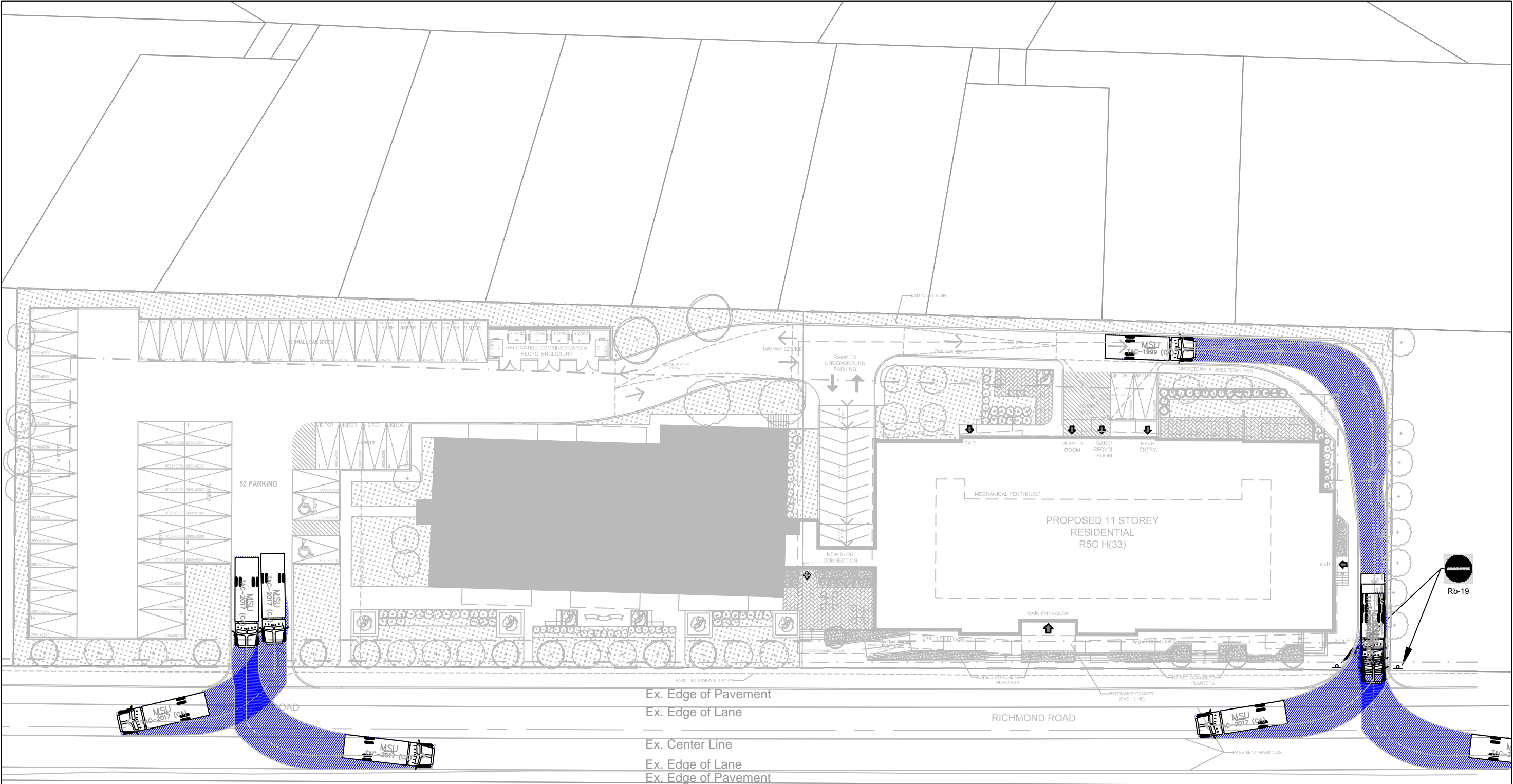
Not to Scale

Drawing Description Modified Accesses - Passenger Vehicle Movements		
Client Homestead Land Holdings	Date June 1, 2018	Figure Number 003
Project Number 476418	Project Description 851 Richmond Road	



Not to Scale

Drawing Description			Modified Accesses - MSU IN Truck Movements		
Client		Homestead Land Holdings		Date	June 14, 2018
				Figure Number	001
Project Number		476418		Project Description	
				851 Richmond Road	



Not to Scale

Drawing Description Modified Accesses - MSU OUT Truck Movements			
Client	Homestead Land Holdings	Date	June 14, 2018
Figure Number	002	Project Description	851 Richmond Road
Project Number	476418		

Appendix A

Traffic Data

Turning Movement Count - Peak Hour Diagram

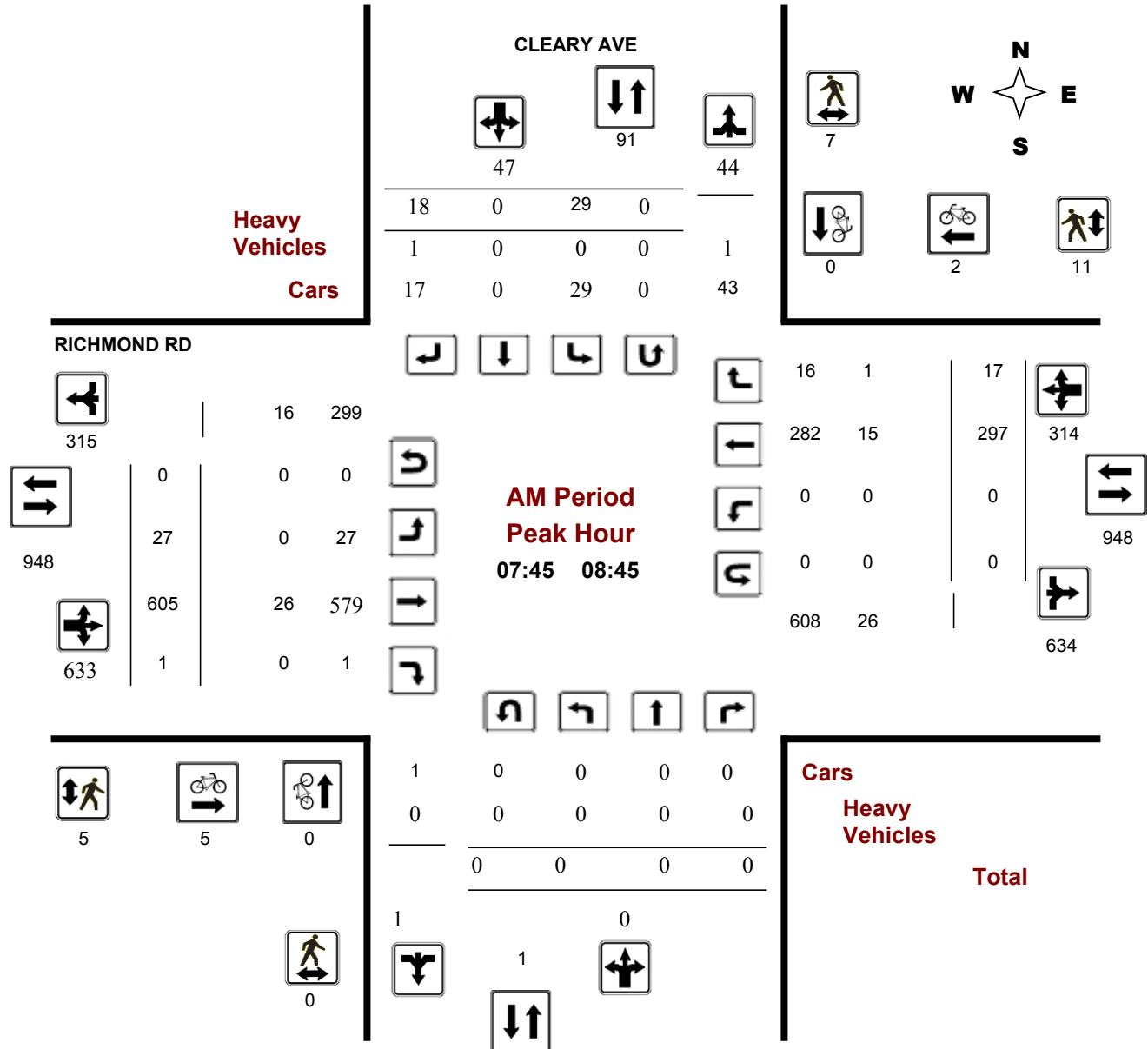
CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

Start Time: 07:00

WO No: 34681

Device: Jamar Technologies, Inc



Turning Movement Count - Peak Hour Diagram

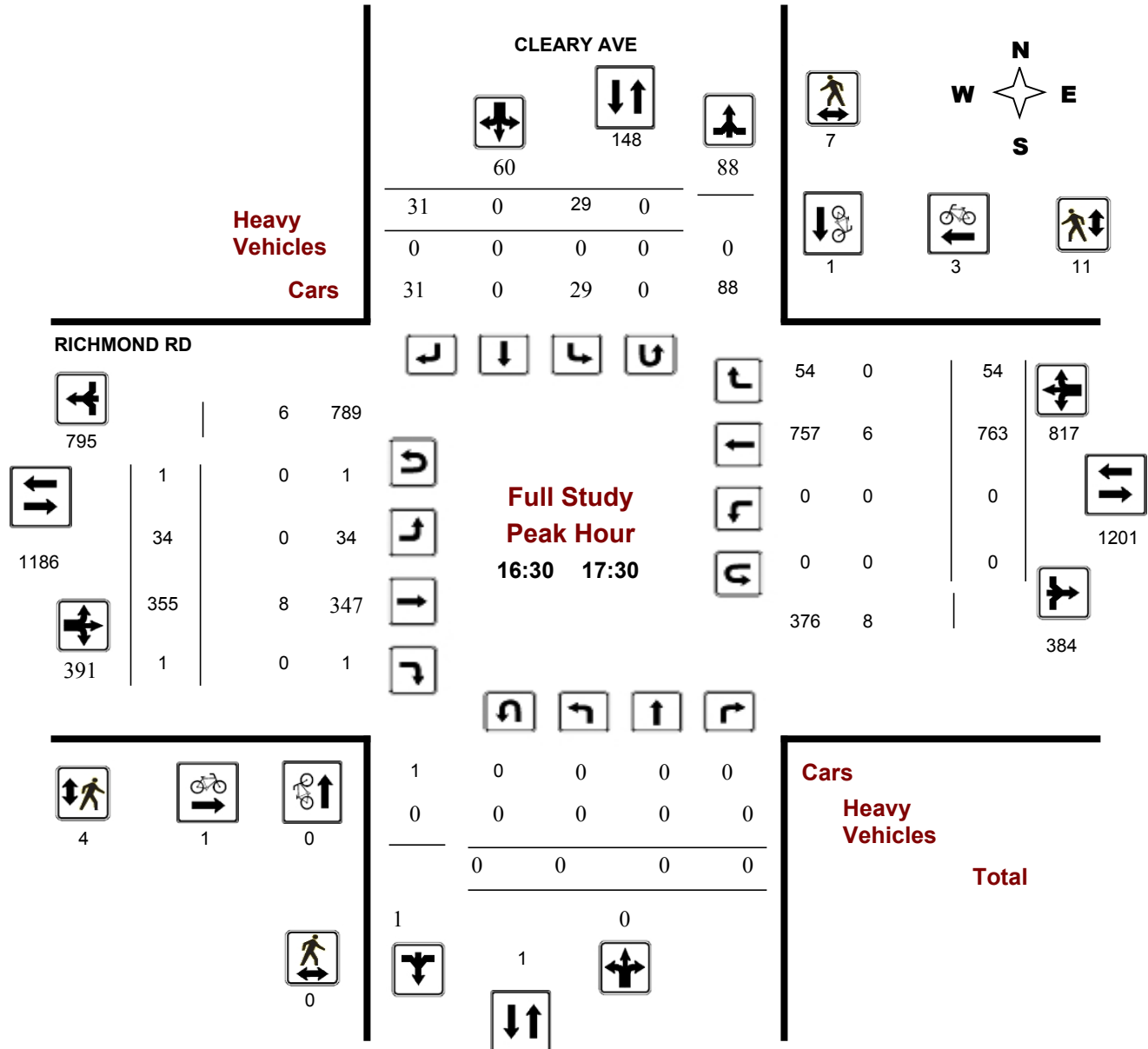
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Survey Date: Friday, June 12, 2015

Start Time: 07:00

WO No: 34681

Device: Jamar Technologies, Inc



Comments

Turning Movement Count - Peak Hour Diagram

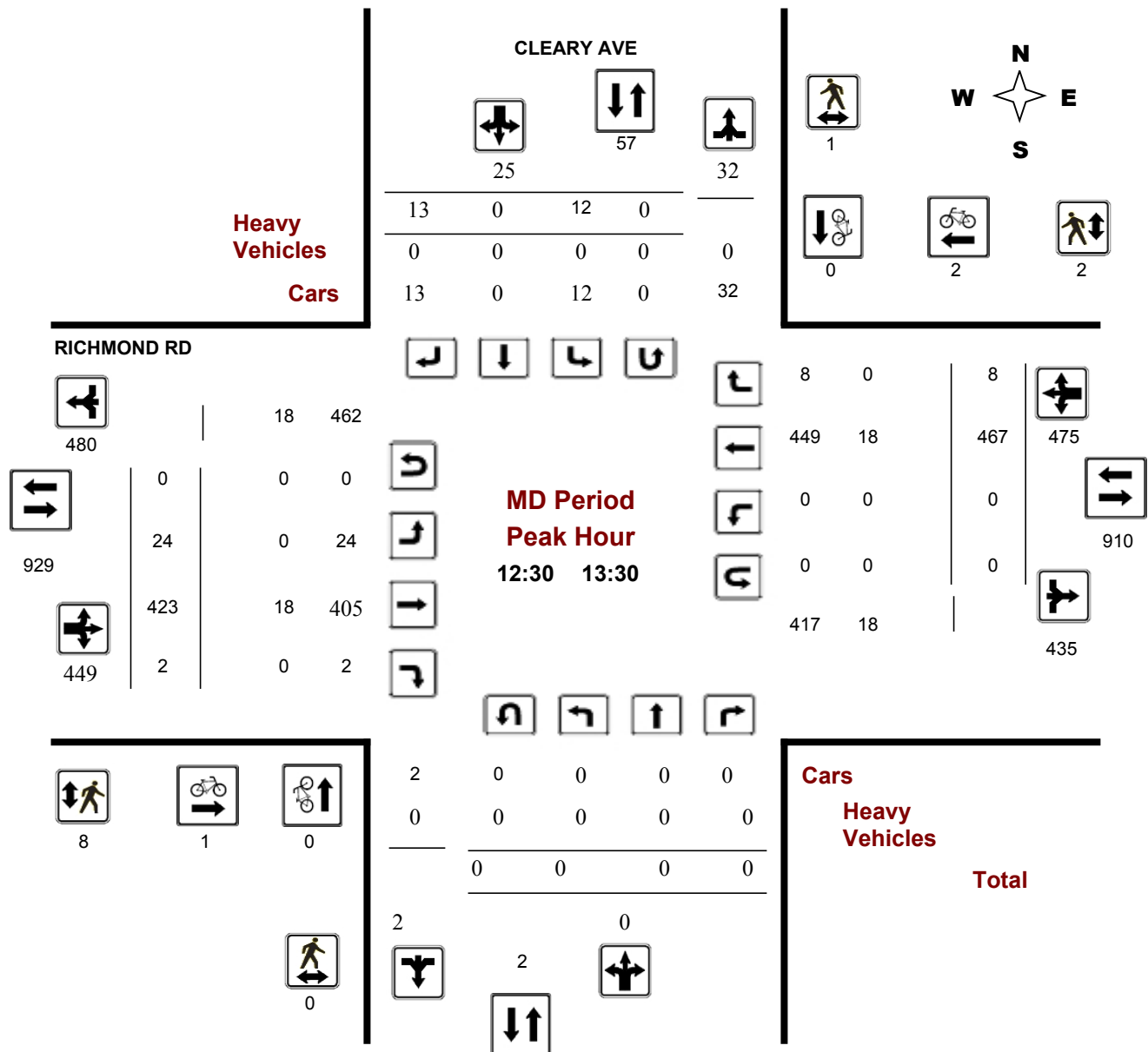
CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

Start Time: 07:00

WO No: 34681

Device: Jamar Technologies, Inc



Turning Movement Count - Peak Hour Diagram

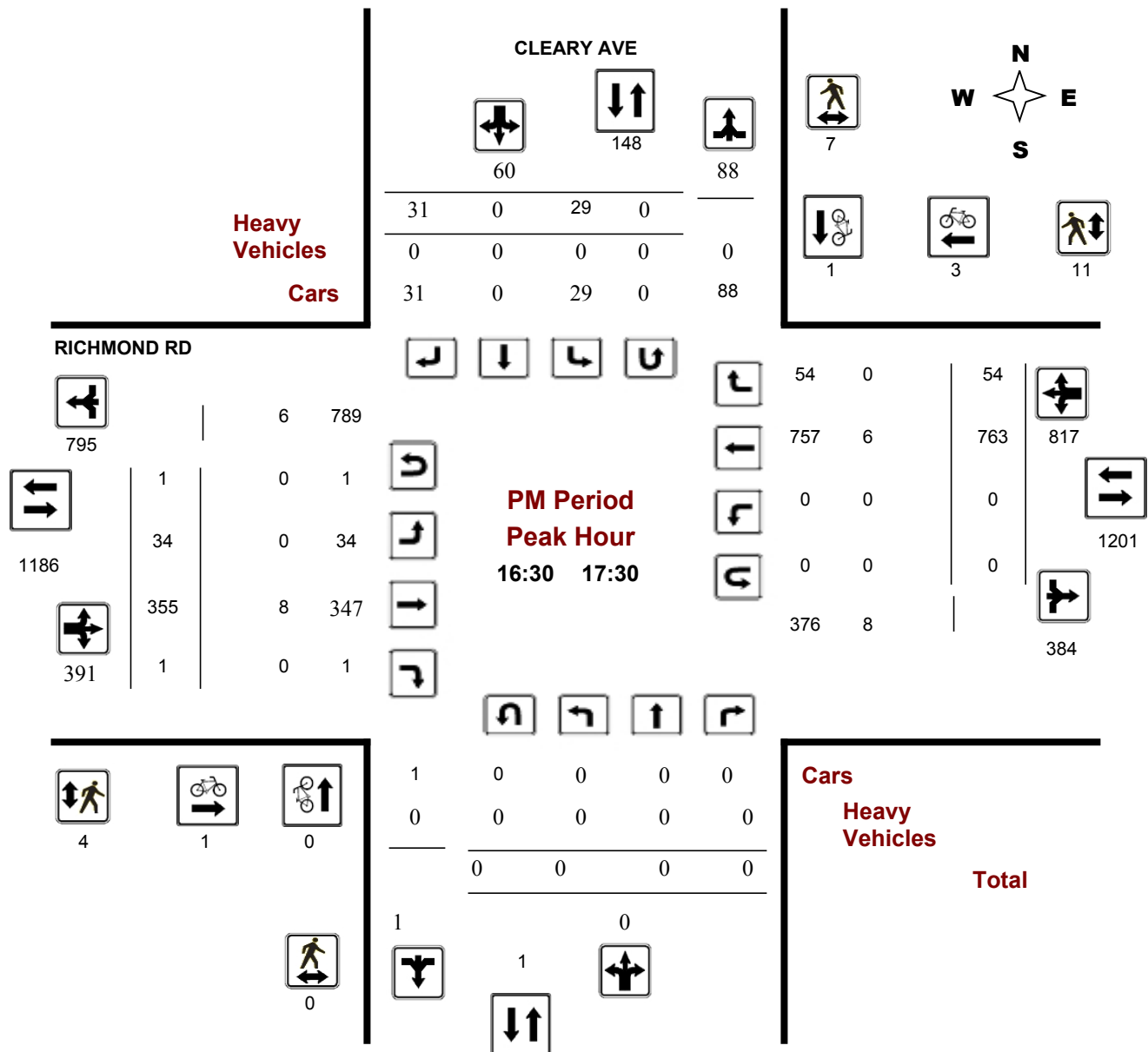
CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

Start Time: 07:00

WO No: 34681

Device: Jamar Technologies, Inc



Turning Movement Count - Full Study Summary Report

CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

Total Observed U-Turns

Northbound: 0 Southbound: 0
Eastbound: 1 Westbound: 0

AADT Factor

.80

Full Study

CLEARY AVE										RICHMOND RD									
Northbound					Southbound					Eastbound					Westbound				
Period	LT	ST	RT	NB TOT	LT	ST	RT	SB TOT	STR TOT	LT	ST	RT	EB TOT	LT	ST	RT	WB TOT	STR TOT	Grand Total
07:00 08:00	0	0	0	0	12	0	10	22	22	14	549	0	563	0	204	12	216	779	801
08:00 09:00	0	0	0	0	28	0	18	46	46	28	568	1	597	0	322	13	335	932	978
09:00 10:00	0	0	0	0	17	0	14	31	31	11	404	0	415	0	340	11	351	766	797
11:30 12:30	0	0	0	0	23	0	15	38	38	16	374	0	390	0	430	20	450	840	878
12:30 13:30	0	0	0	0	12	0	13	25	25	24	423	2	449	0	467	8	475	924	949
15:00 16:00	0	0	0	0	10	0	23	33	33	16	326	0	342	0	693	12	705	1047	1080
16:00 17:00	0	0	0	0	27	1	30	58	58	36	364	2	402	0	748	46	794	1196	1254
17:00 18:00	0	0	0	0	23	0	24	47	47	23	378	1	402	0	750	22	772	1174	1221
Sub Total	0	0	0	0	152	1	147	300	300	168	3386	6	3560	0	3954	144	4098	7658	7958
U Turns				0				0	0				1				0	1	1
Total	0	0	0	0	152	1	147	300	300	168	3386	6	3561	0	3954	144	4098	7659	7959
EQ 12Hr	0	0	0	0	211	1	204	417	417	234	4707	8	4950	0	5496	200	5696	10646	11063
Note: These values are calculated by multiplying the totals by the appropriate expansion factor.													1.39						
AVG 12Hr	0	0	0	0	169	1	163	334	334	187	3765	7	3960	0	4397	160	4557	8517	8851
Note: These volumes are calculated by multiplying the Equivalent 12 hr. totals by the AADT factor.													.80						
AVG 24Hr	0	0	0	0	221	1	214	437	437	245	4932	9	5187	0	5760	210	5970	11157	11594
Note: These volumes are calculated by multiplying the Average Daily 12 hr. totals by 12 to 24 expansion factor.													1.31						

Comments:

Note: U-Turns provided for approach totals. Refer to 'U-Turn' Report for specific breakdown.

Public Works - Traffic Services

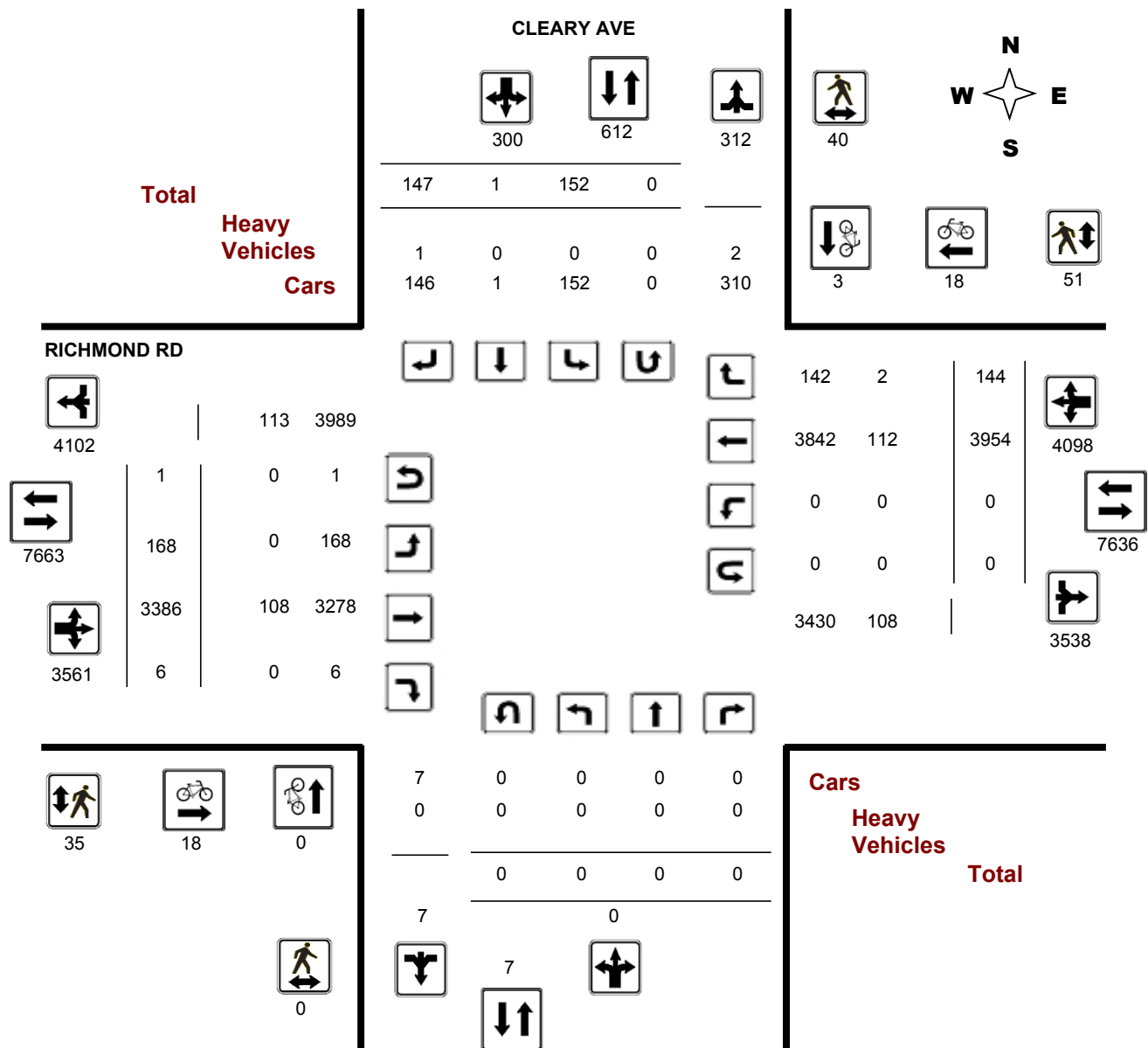
Turning Movement Count - Full Study Diagram

CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

WO#: 34681

Device: Jamar Technologies, Inc



Comments

Turning Movement Count - 15 Minute Summary Report

CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

Total Observed U-Turns

Northbound: 0 Southbound: 0
Eastbound: 1 Westbound: 0

CLEARY AVE

RICHMOND RD

Time Period	Northbound			N TOT	Southbound			S TOT	STR TOT	Eastbound			E TOT	Westbound			W TOT	STR TOT	Grand Total
	LT	ST	RT		LT	ST	RT			LT	ST	RT		LT	ST	RT			
07:00 07:15	0	0	0	0	1	0	4	5	5	4	106	0	110	0	40	1	41	151	156
07:15 07:30	0	0	0	0	2	0	1	3	3	3	144	0	147	0	52	3	55	202	205
07:30 07:45	0	0	0	0	5	0	2	7	7	3	133	0	136	0	54	4	58	194	201
07:45 08:00	0	0	0	0	4	0	3	7	7	4	166	0	170	0	58	4	62	232	239
08:00 08:15	0	0	0	0	10	0	1	11	11	6	136	0	142	0	79	7	86	228	239
08:15 08:30	0	0	0	0	9	0	8	17	17	12	154	1	167	0	94	4	98	265	282
08:30 08:45	0	0	0	0	6	0	6	12	12	5	149	0	154	0	66	2	68	222	234
08:45 09:00	0	0	0	0	3	0	3	6	6	5	129	0	134	0	83	0	83	217	223
09:00 09:15	0	0	0	0	5	0	4	9	9	4	97	0	101	0	107	4	111	212	221
09:15 09:30	0	0	0	0	7	0	5	12	12	2	109	0	111	0	68	2	70	181	193
09:30 09:45	0	0	0	0	1	0	1	2	2	1	78	0	79	0	83	1	84	163	165
09:45 10:00	0	0	0	0	4	0	4	8	8	4	120	0	124	0	82	4	86	210	218
11:30 11:45	0	0	0	0	8	0	3	11	11	4	99	0	103	0	109	3	112	215	226
11:45 12:00	0	0	0	0	7	0	1	8	8	3	113	0	116	0	100	8	108	224	232
12:00 12:15	0	0	0	0	2	0	4	6	6	4	73	0	77	0	117	3	120	197	203
12:15 12:30	0	0	0	0	6	0	7	13	13	5	89	0	94	0	104	6	110	204	217
12:30 12:45	0	0	0	0	2	0	2	4	4	3	116	0	119	0	104	2	106	225	229
12:45 13:00	0	0	0	0	6	0	3	9	9	6	114	0	120	0	124	3	127	247	256
13:00 13:15	0	0	0	0	0	0	7	7	7	5	97	1	103	0	119	1	120	223	230
13:15 13:30	0	0	0	0	4	0	1	5	5	10	96	1	107	0	120	2	122	229	234
15:00 15:15	0	0	0	0	3	0	1	4	4	2	75	0	77	0	120	4	124	201	205
15:15 15:30	0	0	0	0	2	0	3	5	5	2	82	0	84	0	163	3	166	250	255
15:30 15:45	0	0	0	0	3	0	8	11	11	4	89	0	93	0	205	4	209	302	313
15:45 16:00	0	0	0	0	2	0	11	13	13	8	80	0	88	0	205	1	206	294	307
16:00 16:15	0	0	0	0	7	0	3	10	10	9	106	0	115	0	190	4	194	309	319
16:15 16:30	0	0	0	0	5	1	7	13	13	8	87	1	96	0	187	5	192	288	301
16:30 16:45	0	0	0	0	9	0	11	20	20	9	93	0	103	0	198	8	206	309	329
16:45 17:00	0	0	0	0	6	0	9	15	15	10	78	1	89	0	173	29	202	291	306
17:00 17:15	0	0	0	0	7	0	10	17	17	11	82	0	93	0	193	11	204	297	314
17:15 17:30	0	0	0	0	7	0	1	8	8	4	102	0	106	0	199	6	205	311	319
17:30 17:45	0	0	0	0	3	0	10	13	13	6	97	0	103	0	183	1	184	287	300
17:45 18:00	0	0	0	0	6	0	3	9	9	2	97	1	100	0	175	4	179	279	288
TOTAL:	0	0	0	0	152	1	147	300	300	168	3386	6	3561	0	3954	144	4098	7659	7959

Note: U-Turns are included in Totals.

Comment:



Public Works - Traffic Services

Turning Movement Count - Cyclist Volume Report

Work Order
34681

CLEARY AVE @ RICHMOND RD

Count Date: Friday, June 12, 2015

Start Time: 07:00

Time Period	CLEARY AVE			RICHMOND RD			Grand Total
	Northbound	Southbound	Street Total	Eastbound	Westbound	Street Total	
07:00 08:00	0	0	0	6	1	7	7
08:00 09:00	0	0	0	6	2	8	8
09:00 10:00	0	0	0	0	3	3	3
11:30 12:30	0	1	1	2	0	2	3
12:30 13:30	0	0	0	1	2	3	3
15:00 16:00	0	0	0	1	3	4	4
16:00 17:00	0	2	2	2	1	3	5
17:00 18:00	0	0	0	0	6	6	6
Total	0	3	3	18	18	36	39

Comment:

Note: These volumes consists of bicycles only (no mopeds or motorcycles) and ARE NOT included in the Turning Movement Count Summary.

Turning Movement Count - Heavy Vehicle Report

CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

CLEARY AVE											RICHMOND RD									
Time Period		Northbound			Southbound						Eastbound			Westbound						Grand Total
		LT	ST	RT	N TOT	LT	ST	RT	S TOT	STR TOT	LT	ST	RT	E TOT	LT	ST	RT	W TOT	STR TOT	
07:00	08:00	0	0	0	0	0	0	0	0	0	0	17	0	17	0	17	0	17	34	34
08:00	09:00	0	0	0	0	0	0	1	1	1	0	21	0	21	0	16	1	17	38	39
09:00	10:00	0	0	0	0	0	0	0	0	0	0	19	0	19	0	16	1	17	36	36
11:30	12:30	0	0	0	0	0	0	0	0	0	0	13	0	13	0	20	0	20	33	33
12:30	13:30	0	0	0	0	0	0	0	0	0	0	18	0	18	0	18	0	18	36	36
15:00	16:00	0	0	0	0	0	0	0	0	0	0	8	0	8	0	11	0	11	19	19
16:00	17:00	0	0	0	0	0	0	0	0	0	0	8	0	8	0	7	0	7	15	15
17:00	18:00	0	0	0	0	0	0	0	0	0	0	4	0	4	0	7	0	7	11	11
Sub Total		0	0	0	0	0	0	1	1	1	0	108	0	108	0	112	2	114	222	223
U-Turns (Heavy Vehicles)					0				0	0				0				0	0	0
Total		0	0	0	0	0	0	1	1	1	0	108	0	108	0	112	2	114	222	223

Heavy Vehicles are vehicles having one rear axle with four or more wheels, or having two or more rear axles. These vehicles include most O.C. Transpo, school and inter-city buses. Further, they ARE included in the Turning Movement Count Summary.



Public Works - Traffic Services

Work Order

34681

Turning Movement Count - Pedestrian Volume Report

CLEARY AVE @ RICHMOND RD

Count Date: Friday, June 12, 2015

Start Time: 07:00

Time Period	NB Approach (E or W Crossing)	SB Approach (E or W Crossing)	Total	EB Approach (N or S Crossing)	WB Approach (N or S Crossing)	Total	Grand Total
07:00 07:15	0	0	0	1	0	1	1
07:15 07:30	0	1	1	0	2	2	3
07:30 07:45	0	3	3	0	2	2	5
07:45 08:00	0	2	2	1	1	2	4
07:00 08:00	0	6	6	2	5	7	13
08:00 08:15	0	3	3	1	2	3	6
08:15 08:30	0	2	2	2	5	7	9
08:30 08:45	0	0	0	1	3	4	4
08:45 09:00	0	0	0	0	3	3	3
08:00 09:00	0	5	5	4	13	17	22
09:00 09:15	0	3	3	0	0	0	3
09:15 09:30	0	6	6	0	5	5	11
09:30 09:45	0	2	2	1	0	1	3
09:45 10:00	0	0	0	0	1	1	1
09:00 10:00	0	11	11	1	6	7	18
11:30 11:45	0	0	0	3	1	4	4
11:45 12:00	0	0	0	1	1	2	2
12:00 12:15	0	0	0	1	7	8	8
12:15 12:30	0	1	1	0	0	0	1
11:30 12:30	0	1	1	5	9	14	15
12:30 12:45	0	1	1	2	1	3	4
12:45 13:00	0	0	0	2	0	2	2
13:00 13:15	0	0	0	2	0	2	2
13:15 13:30	0	0	0	2	1	3	3
12:30 13:30	0	1	1	8	2	10	11
15:00 15:15	0	3	3	1	0	1	4
15:15 15:30	0	2	2	1	0	1	3
15:30 15:45	0	0	0	2	2	4	4
15:45 16:00	0	1	1	0	0	0	1
15:00 16:00	0	6	6	4	2	6	12
16:00 16:15	0	2	2	4	2	6	8
16:15 16:30	0	0	0	0	0	0	0
16:30 16:45	0	1	1	1	3	4	5
16:45 17:00	0	2	2	1	1	2	4
16:00 17:00	0	5	5	6	6	12	17
17:00 17:15	0	1	1	0	5	5	6
17:15 17:30	0	3	3	2	2	4	7
17:30 17:45	0	1	1	0	0	0	1
17:45 18:00	0	0	0	3	1	4	4
17:00 18:00	0	5	5	5	8	13	18
Total	0	40	40	35	51	86	126

Comment:

Turning Movement Count - 15 Min U-Turn Total Report

CLEARY AVE @ RICHMOND RD

Survey Date: Friday, June 12, 2015

Time Period		Northbound U-Turn Total	Southbound U-Turn Total	Eastbound U-Turn Total	Westbound U-Turn Total	Total
07:00	07:15	0	0	0	0	0
07:15	07:30	0	0	0	0	0
07:30	07:45	0	0	0	0	0
07:45	08:00	0	0	0	0	0
08:00	08:15	0	0	0	0	0
08:15	08:30	0	0	0	0	0
08:30	08:45	0	0	0	0	0
08:45	09:00	0	0	0	0	0
09:00	09:15	0	0	0	0	0
09:15	09:30	0	0	0	0	0
09:30	09:45	0	0	0	0	0
09:45	10:00	0	0	0	0	0
11:30	11:45	0	0	0	0	0
11:45	12:00	0	0	0	0	0
12:00	12:15	0	0	0	0	0
12:15	12:30	0	0	0	0	0
12:30	12:45	0	0	0	0	0
12:45	13:00	0	0	0	0	0
13:00	13:15	0	0	0	0	0
13:15	13:30	0	0	0	0	0
15:00	15:15	0	0	0	0	0
15:15	15:30	0	0	0	0	0
15:30	15:45	0	0	0	0	0
15:45	16:00	0	0	0	0	0
16:00	16:15	0	0	0	0	0
16:15	16:30	0	0	0	0	0
16:30	16:45	0	0	1	0	1
16:45	17:00	0	0	0	0	0
17:00	17:15	0	0	0	0	0
17:15	17:30	0	0	0	0	0
17:30	17:45	0	0	0	0	0
17:45	18:00	0	0	0	0	0
Total		0	0	1	0	1

Turning Movement Count - Peak Hour Diagram

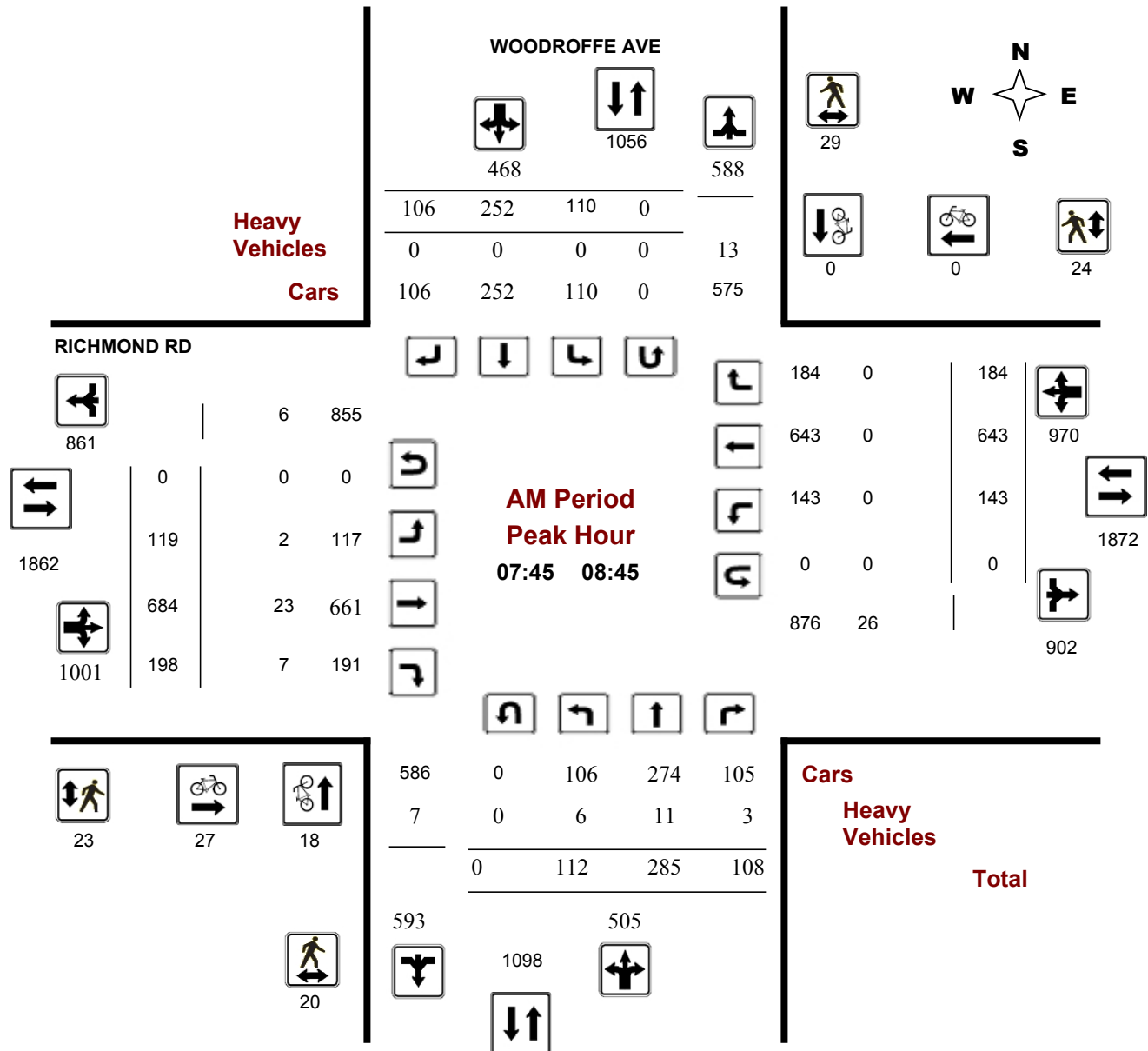
RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Start Time: 07:00

WO No: 1044

Device: Jamar Technologies, Inc



Turning Movement Count - Peak Hour Diagram

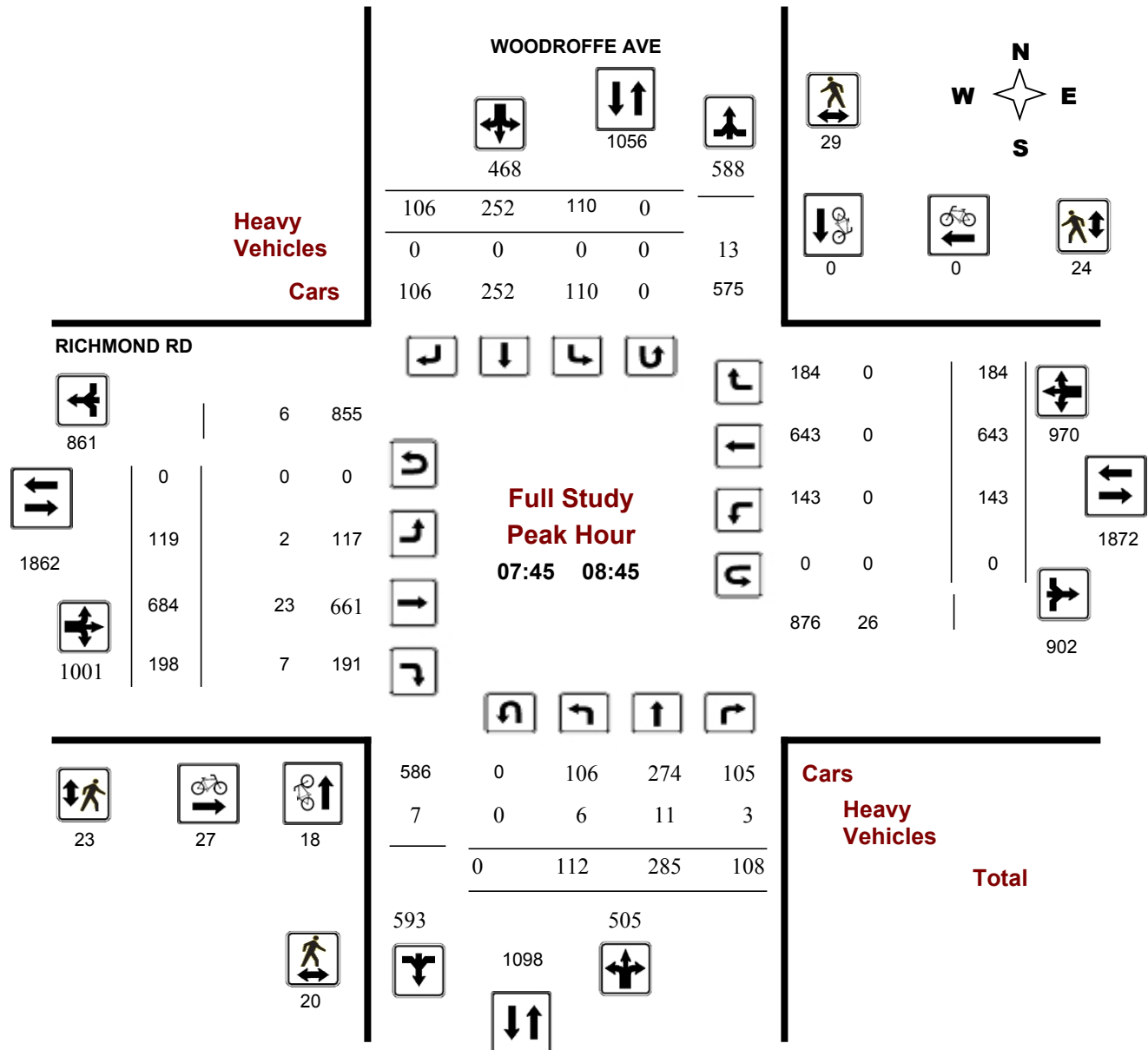
RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Start Time: 07:00

WO No: 1044

Device: Jamar Technologies, Inc



Comments

Turning Movement Count - Peak Hour Diagram

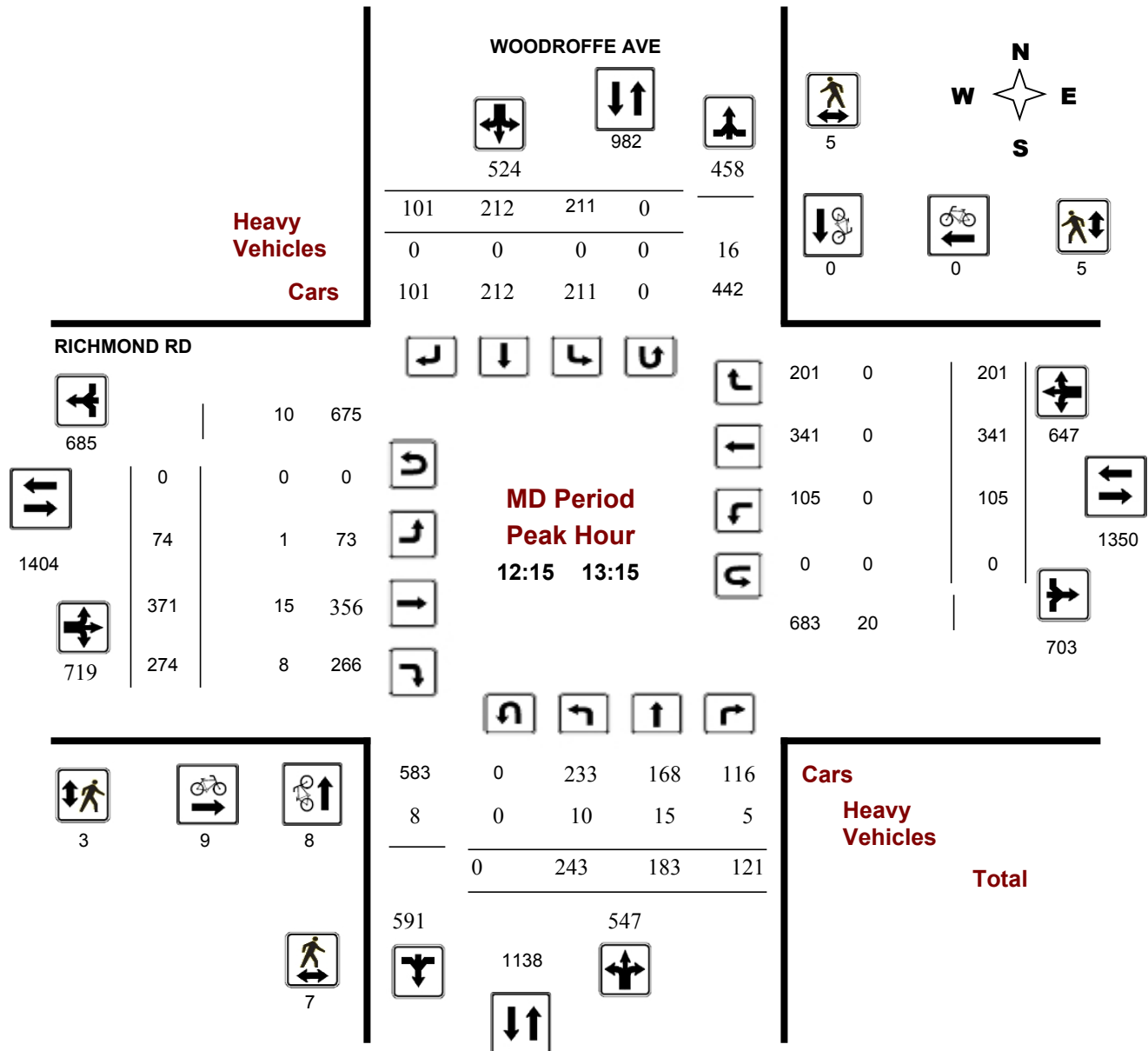
RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Start Time: 07:00

WO No: 1044

Device: Jamar Technologies, Inc



Turning Movement Count - Peak Hour Diagram

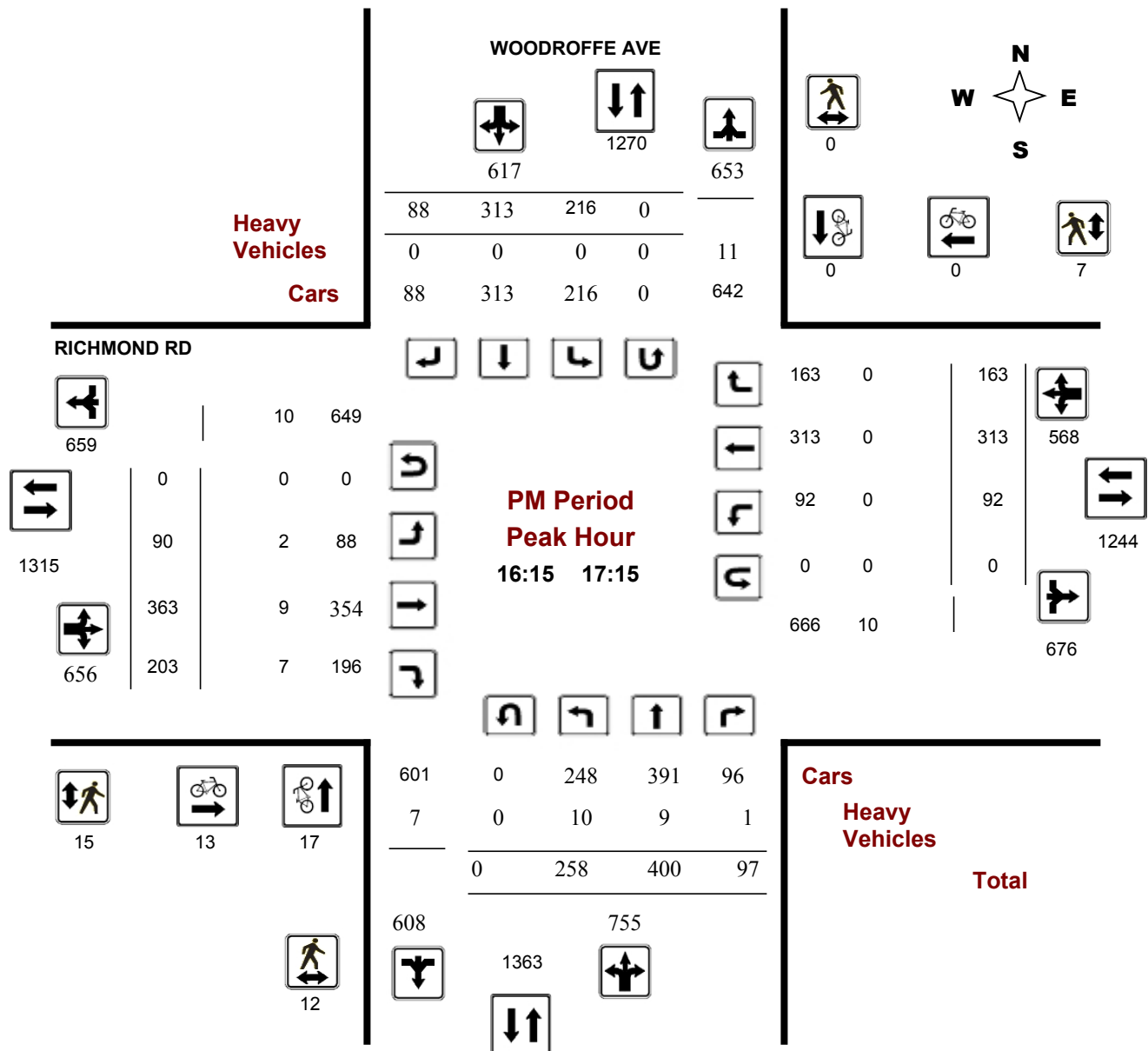
RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Start Time: 07:00

WO No: 1044

Device: Jamar Technologies, Inc



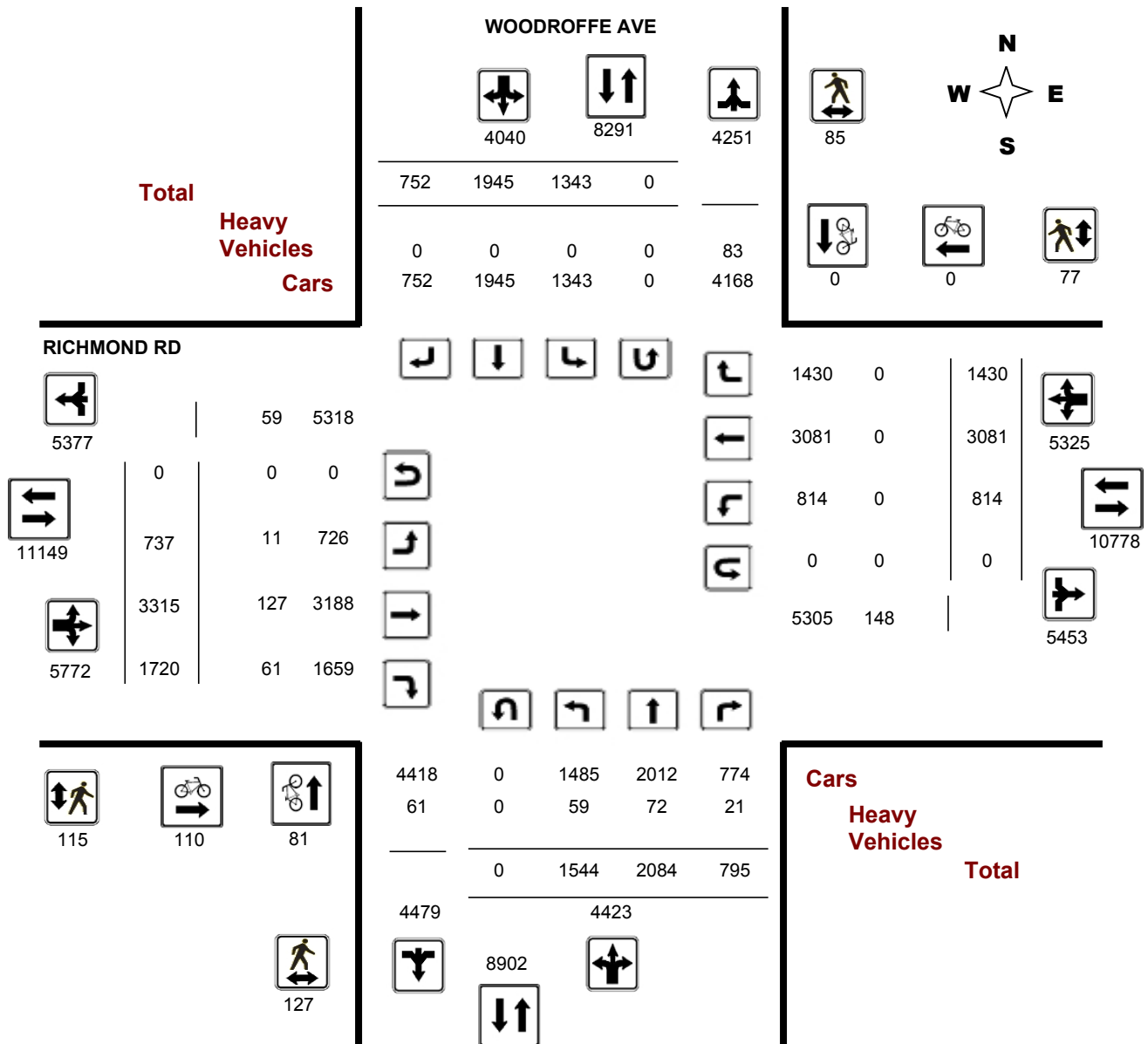
Public Works - Traffic Services

Turning Movement Count - Full Study Diagram

RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

WO#: 1044
Device: Jamar Technologies, Inc



Turning Movement Count - Full Study Summary Report

RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Total Observed U-Turns

Northbound: 0 Southbound: 0
Eastbound: 0 Westbound: 0

AADT Factor

.80

Full Study

WOODROFFE AVE										RICHMOND RD									
Northbound					Southbound					Eastbound					Westbound				
Period	LT	ST	RT	NB TOT	LT	ST	RT	SB TOT	STR TOT	LT	ST	RT	EB TOT	LT	ST	RT	WB TOT	STR TOT	Grand Total
07:00 08:00	62	237	85	384	83	200	85	368	752	111	533	158	802	127	524	153	804	1606	2358
08:00 09:00	121	282	108	511	116	242	101	459	970	117	647	212	976	124	630	195	949	1925	2895
09:00 10:00	154	191	93	438	104	157	86	347	785	68	392	216	676	86	351	182	619	1295	2080
11:30 12:30	240	202	112	554	204	196	127	527	1081	63	371	240	674	89	353	208	650	1324	2405
12:30 13:30	228	184	123	535	202	217	89	508	1043	77	351	278	706	99	335	225	659	1365	2408
15:00 16:00	247	309	86	642	205	311	84	600	1242	119	355	215	689	97	251	146	494	1183	2425
16:00 17:00	255	382	91	728	217	329	86	632	1360	84	323	203	610	91	330	165	586	1196	2556
17:00 18:00	237	297	97	631	212	293	94	599	1230	98	343	198	639	101	307	156	564	1203	2433
Sub Total	1544	2084	795	4423	1343	1945	752	4040	8463	737	3315	1720	5772	814	3081	1430	5325	11097	19560
U Turns				0				0	0				0				0	0	0
Total	1544	2084	795	4423	1343	1945	752	4040	8463	737	3315	1720	5772	814	3081	1430	5325	11097	19560
EQ 12Hr	2146	2897	1105	6148	1867	2704	1045	5616	11764	1024	4608	2391	8023	1131	4283	1988	7402	15425	27189
Note: These values are calculated by multiplying the totals by the appropriate expansion factor.										1.39									
AVG 12Hr	1717	2317	884	4918	1493	2163	836	4492	9410	820	3686	1913	6418	905	3426	1590	5921	12339	21749
Note: These volumes are calculated by multiplying the Equivalent 12 hr. totals by the AADT factor.										.80									
AVG 24Hr	2249	3036	1158	6443	1956	2833	1095	5885	12328	1074	4829	2506	8408	1186	4488	2083	7757	16165	28493
Note: These volumes are calculated by multiplying the Average Daily 12 hr. totals by 12 to 24 expansion factor.										1.31									

Comments:

Note: U-Turns provided for approach totals. Refer to 'U-Turn' Report for specific breakdown.

Turning Movement Count - 15 Minute Summary Report

RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Total Observed U-Turns

Northbound: 0 Southbound: 0
Eastbound: 0 Westbound: 0

WOODROFFE AVE

RICHMOND RD

Time Period	Northbound			N TOT	Southbound			S TOT	STR TOT	Eastbound			E TOT	Westbound			W TOT	STR TOT	Grand Total
	LT	ST	RT		LT	ST	RT			LT	ST	RT		LT	ST	RT			
07:00 07:15	17	42	12	71	12	36	14	62	133	18	94	33	145	23	98	37	158	303	436
07:15 07:30	10	73	27	110	17	56	22	95	205	36	124	39	199	30	127	30	187	386	591
07:30 07:45	12	57	19	88	25	50	21	96	184	29	132	40	201	35	140	43	218	419	603
07:45 08:00	23	65	27	115	29	58	28	115	230	28	183	46	257	39	159	43	241	498	728
08:00 08:15	25	70	23	118	24	64	16	104	222	31	164	51	246	42	161	51	254	500	722
08:15 08:30	22	75	28	125	33	57	31	121	246	30	168	46	244	33	171	47	251	495	741
08:30 08:45	42	75	30	147	24	73	31	128	275	30	169	55	254	29	152	43	224	478	753
08:45 09:00	32	62	27	121	35	48	23	106	227	26	146	60	232	20	146	54	220	452	679
09:00 09:15	31	59	25	115	31	51	24	106	221	19	101	65	185	26	98	41	165	350	571
09:15 09:30	33	51	26	110	20	42	26	88	198	17	106	50	173	16	92	51	159	332	530
09:30 09:45	49	46	17	112	37	36	16	89	201	13	89	48	150	24	83	43	150	300	501
09:45 10:00	41	35	25	101	16	28	20	64	165	19	96	53	168	20	78	47	145	313	478
11:30 11:45	70	59	26	155	54	47	34	135	290	17	81	40	138	20	97	64	181	319	609
11:45 12:00	58	43	29	130	47	41	35	123	253	17	110	62	189	19	90	50	159	348	601
12:00 12:15	48	55	32	135	43	55	31	129	264	16	76	74	166	23	77	50	150	316	580
12:15 12:30	64	45	25	134	60	53	27	140	274	13	104	64	181	27	89	44	160	341	615
12:30 12:45	54	45	31	130	40	48	24	112	242	20	86	67	173	27	90	58	175	348	590
12:45 13:00	63	42	42	147	45	52	33	130	277	22	94	63	179	26	95	49	170	349	626
13:00 13:15	62	51	23	136	66	59	17	142	278	19	87	80	186	25	67	50	142	328	606
13:15 13:30	49	46	27	122	51	58	15	124	246	16	84	68	168	21	83	68	172	340	586
15:00 15:15	58	76	23	157	57	77	27	161	318	28	97	59	184	32	64	47	143	327	645
15:15 15:30	63	93	15	171	46	83	23	152	323	25	93	48	166	21	48	39	108	274	597
15:30 15:45	60	69	28	157	50	69	19	138	295	27	76	54	157	22	69	29	120	277	572
15:45 16:00	66	71	20	157	52	82	15	149	306	39	89	54	182	22	70	31	123	305	611
16:00 16:15	61	71	16	148	58	97	20	175	323	23	63	48	134	30	88	45	163	297	620
16:15 16:30	61	125	12	198	52	92	20	164	362	27	80	52	159	13	70	33	116	275	637
16:30 16:45	67	85	35	187	52	68	23	143	330	15	87	55	157	27	84	41	152	309	639
16:45 17:00	66	101	28	195	55	72	23	150	345	19	93	48	160	21	88	46	155	315	660
17:00 17:15	64	89	22	175	57	81	22	160	335	29	103	48	180	31	71	43	145	325	660
17:15 17:30	64	68	27	159	65	79	35	179	338	26	75	50	151	26	78	38	142	293	631
17:30 17:45	57	73	27	157	51	75	18	144	301	24	83	52	159	24	87	31	142	301	602
17:45 18:00	52	67	21	140	39	58	19	116	256	19	82	48	149	20	71	44	135	284	540
TOTAL:	1544	2084	795	4423	1343	1945	752	4040	8463	737	3315	1720	5772	814	3081	1430	5325	11097	19560

Note: U-Turns are included in Totals.

Comment:



Public Works - Traffic Services

Turning Movement Count - Cyclist Volume Report

Work Order
1044

RICHMOND RD @ WOODROFFE AVE

Count Date: Friday, May 23, 2014

Start Time: 07:00

Time Period	WOODROFFE AVE			RICHMOND RD			Grand Total
	Northbound	Southbound	Street Total	Eastbound	Westbound	Street Total	
07:00 08:00	6	0	6	18	0	18	24
08:00 09:00	20	0	20	27	0	27	47
09:00 10:00	8	0	8	2	0	2	10
11:30 12:30	9	0	9	8	0	8	17
12:30 13:30	4	0	4	9	0	9	13
15:00 16:00	11	0	11	10	0	10	21
16:00 17:00	14	0	14	10	0	10	24
17:00 18:00	9	0	9	26	0	26	35
Total	81	0	81	110	0	110	191

Comment:

Note: These volumes consists of bicycles only (no mopeds or motorcycles) and ARE NOT included in the Turning Movement Count Summary.

Turning Movement Count - Heavy Vehicle Report

RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

WOODROFFE AVE										RICHMOND RD										Grand Total
Northbound					Southbound					Eastbound					Westbound					
Time Period	LT	ST	RT	N TOT	LT	ST	RT	S TOT	STR TOT	LT	ST	RT	E TOT	LT	ST	RT	W TOT	STR TOT		
07:00	08:00	4	6	0	10	0	0	0	0	10	2	12	3	17	0	0	0	0	17	27
08:00	09:00	5	11	5	21	0	0	0	0	21	3	22	12	37	0	0	0	0	37	58
09:00	10:00	7	9	2	18	0	0	0	0	18	1	13	4	18	0	0	0	0	18	36
11:30	12:30	12	10	5	27	0	0	0	0	27	0	25	16	41	0	0	0	0	41	68
12:30	13:30	8	14	4	26	0	0	0	0	26	1	18	8	27	0	0	0	0	27	53
15:00	16:00	10	5	3	18	0	0	0	0	18	2	17	6	25	0	0	0	0	25	43
16:00	17:00	11	11	2	24	0	0	0	0	24	2	13	9	24	0	0	0	0	24	48
17:00	18:00	2	6	0	8	0	0	0	0	8	0	7	3	10	0	0	0	0	10	18
Sub Total		59	72	21	152	0	0	0	0	152	11	127	61	199	0	0	0	0	199	351
U-Turns (Heavy Vehicles)					0				0	0				0				0	0	0
Total		59	72	21	0	0	0	0	0	152	11	127	61	199	0	0	0	0	199	351

Heavy Vehicles are vehicles having one rear axle with four or more wheels, or having two or more rear axles. These vehicles include most O.C. Transpo, school and inter-city buses. Further, they ARE included in the Turning Movement Count Summary.



Public Works - Traffic Services

Work Order

1044

Turning Movement Count - Pedestrian Volume Report

RICHMOND RD @ WOODROFFE AVE

Count Date: Friday, May 23, 2014

Start Time: 07:00

Time Period	NB Approach (E or W Crossing)	SB Approach (E or W Crossing)	Total	EB Approach (N or S Crossing)	WB Approach (N or S Crossing)	Total	Grand Total
07:00 07:15	0	0	0	2	0	2	2
07:15 07:30	0	5	5	1	4	5	10
07:30 07:45	1	7	8	4	2	6	14
07:45 08:00	5	4	9	2	3	5	14
07:00 08:00	6	16	22	9	9	18	40
08:00 08:15	3	8	11	3	7	10	21
08:15 08:30	5	10	15	7	12	19	34
08:30 08:45	7	7	14	11	2	13	27
08:45 09:00	6	6	12	2	5	7	19
08:00 09:00	21	31	52	23	26	49	101
09:00 09:15	2	2	4	1	0	1	5
09:15 09:30	4	3	7	5	3	8	15
09:30 09:45	13	14	27	8	1	9	36
09:45 10:00	5	2	7	2	1	3	10
09:00 10:00	24	21	45	16	5	21	66
11:30 11:45	4	0	4	3	1	4	8
11:45 12:00	4	3	7	2	4	6	13
12:00 12:15	5	1	6	2	0	2	8
12:15 12:30	3	1	4	2	1	3	7
11:30 12:30	16	5	21	9	6	15	36
12:30 12:45	3	0	3	0	1	1	4
12:45 13:00	0	3	3	0	2	2	5
13:00 13:15	1	1	2	1	1	2	4
13:15 13:30	3	2	5	1	0	1	6
12:30 13:30	7	6	13	2	4	6	19
15:00 15:15	5	2	7	5	3	8	15
15:15 15:30	4	2	6	7	1	8	14
15:30 15:45	1	0	1	0	2	2	3
15:45 16:00	3	0	3	4	2	6	9
15:00 16:00	13	4	17	16	8	24	41
16:00 16:15	7	1	8	5	3	8	16
16:15 16:30	1	0	1	2	0	2	3
16:30 16:45	4	0	4	3	2	5	9
16:45 17:00	0	0	0	3	4	7	7
16:00 17:00	12	1	13	13	9	22	35
17:00 17:15	7	0	7	7	1	8	15
17:15 17:30	5	0	5	3	3	6	11
17:30 17:45	15	0	15	12	4	16	31
17:45 18:00	1	1	2	5	2	7	9
17:00 18:00	28	1	29	27	10	37	66
Total	127	85	212	115	77	192	404

Comment:

Turning Movement Count - 15 Min U-Turn Total Report

RICHMOND RD @ WOODROFFE AVE

Survey Date: Friday, May 23, 2014

Time Period		Northbound U-Turn Total	Southbound U-Turn Total	Eastbound U-Turn Total	Westbound U-Turn Total	Total
07:00	07:15	0	0	0	0	0
07:15	07:30	0	0	0	0	0
07:30	07:45	0	0	0	0	0
07:45	08:00	0	0	0	0	0
08:00	08:15	0	0	0	0	0
08:15	08:30	0	0	0	0	0
08:30	08:45	0	0	0	0	0
08:45	09:00	0	0	0	0	0
09:00	09:15	0	0	0	0	0
09:15	09:30	0	0	0	0	0
09:30	09:45	0	0	0	0	0
09:45	10:00	0	0	0	0	0
11:30	11:45	0	0	0	0	0
11:45	12:00	0	0	0	0	0
12:00	12:15	0	0	0	0	0
12:15	12:30	0	0	0	0	0
12:30	12:45	0	0	0	0	0
12:45	13:00	0	0	0	0	0
13:00	13:15	0	0	0	0	0
13:15	13:30	0	0	0	0	0
15:00	15:15	0	0	0	0	0
15:15	15:30	0	0	0	0	0
15:30	15:45	0	0	0	0	0
15:45	16:00	0	0	0	0	0
16:00	16:15	0	0	0	0	0
16:15	16:30	0	0	0	0	0
16:30	16:45	0	0	0	0	0
16:45	17:00	0	0	0	0	0
17:00	17:15	0	0	0	0	0
17:15	17:30	0	0	0	0	0
17:30	17:45	0	0	0	0	0
17:45	18:00	0	0	0	0	0
Total		0	0	0	0	0

Traffic Signal Timing

City of Ottawa, Public Works Department

Traffic Operations Unit

Intersection:	Main: Richmond	Side: Woodroffe
Controller:	MS-3200	TSD: 5230
Author:	Basel Ansari	Date: 24-Mar-2016

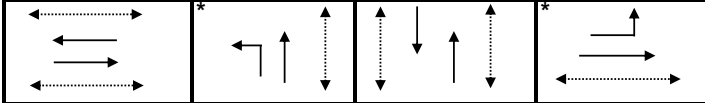
Existing Timing Plans†

	Plan					Ped Minimum Time		
	AM Peak 1	Off Peak 2	PM Peak 3	Night 4	Weekend 5	Walk	DW	A+R
Cycle	100	95	100	70	95			
Offset	35	50	35	3	50			
EB Thru	54	34	33	36	34	7	11	3.3+2.9
WB Thru	39	34	33	36	34	7	11	3.3+2.9
NB Left	12	15	16	-	15	-	-	3.3+1.6
SB Thru	34	34	37	34	34	7	20	3.3+3.3
NB Thru	46	49	53	34	49	7	20	3.3+3.3
EB Left	15	12	14	-	12	-	-	3.3+2.9
WB Left	-	12	14	-	12	-	-	3.3+2.9

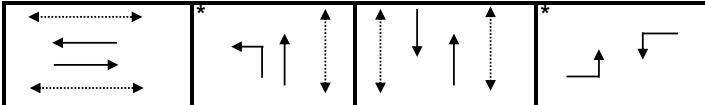
Notes: 1) For Plan 3, all unused time throughout the cycle is given to the EB and WB Thru movements

Phasing Sequence†

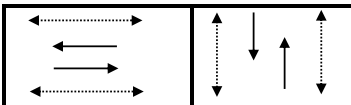
Plan: 1



Plans: 2, 3, 5



Plan: 4



Schedule

Weekday

Time	Plan
0:15	4
6:30	1
9:30	2
15:00	3
18:30	2
23:00	4

Saturday

Time	Plan
0:15	4
9:10	5
18:30	2
23:30	4

Sunday

Time	Plan
0:15	4
9:10	2
22:30	4

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)

Traffic Signal Timing

City of Ottawa, Public Works Department

Traffic Operations Unit

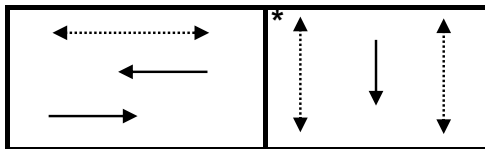
Intersection:	Main: Richmond	Side: Cleary
Controller:	MS-3200	TSD: 5845
Author:	Basel Ansari	Date: 24-Mar-2016

Existing Timing Plans[†]

	Plan					Ped Minimum Time		
	AM Peak 1	Off Peak 2	PM Peak 3	Night 4	Weekend 5	Walk	DW	A+R
Cycle	65	55	65	50	55			
Offset	53	X	13	X	X			
EB Thru	43	33	43	28	33	13	5	3.3+1.8
WB Thru	43	33	43	28	33	13	5	3.3+1.8
SB Thru	22	22	22	22	22	7	9	3.3+2.0

Phasing Sequence[‡]

Plan: All



Schedule

Weekday

Time	Plan
0:15	4
6:30	1
9:30	2
15:00	3
18:30	2
23:00	4

Saturday

Time	Plan
0:10	4
9:10	5
18:30	2
23:30	4

Sunday

Time	Plan
0:15	4
9:10	2
22:30	4

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)

Appendix B

Existing Conditions Synchro Analysis Sheets

Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2017 Existing AM
809 Richmond Road TIS

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	124	715	207	150	672	192	117	298	113	117	264	111
Future Volume (vph)	124	715	207	150	672	192	117	298	113	117	264	111
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Storage Length (m)	65.0		0.0	65.0		0.0	60.0		0.0	30.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (m)	85.0			60.0			15.0			45.0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.966			0.967			0.959			0.956	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1695	3236	0	1729	3344	0	1647	1683	0	1729	1740	0
Flt Permitted	0.133			0.304			0.241			0.517		
Satd. Flow (perm)	237	3236	0	553	3344	0	418	1683	0	941	1740	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		51			39			22			21	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		143.1			207.3			173.3			231.8	
Travel Time (s)		10.3			14.9			12.5			16.7	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	3%	4%	0%	0%	0%	5%	4%	3%	0%	0%	0%
Adj. Flow (vph)	127	730	211	153	686	196	119	304	115	119	269	113
Shared Lane Traffic (%)												
Lane Group Flow (vph)	127	941	0	153	882	0	119	419	0	119	382	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			1.6	
Two way Left Turn Lane												
Headway Factor	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	6.1	1.8		6.1	1.8		6.1	1.8		6.1	1.8	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	pm+pt	NA		Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases	5	2			6		3	8			4	

Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2017 Existing AM
809 Richmond Road TIS



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases	2			6			8			4		
Detector Phase	5	2		6	6		3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	10.2	24.2		24.2	24.2		8.9	33.6		33.6	33.6	
Total Split (s)	15.0	54.0		39.0	39.0		12.0	46.0		34.0	34.0	
Total Split (%)	15.0%	54.0%		39.0%	39.0%		12.0%	46.0%		34.0%	34.0%	
Maximum Green (s)	8.8	47.8		32.8	32.8		7.1	39.4		27.4	27.4	
Yellow Time (s)	3.3	3.3		3.3	3.3		3.3	3.3		3.3	3.3	
All-Red Time (s)	2.9	2.9		2.9	2.9		1.6	3.3		3.3	3.3	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	6.2	6.2		6.2	6.2		4.9	6.6		6.6	6.6	
Lead/Lag	Lead			Lag	Lag		Lead			Lag	Lag	
Lead-Lag Optimize?	Yes			Yes	Yes		Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	C-Max		C-Max	C-Max		None	Max		Max	Max	
Walk Time (s)		7.0		7.0	7.0			7.0		7.0	7.0	
Flash Dont Walk (s)		11.0		11.0	11.0			20.0		20.0	20.0	
Pedestrian Calls (#/hr)		0		0	0			0		0	0	
Act Effect Green (s)	47.8	47.8		33.3	33.3		41.1	39.4		27.5	27.5	
Actuated g/C Ratio	0.48	0.48		0.33	0.33		0.41	0.39		0.28	0.28	
v/c Ratio	0.54	0.60		0.83	0.77		0.46	0.62		0.46	0.77	
Control Delay	23.8	19.9		68.0	34.3		25.0	27.8		37.1	43.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	23.8	19.9		68.0	34.3		25.0	27.8		37.1	43.8	
LOS	C	B		E	C		C	C		D	D	
Approach Delay		20.3			39.3			27.2			42.2	
Approach LOS		C			D			C			D	
Queue Length 50th (m)	13.4	64.0		27.3	77.5		14.3	60.6		19.2	64.6	
Queue Length 95th (m)	23.9	83.4		#63.8	101.0		26.0	92.2		36.6	#107.3	
Internal Link Dist (m)		119.1			183.3			149.3			207.8	
Turn Bay Length (m)	65.0			65.0			60.0			30.0		
Base Capacity (vph)	241	1573		184	1139		259	676		258	493	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.53	0.60		0.83	0.77		0.46	0.62		0.46	0.77	

Intersection Summary

Area Type: Other

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.83

Intersection Signal Delay: 31.2

Intersection LOS: C

Intersection Capacity Utilization 88.6%

ICU Level of Service E

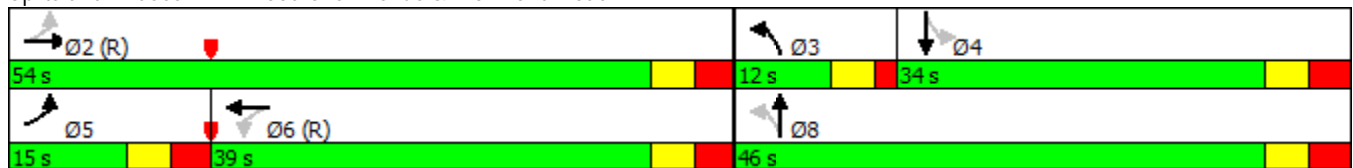
Analysis Period (min) 15

Lanes, Volumes, Timings 1: Woodroffe Avenue & Richmond Road

2017 Existing AM
809 Richmond Road TIS

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road



Lanes, Volumes, Timings
4: Richmond Road & Cleary Avenue

2017 Existing AM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	28	623	306	18	30	19
Future Volume (vph)	28	623	306	18	30	19
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.993		0.947	
Flt Protected		0.998			0.971	
Satd. Flow (prot)	0	1749	1720	0	1641	0
Flt Permitted		0.975			0.971	
Satd. Flow (perm)	0	1709	1720	0	1641	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)			8		22	
Link Speed (k/h)		50	50		50	
Link Distance (m)		160.2	91.9		133.2	
Travel Time (s)		11.5	6.6		9.6	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Heavy Vehicles (%)	0%	4%	5%	6%	0%	5%
Adj. Flow (vph)	32	708	348	20	34	22
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	740	368	0	56	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		3.7	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.06	1.06	1.06	1.06	1.06	1.06
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2		1	
Detector Template	Left	Thru	Thru		Left	
Leading Detector (m)	6.1	30.5	30.5		6.1	
Trailing Detector (m)	0.0	0.0	0.0		0.0	
Detector 1 Position(m)	0.0	0.0	0.0		0.0	
Detector 1 Size(m)	6.1	1.8	1.8		6.1	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	Perm	NA	NA		Prot	
Protected Phases		2	6		4	
Permitted Phases	2					
Detector Phase	2	2	6		4	
Switch Phase						

Lanes, Volumes, Timings

4: Richmond Road & Cleary Avenue

2017 Existing AM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Minimum Initial (s)	4.0	4.0	4.0		4.0	
Minimum Split (s)	29.1	29.1	29.1		21.3	
Total Split (s)	43.0	43.0	43.0		22.0	
Total Split (%)	66.2%	66.2%	66.2%		33.8%	
Maximum Green (s)	37.9	37.9	37.9		16.7	
Yellow Time (s)	3.3	3.3	3.3		3.3	
All-Red Time (s)	1.8	1.8	1.8		2.0	
Lost Time Adjust (s)		0.0	0.0		0.0	
Total Lost Time (s)		5.1	5.1		5.3	
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Recall Mode	C-Max	C-Max	C-Max		Max	
Walk Time (s)	13.0	13.0	13.0		4.0	
Flash Dont Walk (s)	5.0	5.0	5.0		9.0	
Pedestrian Calls (#/hr)	0	0	0		0	
Act Effect Green (s)		37.9	37.9		16.7	
Actuated g/C Ratio		0.58	0.58		0.26	
v/c Ratio		0.74	0.37		0.13	
Control Delay		15.8	8.3		13.8	
Queue Delay		0.0	0.0		0.0	
Total Delay		15.8	8.3		13.8	
LOS		B	A		B	
Approach Delay		15.8	8.3		13.8	
Approach LOS		B	A		B	
Queue Length 50th (m)		58.1	20.3		3.1	
Queue Length 95th (m)		94.0	33.7		10.3	
Internal Link Dist (m)		136.2	67.9		109.2	
Turn Bay Length (m)						
Base Capacity (vph)		996	1006		437	
Starvation Cap Reductn		0	0		0	
Spillback Cap Reductn		0	0		0	
Storage Cap Reductn		0	0		0	
Reduced v/c Ratio		0.74	0.37		0.13	

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 65
Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 13.3
Intersection Capacity Utilization 70.6%
Analysis Period (min) 15





















Intersection LOS: B
ICU Level of Service C

Splits and Phases: 4: Richmond Road & Cleary Avenue



Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2017 Existing PM
809 Richmond Road TIS

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	94	380	212	96	327	170	270	418	101	229	327	92
Future Volume (vph)	94	380	212	96	327	170	270	418	101	229	327	92
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Storage Length (m)	65.0		0.0	65.0		0.0	60.0		0.0	30.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (m)	85.0			60.0			15.0			45.0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.946			0.949			0.971			0.967	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1712	3156	0	1729	3282	0	1662	1648	0	1729	1760	0
Flt Permitted	0.363			0.287			0.222			0.467		
Satd. Flow (perm)	654	3156	0	522	3282	0	388	1648	0	850	1760	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		104			91			16			15	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		143.1			207.3			173.3			231.8	
Travel Time (s)		10.3			14.9			12.5			16.7	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	1%	4%	3%	0%	0%	0%	4%	8%	4%	0%	0%	0%
Adj. Flow (vph)	96	388	216	98	334	173	276	427	103	234	334	94
Shared Lane Traffic (%)												
Lane Group Flow (vph)	96	604	0	98	507	0	276	530	0	234	428	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			1.6	
Two way Left Turn Lane												
Headway Factor	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	6.1	1.8		6.1	1.8		6.1	1.8		6.1	1.8	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		Perm	NA	
Protected Phases	5	2		1	6		3	8			4	

Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2017 Existing PM
809 Richmond Road TIS



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases	2			6			8			4		
Detector Phase	5	2		1	6		3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	10.2	24.2		10.2	24.2		8.9	33.6		33.6	33.6	
Total Split (s)	14.0	33.0		14.0	33.0		16.0	53.0		37.0	37.0	
Total Split (%)	14.0%	33.0%		14.0%	33.0%		16.0%	53.0%		37.0%	37.0%	
Maximum Green (s)	7.8	26.8		7.8	26.8		11.1	46.4		30.4	30.4	
Yellow Time (s)	3.3	3.3		3.3	3.3		3.3	3.3		3.3	3.3	
All-Red Time (s)	2.9	2.9		2.9	2.9		1.6	3.3		3.3	3.3	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	6.2	6.2		6.2	6.2		4.9	6.6		6.6	6.6	
Lead/Lag	Lead	Lag		Lead	Lag		Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	C-Max		None	C-Max		None	Max		Max	Max	
Walk Time (s)		7.0			7.0			7.0		7.0	7.0	
Flash Dont Walk (s)		11.0			11.0			20.0		20.0	20.0	
Pedestrian Calls (#/hr)		0			0			0		0	0	
Act Effect Green (s)	35.8	29.6		35.8	29.6		48.1	46.4		30.4	30.4	
Actuated g/C Ratio	0.36	0.30		0.36	0.30		0.48	0.46		0.30	0.30	
v/c Ratio	0.31	0.60		0.35	0.49		0.84	0.69		0.91	0.79	
Control Delay	21.6	28.5		22.7	26.3		41.4	26.0		72.2	42.5	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	21.6	28.5		22.7	26.3		41.4	26.0		72.2	42.5	
LOS	C	C		C	C		D	C		E	D	
Approach Delay		27.6			25.7			31.3			53.0	
Approach LOS		C			C			C			D	
Queue Length 50th (m)	11.5	45.3		11.7	36.0		32.1	75.9		43.4	73.0	
Queue Length 95th (m)	21.7	63.8		22.0	52.0		#67.1	113.6		#88.3	#118.2	
Internal Link Dist (m)		119.1			183.3			149.3			207.8	
Turn Bay Length (m)	65.0			65.0			60.0			30.0		
Base Capacity (vph)	316	1007		281	1035		328	773		258	545	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.30	0.60		0.35	0.49		0.84	0.69		0.91	0.79	

Intersection Summary

Area Type: Other

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green

Natural Cycle: 80

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.91

Intersection Signal Delay: 34.3

Intersection LOS: C

Intersection Capacity Utilization 88.3%

ICU Level of Service E

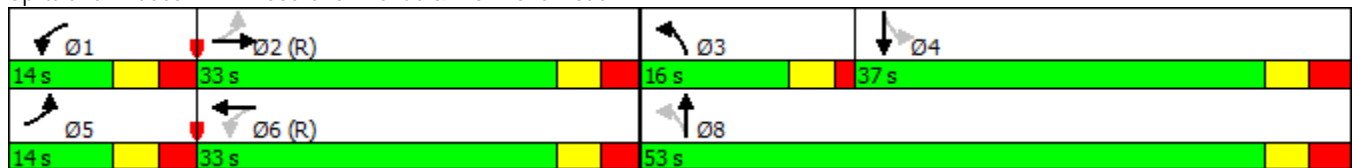
Analysis Period (min) 15

Lanes, Volumes, Timings 1: Woodroffe Avenue & Richmond Road

2017 Existing PM
809 Richmond Road TIS

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road



Lanes, Volumes, Timings
4: Richmond Road & Cleary Avenue

2017 Existing PM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	36	366	786	56	30	32
Future Volume (vph)	36	366	786	56	30	32
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.991		0.930	
Flt Protected		0.995			0.976	
Satd. Flow (prot)	0	1779	1787	0	1652	0
Flt Permitted		0.749			0.976	
Satd. Flow (perm)	0	1339	1787	0	1652	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)			9		33	
Link Speed (k/h)		50	50		50	
Link Distance (m)		160.2	91.9		133.2	
Travel Time (s)		11.5	6.6		9.6	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	2%	1%	0%	0%	0%
Adj. Flow (vph)	38	381	819	58	31	33
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	419	877	0	64	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		3.7	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.06	1.06	1.06	1.06	1.06	1.06
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2		1	
Detector Template	Left	Thru	Thru		Left	
Leading Detector (m)	6.1	30.5	30.5		6.1	
Trailing Detector (m)	0.0	0.0	0.0		0.0	
Detector 1 Position(m)	0.0	0.0	0.0		0.0	
Detector 1 Size(m)	6.1	1.8	1.8		6.1	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	Perm	NA	NA		Prot	
Protected Phases		2	6		4	
Permitted Phases	2					
Detector Phase	2	2	6		4	
Switch Phase						

Lanes, Volumes, Timings

4: Richmond Road & Cleary Avenue

2017 Existing PM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Minimum Initial (s)	4.0	4.0	4.0		4.0	
Minimum Split (s)	29.1	29.1	29.1		21.3	
Total Split (s)	43.0	43.0	43.0		22.0	
Total Split (%)	66.2%	66.2%	66.2%		33.8%	
Maximum Green (s)	37.9	37.9	37.9		16.7	
Yellow Time (s)	3.3	3.3	3.3		3.3	
All-Red Time (s)	1.8	1.8	1.8		2.0	
Lost Time Adjust (s)		0.0	0.0		0.0	
Total Lost Time (s)		5.1	5.1		5.3	
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Recall Mode	C-Max	C-Max	C-Max		Max	
Walk Time (s)	13.0	13.0	13.0		4.0	
Flash Dont Walk (s)	5.0	5.0	5.0		9.0	
Pedestrian Calls (#/hr)	0	0	0		0	
Act Effect Green (s)		37.9	37.9		16.7	
Actuated g/C Ratio		0.58	0.58		0.26	
v/c Ratio		0.54	0.84		0.14	
Control Delay		11.4	20.7		12.0	
Queue Delay		0.0	0.0		0.0	
Total Delay		11.4	20.7		12.0	
LOS		B	C		B	
Approach Delay		11.4	20.7		12.0	
Approach LOS		B	C		B	
Queue Length 50th (m)		27.2	75.9		2.8	
Queue Length 95th (m)		49.0	#153.0		10.9	
Internal Link Dist (m)		136.2	67.9		109.2	
Turn Bay Length (m)						
Base Capacity (vph)		780	1045		448	
Starvation Cap Reductn		0	0		0	
Spillback Cap Reductn		0	0		0	
Storage Cap Reductn		0	0		0	
Reduced v/c Ratio		0.54	0.84		0.14	

Intersection Summary

Area Type: Other

Cycle Length: 65

Actuated Cycle Length: 65

Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.84

Intersection Signal Delay: 17.4

Intersection LOS: B

Intersection Capacity Utilization 64.4%

ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: Richmond Road & Cleary Avenue



















Appendix C

2019 Future Background Synchro Analysis Sheets

Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2019 Future Background AM
809 Richmond Road TIS

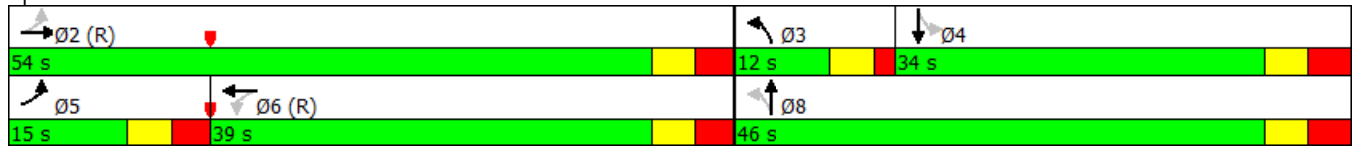
								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	137	743	166	700	122	302	118	267
Future Volume (vph)	137	743	166	700	122	302	118	267
Lane Group Flow (vph)	140	979	169	916	124	431	120	391
Turn Type	pm+pt	NA	Perm	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2		6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	6	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	24.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	15.0	54.0	39.0	39.0	12.0	46.0	34.0	34.0
Total Split (%)	15.0%	54.0%	39.0%	39.0%	12.0%	46.0%	34.0%	34.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead		Lag	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes		Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	C-Max	C-Max	None	Max	Max	Max
Act Effct Green (s)	47.8	47.8	33.2	33.2	41.1	39.4	27.5	27.5
Actuated g/C Ratio	0.48	0.48	0.33	0.33	0.41	0.39	0.28	0.28
v/c Ratio	0.62	0.62	0.97	0.81	0.50	0.64	0.48	0.79
Control Delay	28.2	20.4	95.9	35.9	26.1	28.3	38.1	45.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.2	20.4	95.9	35.9	26.1	28.3	38.1	45.2
LOS	C	C	F	D	C	C	D	D
Approach Delay		21.4		45.3		27.8		43.5
Approach LOS		C		D		C		D
Queue Length 50th (m)	14.9	67.7	32.1	81.8	15.0	62.8	19.4	66.7
Queue Length 95th (m)	28.0	88.1	#73.0	106.3	27.1	95.3	37.2	#111.0
Internal Link Dist (m)		235.6		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	231	1573	175	1135	251	676	250	492
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.61	0.62	0.97	0.81	0.49	0.64	0.48	0.79

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.97
 Intersection Signal Delay: 33.9
 Intersection Capacity Utilization 91.5%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road



Lanes, Volumes, Timings

4: Richmond Road & Cleary Avenue

2019 Future Background AM

809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	28	669	324	30
Future Volume (vph)	28	669	324	30
Lane Group Flow (vph)	0	792	388	56
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effect Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.79	0.39	0.13
Control Delay		18.4	8.5	13.8
Queue Delay		0.0	0.0	0.0
Total Delay		18.4	8.5	13.8
LOS		B	A	B
Approach Delay		18.4	8.5	13.8
Approach LOS		B	A	B
Queue Length 50th (m)		65.8	21.9	3.1
Queue Length 95th (m)		#108.7	35.9	10.3
Internal Link Dist (m)		136.2	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		997	1005	437
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.79	0.39	0.13

Intersection Summary

Cycle Length: 65
 Actuated Cycle Length: 65
 Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.79
 Intersection Signal Delay: 15.1
 Intersection Capacity Utilization 73.1%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

















Queue shown is maximum after two cycles.

Splits and Phases: 4: Richmond Road & Cleary Avenue



Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2019 Future Background PM
809 Richmond Road TIS

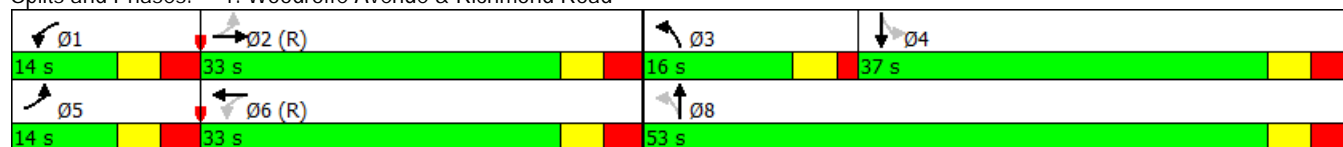
								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	104	408	109	354	281	425	232	332
Future Volume (vph)	104	408	109	354	281	425	232	332
Lane Group Flow (vph)	106	642	111	541	287	554	237	445
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2	1	6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	1	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	10.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	14.0	33.0	14.0	33.0	16.0	53.0	37.0	37.0
Total Split (%)	14.0%	33.0%	14.0%	33.0%	16.0%	53.0%	37.0%	37.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead	Lag	Lead	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	None	C-Max	None	Max	Max	Max
Act Effct Green (s)	34.6	27.1	34.6	27.1	48.1	46.4	30.4	30.4
Actuated g/C Ratio	0.35	0.27	0.35	0.27	0.48	0.46	0.30	0.30
v/c Ratio	0.37	0.69	0.44	0.57	0.91	0.72	0.98	0.82
Control Delay	22.9	32.1	24.8	29.1	52.8	27.1	89.7	45.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.9	32.1	24.8	29.1	52.8	27.1	89.7	45.0
LOS	C	C	C	C	D	C	F	D
Approach Delay		30.8		28.4		35.9		60.5
Approach LOS		C		C		D		E
Queue Length 50th (m)	12.7	50.0	13.3	40.1	33.7	80.8	45.3	77.0
Queue Length 95th (m)	23.6	69.6	24.6	57.0	#75.0	120.9	#92.8	#126.1
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	292	927	256	950	315	773	242	544
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.36	0.69	0.43	0.57	0.91	0.72	0.98	0.82

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green
 Natural Cycle: 80
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.98
 Intersection Signal Delay: 38.7
 Intersection Capacity Utilization 91.8%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road



Lanes, Volumes, Timings

4: Richmond Road & Cleary Avenue

2019 Future Background PM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	37	398	836	31
Future Volume (vph)	37	398	836	31
Lane Group Flow (vph)	0	454	929	65
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effect Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.65	0.89	0.14
Control Delay		14.5	24.8	12.2
Queue Delay		0.0	0.0	0.0
Total Delay		14.5	24.8	12.2
LOS		B	C	B
Approach Delay		14.5	24.8	12.2
Approach LOS		B	C	B
Queue Length 50th (m)		32.5	85.1	2.9
Queue Length 95th (m)		61.8	#167.7	11.1
Internal Link Dist (m)		279.0	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		702	1046	449
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.65	0.89	0.14

Intersection Summary

Cycle Length: 65
 Actuated Cycle Length: 65
 Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green
 Natural Cycle: 65
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.89
 Intersection Signal Delay: 21.0
 Intersection Capacity Utilization 67.1%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: Richmond Road & Cleary Avenue



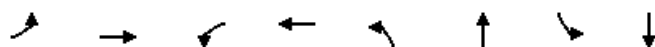
Appendix D

2019 Total Future Synchro Analysis Sheets

Timings

1: Woodroffe Avenue & Richmond Road

2019 Total Future AM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	137	745	172	706	122	302	118	267
Future Volume (vph)	137	745	172	706	122	302	118	267
Lane Group Flow (vph)	140	981	176	923	124	434	120	391
Turn Type	pm+pt	NA	Perm	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2		6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	6	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	24.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	15.0	54.0	39.0	39.0	12.0	46.0	34.0	34.0
Total Split (%)	15.0%	54.0%	39.0%	39.0%	12.0%	46.0%	34.0%	34.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead		Lag	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes		Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	C-Max	C-Max	None	Max	Max	Max
Act Effct Green (s)	47.8	47.8	33.1	33.1	41.1	39.4	27.5	27.5
Actuated g/C Ratio	0.48	0.48	0.33	0.33	0.41	0.39	0.28	0.28
v/c Ratio	0.62	0.62	1.01	0.81	0.50	0.64	0.48	0.79
Control Delay	28.8	20.4	106.5	36.4	26.1	28.4	38.3	45.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.8	20.4	106.5	36.4	26.1	28.4	38.3	45.2
LOS	C	C	F	D	C	C	D	D
Approach Delay		21.5		47.6		27.9		43.6
Approach LOS		C		D		C		D
Queue Length 50th (m)	14.9	68.0	~34.7	82.7	15.0	63.3	19.5	66.7
Queue Length 95th (m)	#29.1	88.2	#76.7	107.4	27.1	96.5	37.3	#111.0
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	229	1573	175	1133	251	675	248	492
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.61	0.62	1.01	0.81	0.49	0.64	0.48	0.79

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.01

Intersection Signal Delay: 34.7

Intersection LOS: C

Intersection Capacity Utilization 92.0%

ICU Level of Service F

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.

Timings

1: Woodroffe Avenue & Richmond Road

2019 Total Future AM

809 Richmond Road TIS

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

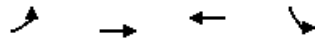
Splits and Phases: 1: Woodroffe Avenue & Richmond Road



Timings

4: Richmond Road & Cleary Avenue

2019 Total Future AM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	28	680	327	30
Future Volume (vph)	28	680	327	30
Lane Group Flow (vph)	0	805	392	56
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effct Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.81	0.39	0.13
Control Delay		19.2	8.6	13.8
Queue Delay		0.0	0.0	0.0
Total Delay		19.2	8.6	13.8
LOS		B	A	B
Approach Delay		19.2	8.6	13.8
Approach LOS		B	A	B
Queue Length 50th (m)		67.7	22.2	3.1
Queue Length 95th (m)		#115.6	36.3	10.3
Internal Link Dist (m)		279.9	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		997	1005	437
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.81	0.39	0.13

Intersection Summary

Cycle Length: 65
 Actuated Cycle Length: 65
 Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.81
 Intersection Signal Delay: 15.6
 Intersection Capacity Utilization 73.7%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

Timings
4: Richmond Road & Cleary Avenue

2019 Total Future AM
809 Richmond Road TIS

Queue shown is maximum after two cycles.










Splits and Phases: 4: Richmond Road & Cleary Avenue



HCM Unsignalized Intersection Capacity Analysis

2: Richmond Road & West Site Access

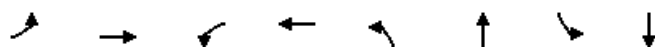
2019 Total Future AM
809 Richmond Road TIS

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	7	690	369	6	21	27
Future Volume (Veh/h)	7	690	369	6	21	27
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	750	401	7	23	29
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)		340	304			
pX, platoon unblocked	0.96				0.77	0.96
vC, conflicting volume	408				1170	404
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	357				944	353
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				90	96
cM capacity (veh/h)	1148				223	660
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	758	408	52			
Volume Left	8	0	23			
Volume Right	0	7	29			
cSH	1148	1700	354			
Volume to Capacity	0.01	0.24	0.15			
Queue Length 95th (m)	0.2	0.0	3.9			
Control Delay (s)	0.2	0.0	16.9			
Lane LOS	A		C			
Approach Delay (s)	0.2	0.0	16.9			
Approach LOS			C			
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			54.2%	ICU Level of Service		A
Analysis Period (min)			15			

Timings

1: Woodroffe Avenue & Richmond Road

2019 Total Future PM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	104	414	113	358	281	425	233	332
Future Volume (vph)	104	414	113	358	281	425	233	332
Lane Group Flow (vph)	106	648	115	546	287	561	238	445
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2	1	6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	1	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	10.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	14.0	33.0	14.0	33.0	16.0	53.0	37.0	37.0
Total Split (%)	14.0%	33.0%	14.0%	33.0%	16.0%	53.0%	37.0%	37.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead	Lag	Lead	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	None	C-Max	None	Max	Max	Max
Act Effct Green (s)	34.6	27.0	34.6	27.1	48.1	46.4	30.4	30.4
Actuated g/C Ratio	0.35	0.27	0.35	0.27	0.48	0.46	0.30	0.30
v/c Ratio	0.37	0.70	0.46	0.57	0.91	0.73	1.00	0.82
Control Delay	22.9	32.5	25.4	29.3	52.8	27.5	96.7	45.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.9	32.5	25.4	29.3	52.8	27.5	96.7	45.0
LOS	C	C	C	C	D	C	F	D
Approach Delay		31.1		28.6		36.1		63.0
Approach LOS		C		C		D		E
Queue Length 50th (m)	12.7	51.0	13.9	40.6	33.7	82.3	~46.2	77.0
Queue Length 95th (m)	23.6	70.6	25.2	57.6	#75.0	123.6	#94.2	#126.1
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	290	925	253	950	315	772	237	544
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.37	0.70	0.45	0.57	0.91	0.73	1.00	0.82

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green

Natural Cycle: 80

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.00

Intersection Signal Delay: 39.4

Intersection LOS: D

Intersection Capacity Utilization 92.7%

ICU Level of Service F

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.

Timings

1: Woodroffe Avenue & Richmond Road

2019 Total Future PM

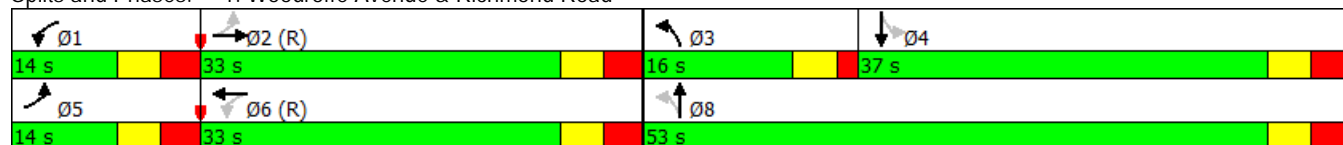
809 Richmond Road TIS

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road

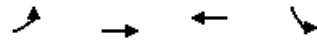


Timings

4: Richmond Road & Cleary Avenue

2019 Total Future PM

809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations		←	←	←
Traffic Volume (vph)	37	404	846	31
Future Volume (vph)	37	404	846	31
Lane Group Flow (vph)	0	460	939	65
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effect Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.67	0.90	0.14
Control Delay		15.4	25.8	12.2
Queue Delay		0.0	0.0	0.0
Total Delay		15.4	25.8	12.2
LOS		B	C	B
Approach Delay		15.4	25.8	12.2
Approach LOS		B	C	B
Queue Length 50th (m)		33.7	87.2	2.9
Queue Length 95th (m)		64.9	#170.6	11.1
Internal Link Dist (m)		279.0	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		686	1046	449
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.67	0.90	0.14

Intersection Summary

Cycle Length: 65

Actuated Cycle Length: 65

Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Natural Cycle: 65

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.90

Intersection Signal Delay: 21.9

Intersection LOS: C

Intersection Capacity Utilization 67.4%

ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

03/19/2018

MC

Synchro 9 Report

Page 3

Timings 4: Richmond Road & Cleary Avenue

2019 Total Future PM
809 Richmond Road TIS

Queue shown is maximum after two cycles.










Splits and Phases: 4: Richmond Road & Cleary Avenue



HCM Unsignalized Intersection Capacity Analysis

2: Richmond Road & West Site Access

2019 Total Future PM
809 Richmond Road TIS

















						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	23	444	878	19	11	15
Future Volume (Veh/h)	23	444	878	19	11	15
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	25	483	954	21	12	16
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)		341	303			
pX, platoon unblocked	0.50				0.55	0.50
vC, conflicting volume	975				1498	964
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	448				1072	427
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				91	95
cM capacity (veh/h)	555				128	313
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	508	975	28			
Volume Left	25	0	12			
Volume Right	0	21	16			
cSH	555	1700	194			
Volume to Capacity	0.05	0.57	0.14			
Queue Length 95th (m)	1.1	0.0	3.8			
Control Delay (s)	1.3	0.0	26.7			
Lane LOS	A		D			
Approach Delay (s)	1.3	0.0	26.7			
Approach LOS			D			
Intersection Summary						
Average Delay			0.9			
Intersection Capacity Utilization		60.0%		ICU Level of Service		B
Analysis Period (min)		15				

Appendix E

2024 Future Background Synchro Analysis Sheets

Lanes, Volumes, Timings
1: Woodroffe Avenue & Richmond Road

2024 Future Background AM
809 Richmond Road TIS

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	139	788	171	743	129	326	126	288
Future Volume (vph)	139	788	171	743	129	326	126	288
Lane Group Flow (vph)	142	1037	174	974	132	462	129	418
Turn Type	pm+pt	NA	Perm	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2		6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	6	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	24.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	15.0	54.0	39.0	39.0	12.0	46.0	34.0	34.0
Total Split (%)	15.0%	54.0%	39.0%	39.0%	12.0%	46.0%	34.0%	34.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead		Lag	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes		Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	C-Max	C-Max	None	Max	Max	Max
Act Effct Green (s)	47.8	47.8	33.1	33.1	41.1	39.4	27.4	27.4
Actuated g/C Ratio	0.48	0.48	0.33	0.33	0.41	0.39	0.27	0.27
v/c Ratio	0.66	0.66	1.11	0.86	0.57	0.68	0.57	0.85
Control Delay	32.5	21.3	139.5	39.2	29.7	30.0	42.7	50.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	32.5	21.3	139.5	39.2	29.7	30.0	42.7	50.3
LOS	C	C	F	D	C	C	D	D
Approach Delay		22.6		54.4		30.0		48.5
Approach LOS		C		D		C		D
Queue Length 50th (m)	15.1	74.0	~39.0	89.3	16.0	69.4	21.5	73.2
Queue Length 95th (m)	#35.4	95.7	#79.5	#123.6	28.5	104.9	41.4	#123.9
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	220	1573	157	1133	230	676	226	492
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.66	1.11	0.86	0.57	0.68	0.57	0.85

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.11
 Intersection Signal Delay: 38.5
 Intersection Capacity Utilization 95.6%
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.

Lanes, Volumes, Timings 1: Woodroffe Avenue & Richmond Road

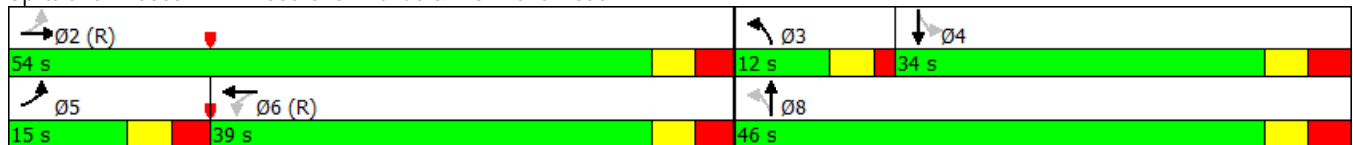
2024 Future Background AM
809 Richmond Road TIS

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road

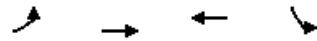


Lanes, Volumes, Timings

4: Richmond Road & Cleary Avenue

2024 Future Background AM

809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	30	698	340	33
Future Volume (vph)	30	698	340	33
Lane Group Flow (vph)	0	827	408	61
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effct Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.83	0.41	0.14
Control Delay		20.7	8.7	14.1
Queue Delay		0.0	0.0	0.0
Total Delay		20.7	8.7	14.1
LOS		C	A	B
Approach Delay		20.7	8.7	14.1
Approach LOS		C	A	B
Queue Length 50th (m)		71.5	23.3	3.5
Queue Length 95th (m)		#139.3	37.9	11.0
Internal Link Dist (m)		279.9	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		995	1006	439
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.83	0.41	0.14

Intersection Summary

Cycle Length: 65
 Actuated Cycle Length: 65
 Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.83
 Intersection Signal Delay: 16.6
 Intersection Capacity Utilization 76.5%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

















Splits and Phases: 4: Richmond Road & Cleary Avenue



Lanes, Volumes, Timings

1: Woodroffe Avenue & Richmond Road

2024 Future Background PM
809 Richmond Road TIS

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	105	424	110	367	298	457	248	358
Future Volume (vph)	105	424	110	367	298	457	248	358
Lane Group Flow (vph)	107	671	112	565	304	586	253	472
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2	1	6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	1	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	10.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	14.0	33.0	14.0	33.0	16.0	53.0	37.0	37.0
Total Split (%)	14.0%	33.0%	14.0%	33.0%	16.0%	53.0%	37.0%	37.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead	Lag	Lead	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	None	C-Max	None	Max	Max	Max
Act Effct Green (s)	34.6	27.1	34.6	27.1	48.1	46.4	30.4	30.4
Actuated g/C Ratio	0.35	0.27	0.35	0.27	0.48	0.46	0.30	0.30
v/c Ratio	0.38	0.72	0.46	0.59	1.03	0.76	1.16	0.87
Control Delay	23.3	33.1	25.6	29.5	82.2	29.2	143.3	49.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.3	33.1	25.6	29.5	82.2	29.2	143.3	49.9
LOS	C	C	C	C	F	C	F	D
Approach Delay		31.7		28.8		47.3		82.5
Approach LOS		C		C		D		F
Queue Length 50th (m)	12.8	53.1	13.5	42.2	~40.2	88.4	~58.2	83.7
Queue Length 95th (m)	23.8	73.3	24.6	59.6	#91.5	132.7	#105.2	#138.1
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	282	929	246	953	295	772	219	544
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.72	0.46	0.59	1.03	0.76	1.16	0.87

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.16

Intersection Signal Delay: 47.6

Intersection LOS: D

Intersection Capacity Utilization 95.5%

ICU Level of Service F

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.

Lanes, Volumes, Timings

1: Woodroffe Avenue & Richmond Road

2024 Future Background PM

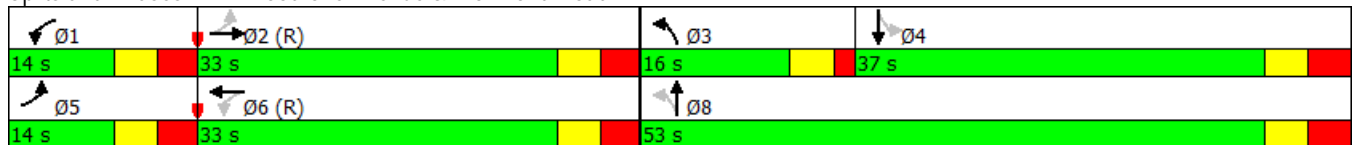
809 Richmond Road TIS

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road

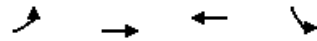


Lanes, Volumes, Timings

4: Richmond Road & Cleary Avenue

2024 Future Background PM

809 Richmond Road TIS



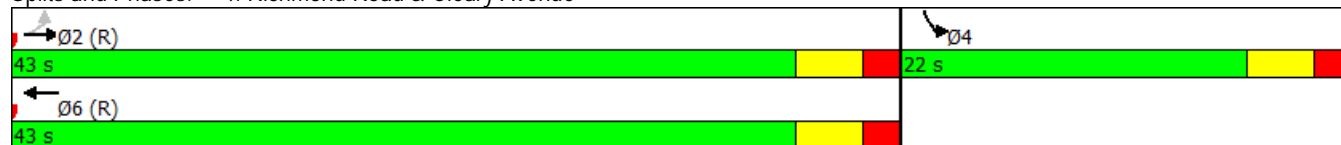
Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	39	411	876	33
Future Volume (vph)	39	411	876	33
Lane Group Flow (vph)	0	469	977	70
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effect Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.77	0.93	0.16
Control Delay		21.2	30.8	12.1
Queue Delay		0.0	0.0	0.0
Total Delay		21.2	30.8	12.1
LOS		C	C	B
Approach Delay		21.2	30.8	12.1
Approach LOS		C	C	B
Queue Length 50th (m)		37.8	94.9	3.1
Queue Length 95th (m)		#91.4	#181.7	11.5
Internal Link Dist (m)		279.0	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		612	1045	451
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.77	0.93	0.16

Intersection Summary

Cycle Length: 65
 Actuated Cycle Length: 65
 Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green
 Natural Cycle: 70
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.93
 Intersection Signal Delay: 27.0
 Intersection Capacity Utilization 69.9%
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: Richmond Road & Cleary Avenue



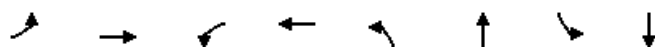
Appendix F

2024 Total Future Synchro Analysis Sheets

Timings

1: Woodroffe Avenue & Richmond Road

2024 Total Future AM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	139	789	174	746	129	326	126	288
Future Volume (vph)	139	789	174	746	129	326	126	288
Lane Group Flow (vph)	142	1038	178	978	132	463	129	418
Turn Type	pm+pt	NA	Perm	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2		6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	6	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	24.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	15.0	54.0	39.0	39.0	12.0	46.0	34.0	34.0
Total Split (%)	15.0%	54.0%	39.0%	39.0%	12.0%	46.0%	34.0%	34.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead		Lag	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes		Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	C-Max	C-Max	None	Max	Max	Max
Act Effct Green (s)	47.8	47.8	33.1	33.1	41.1	39.4	27.4	27.4
Actuated g/C Ratio	0.48	0.48	0.33	0.33	0.41	0.39	0.27	0.27
v/c Ratio	0.66	0.66	1.13	0.86	0.57	0.68	0.57	0.85
Control Delay	32.5	21.3	147.6	39.5	29.7	30.1	42.8	50.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	32.5	21.3	147.6	39.5	29.7	30.1	42.8	50.3
LOS	C	C	F	D	C	C	D	D
Approach Delay		22.7		56.1		30.0		48.5
Approach LOS		C		E		C		D
Queue Length 50th (m)	15.1	74.1	~40.6	89.9	16.0	69.6	21.5	73.2
Queue Length 95th (m)	#35.4	95.7	#81.6	#124.5	28.5	105.2	41.4	#123.9
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	220	1573	157	1133	230	676	226	492
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.66	1.13	0.86	0.57	0.68	0.57	0.85

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green
 Natural Cycle: 100
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.13
 Intersection Signal Delay: 39.1
 Intersection Capacity Utilization 95.9%
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.

Timings

1: Woodroffe Avenue & Richmond Road

2024 Total Future AM

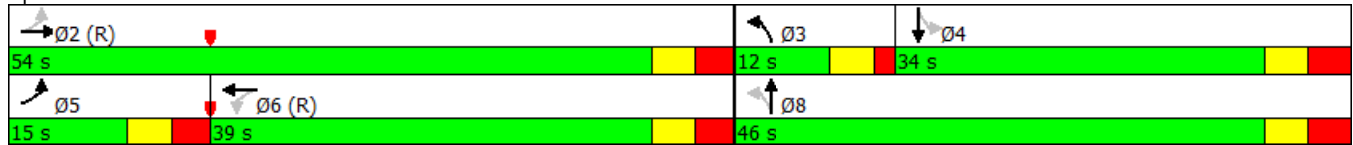
809 Richmond Road TIS

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road

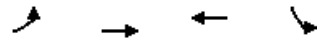


Timings

4: Richmond Road & Cleary Avenue

2024 Total Future AM

809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	30	703	341	33
Future Volume (vph)	30	703	341	33
Lane Group Flow (vph)	0	833	410	61
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effct Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.84	0.41	0.14
Control Delay		21.1	8.8	14.1
Queue Delay		0.0	0.0	0.0
Total Delay		21.1	8.8	14.1
LOS		C	A	B
Approach Delay		21.1	8.8	14.1
Approach LOS		C	A	B
Queue Length 50th (m)		72.5	23.4	3.5
Queue Length 95th (m)		#140.8	38.2	11.0
Internal Link Dist (m)		279.9	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		995	1006	439
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.84	0.41	0.14

Intersection Summary

Cycle Length: 65

Actuated Cycle Length: 65

Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.84

Intersection Signal Delay: 16.9

Intersection LOS: B

Intersection Capacity Utilization 76.8%

ICU Level of Service D

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

03/19/2018

MC

Synchro 9 Report

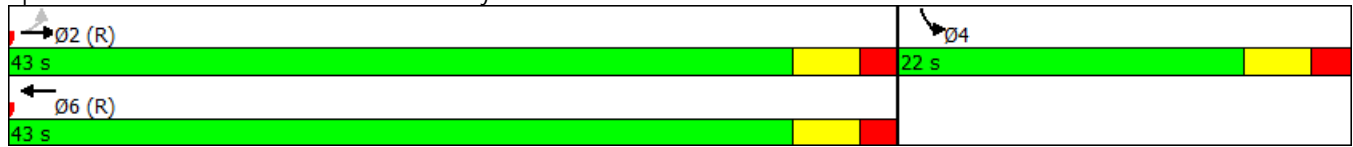
Page 3

Timings
4: Richmond Road & Cleary Avenue

2024 Total Future AM
809 Richmond Road TIS

Queue shown is maximum after two cycles.










Splits and Phases: 4: Richmond Road & Cleary Avenue



HCM Unsignalized Intersection Capacity Analysis

2: Richmond Road & West Site Access

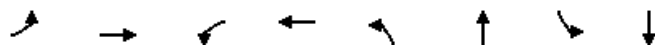
2024 Total Future AM
809 Richmond Road TIS

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	730	376	2	10	12
Future Volume (Veh/h)	3	730	376	2	10	12
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	793	409	2	11	13
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)		340	304			
pX, platoon unblocked	0.94				0.76	0.94
vC, conflicting volume	411				1209	410
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	346				947	345
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				95	98
cM capacity (veh/h)	1145				218	659
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	796	411	24			
Volume Left	3	0	11			
Volume Right	0	2	13			
cSH	1145	1700	342			
Volume to Capacity	0.00	0.24	0.07			
Queue Length 95th (m)	0.1	0.0	1.7			
Control Delay (s)	0.1	0.0	16.3			
Lane LOS	A		C			
Approach Delay (s)	0.1	0.0	16.3			
Approach LOS			C			
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization			53.1%	ICU Level of Service		A
Analysis Period (min)			15			

Timings

1: Woodroffe Avenue & Richmond Road

2024 Total Future PM
809 Richmond Road TIS



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	105	426	111	368	298	457	248	358
Future Volume (vph)	105	426	111	368	298	457	248	358
Lane Group Flow (vph)	107	673	113	567	304	588	253	472
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	Perm	NA
Protected Phases	5	2	1	6	3	8		4
Permitted Phases	2		6		8		4	
Detector Phase	5	2	1	6	3	8	4	4
Switch Phase								
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.2	24.2	10.2	24.2	8.9	33.6	33.6	33.6
Total Split (s)	14.0	33.0	14.0	33.0	16.0	53.0	37.0	37.0
Total Split (%)	14.0%	33.0%	14.0%	33.0%	16.0%	53.0%	37.0%	37.0%
Yellow Time (s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
All-Red Time (s)	2.9	2.9	2.9	2.9	1.6	3.3	3.3	3.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.2	6.2	6.2	6.2	4.9	6.6	6.6	6.6
Lead/Lag	Lead	Lag	Lead	Lag	Lead		Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Recall Mode	None	C-Max	None	C-Max	None	Max	Max	Max
Act Effct Green (s)	34.6	27.1	34.6	27.1	48.1	46.4	30.4	30.4
Actuated g/C Ratio	0.35	0.27	0.35	0.27	0.48	0.46	0.30	0.30
v/c Ratio	0.39	0.73	0.47	0.60	1.03	0.76	1.17	0.87
Control Delay	23.3	33.3	25.8	29.6	82.2	29.3	147.1	49.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.3	33.3	25.8	29.6	82.2	29.3	147.1	49.9
LOS	C	C	C	C	F	C	F	D
Approach Delay		31.9		29.0		47.3		83.8
Approach LOS		C		C		D		F
Queue Length 50th (m)	12.8	53.4	13.6	42.5	~40.2	88.8	~58.5	83.7
Queue Length 95th (m)	23.8	73.7	24.8	59.9	#91.5	132.8	#105.6	#138.1
Internal Link Dist (m)		119.1		183.3		149.3		207.8
Turn Bay Length (m)	65.0		65.0		60.0		30.0	
Base Capacity (vph)	282	928	246	952	295	773	217	544
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.73	0.46	0.60	1.03	0.76	1.17	0.87

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 35 (35%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.17

Intersection Signal Delay: 48.0

Intersection LOS: D

Intersection Capacity Utilization 95.7%

ICU Level of Service F

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.

Timings

1: Woodroffe Avenue & Richmond Road

2024 Total Future PM

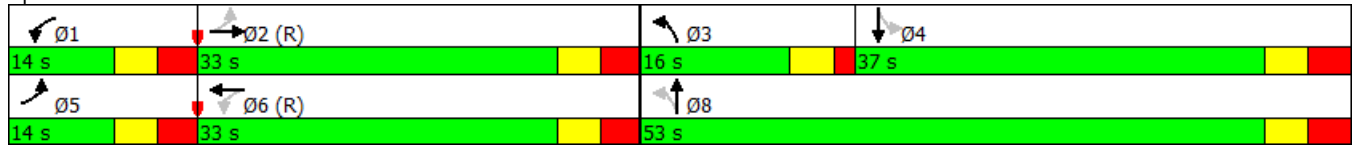
809 Richmond Road TIS

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Woodroffe Avenue & Richmond Road



Timings

4: Richmond Road & Cleary Avenue

2024 Total Future PM

809 Richmond Road TIS



Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Traffic Volume (vph)	39	413	880	33
Future Volume (vph)	39	413	880	33
Lane Group Flow (vph)	0	471	981	70
Turn Type	Perm	NA	NA	Prot
Protected Phases		2	6	4
Permitted Phases	2			
Detector Phase	2	2	6	4
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	29.1	29.1	29.1	21.3
Total Split (s)	43.0	43.0	43.0	22.0
Total Split (%)	66.2%	66.2%	66.2%	33.8%
Yellow Time (s)	3.3	3.3	3.3	3.3
All-Red Time (s)	1.8	1.8	1.8	2.0
Lost Time Adjust (s)		0.0	0.0	0.0
Total Lost Time (s)		5.1	5.1	5.3
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	Max
Act Effct Green (s)		37.9	37.9	16.7
Actuated g/C Ratio		0.58	0.58	0.26
v/c Ratio		0.78	0.94	0.16
Control Delay		22.0	31.4	12.1
Queue Delay		0.0	0.0	0.0
Total Delay		22.0	31.4	12.1
LOS		C	C	B
Approach Delay		22.0	31.4	12.1
Approach LOS		C	C	B
Queue Length 50th (m)		38.4	95.9	3.1
Queue Length 95th (m)		#92.7	#182.8	11.5
Internal Link Dist (m)		279.0	67.9	109.2
Turn Bay Length (m)				
Base Capacity (vph)		606	1045	451
Starvation Cap Reductn		0	0	0
Spillback Cap Reductn		0	0	0
Storage Cap Reductn		0	0	0
Reduced v/c Ratio		0.78	0.94	0.16

Intersection Summary

Cycle Length: 65

Actuated Cycle Length: 65

Offset: 53 (82%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Natural Cycle: 70

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.94

Intersection Signal Delay: 27.6

Intersection LOS: C

Intersection Capacity Utilization 70.0%

ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

03/19/2018

MC

Synchro 9 Report

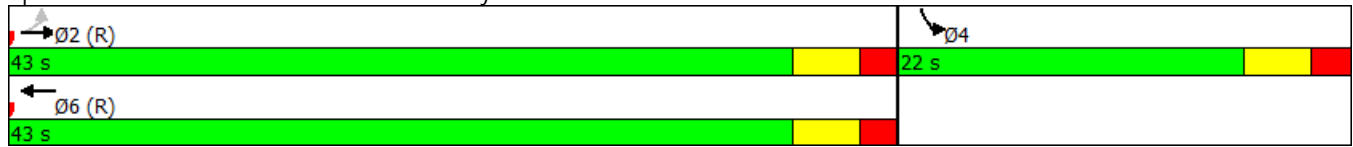
Page 3

Timings
4: Richmond Road & Cleary Avenue

2024 Total Future PM
809 Richmond Road TIS

Queue shown is maximum after two cycles.










Splits and Phases: 4: Richmond Road & Cleary Avenue



HCM Unsignalized Intersection Capacity Analysis

2: Richmond Road & West Site Access













2024 Total Future PM
809 Richmond Road TIS

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	8	459	924	7	4	6
Future Volume (Veh/h)	8	459	924	7	4	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	499	1004	8	4	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)		341	303			
pX, platoon unblocked	0.49				0.54	0.49
vC, conflicting volume	1012				1525	1008
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	496				1123	488
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				97	98
cM capacity (veh/h)	519				120	282
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	508	1012	11			
Volume Left	9	0	4			
Volume Right	0	8	7			
cSH	519	1700	189			
Volume to Capacity	0.02	0.60	0.06			
Queue Length 95th (m)	0.4	0.0	1.4			
Control Delay (s)	0.5	0.0	25.2			
Lane LOS	A		D			
Approach Delay (s)	0.5	0.0	25.2			
Approach LOS			D			
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization		61.8%		ICU Level of Service		B
Analysis Period (min)		15				

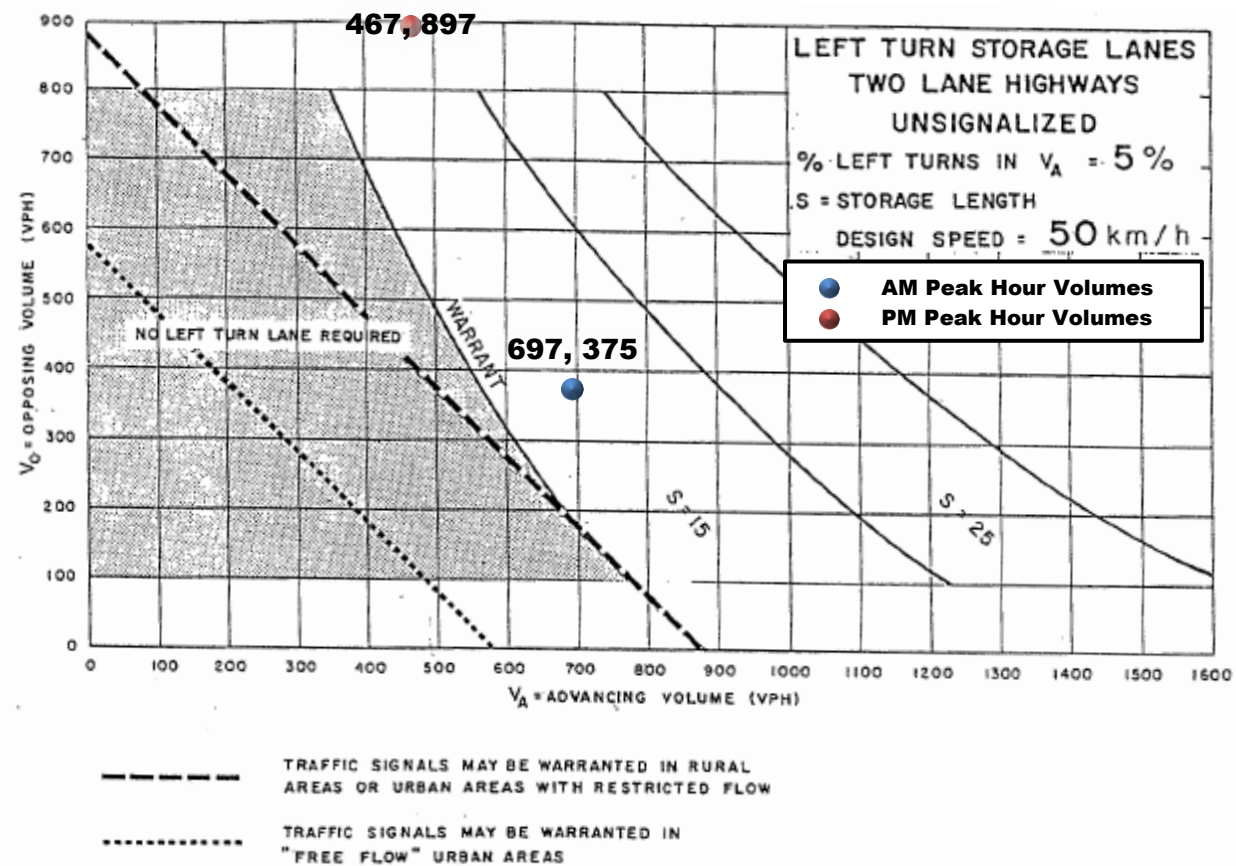
Appendix G

Left-Turn Lane Warrant













	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										
Richmond/Site, 2019 volume projections	50	697	467	375	897	7	23	1%	5%	Yes

Peak	 NBL	 NBT	 NBR	 SBL	 SBT	 SBR	 EBL	 EBT	 EBR	 WBL	 WBT	 WBR
AM	0	0	0	21	0	27	7	690	0	0	369	6
PM	0	0	0	11	0	15	23	444	0	0	878	19

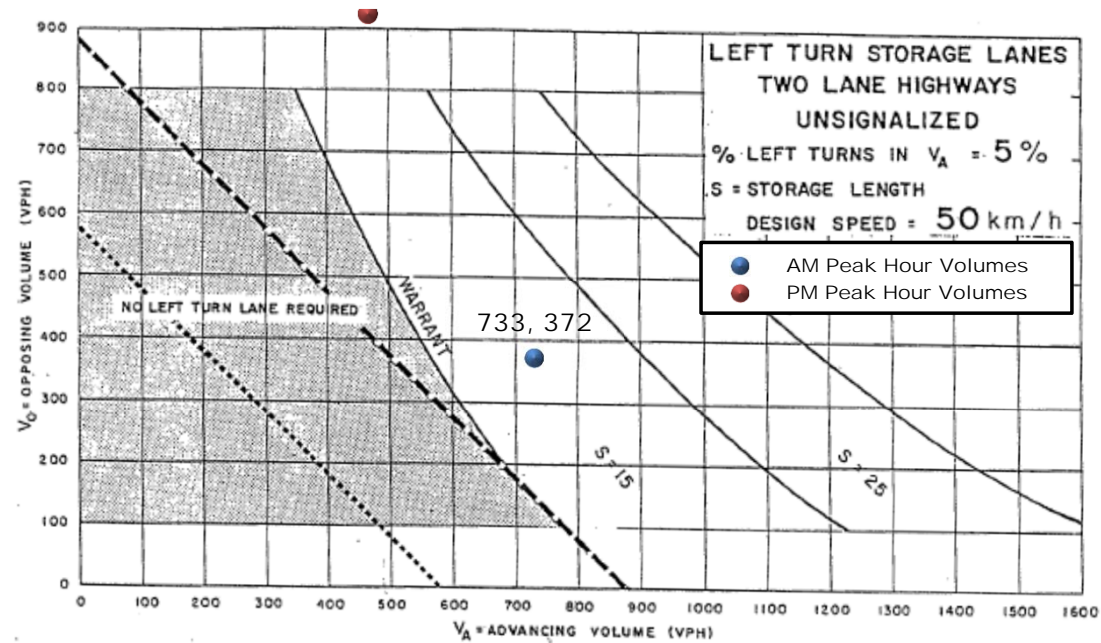
Warrant?



	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										
Richmond/Site, 2024 volume projections	50	733	467	372	928	3	8	0%	2%	Yes

Peak	 NBL	 NBT	 NBR	 SBL	 SBT	 SBR	 EBL	 EBT	 EBR	 WBL	 WBT	 WBR
AM	0	0	0	10	0	12	3	730	0	0	370	2
PM	0	0	0	4	0	6	8	459	0	0	921	7

Warrant?



--- TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

..... TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS