

**5426, 5452 & 5548 LAKESHORE ROAD
VILLAGE OF BALLANTRAE
WHITCHURCH-STOUFFVILLE**

Proposed Residential Development
Transportation Impact Study

Prepared For: Alcorn & Associates

Revised December 19th, 2018



**MOVEMENT
IN URBAN
ENVIRONMENTS**

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1.0 INTRODUCTION

BA Consulting Group (BA Group) is retained by Alcorn & Associates to provide transportation consulting services in relation to the proposed plan of subdivision application on Lakeshore Road in the Town of Whitchurch-Stouffville. The site is located at 5426, 5452, and 5584 Lakeshore Road (herein referred to as 'Farsight Lands') in the village of Ballantrae. The development is to be a private gated low-density residential condominium subdivision consisting of 141 detached homes.

The site which is a single plot of land 16.26 hectares in size, consists of undeveloped land with an agricultural site to the east and north, and a new single-family residential development to the west, and Lakeshore Road to the south. The site has 140 metres of frontage along Lakeshore Road with one small existing home located at the southwest corner of the property. A woodlot bisects the property, which contains a drainage course and pond to be retained.

The site location is illustrated on Figure 1.

1.1 SCOPE OF ANALYSIS

This study reviews the transportation related implications of the proposed development. Key transportation considerations reviewed as part of this study include the following:

- a review of the development programme and site;
- a review of the area transportation context in the site vicinity;
- a review of the vehicular parking requirements for the project and the appropriateness of the proposed parking supply;
- a review of the loading considerations associated with the project including an assessment of the suitability of the proposed road network to accommodate waste collection vehicles;
- a review of existing traffic activity levels and patterns in the study area;
- a review of general corridor growth and background development activity in the study area;
- a review of estimated site-related traffic forecasts;
- an assessment of the traffic operations at the area intersections today and in the future in order to review the impact of new site traffic on the area street network;
- identification of any recommended road modifications to mitigate site traffic impacts;
- a review of the implications of a potential north-south road link through the site as identified in the recent Whitchurch Stouffville TMP; and
- a review of relevant Transportation Demand Management (TDM) strategies proposed for the project; and
- a review and assessment of emergency vehicle access considerations for the site.

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SITE LOCATION

2.0 PROPOSED DEVELOPMENT

The existing home is to be demolished and the new development would consist of 141 single-family detached homes on private condominium roads. The development will have one proposed divided lane access to/from Lakeshore Road with an emergency access block (Block 150) that provides secondary access for emergency vehicles at the southwest corner.

Five (5) new private condominium streets (Streets A through E) are proposed to make up the local road network. All of the detached dwelling units are proposed to have frontage onto the new private local streets. There are three (3) turnaround facilities in the fashion of either cul-de-sacs or a hammerhead turnaround which occur as a result of woodlot and open space (flood plain) constraints to the planning of the lands.

The internal road network will consist of private streets. Two types of internal private streets are proposed:

- 1) a 13.0m wide right-of-way with a 9.5m pavement width; and
- 2) a 11.0m wide right-of-way with a 7.5m pavement width.

The wider street (Street A) will be the primary route through the site and connect to/from Lakeshore Road. All other internal streets will have the 11.0m right of way. A copy of the proposed internal street cross sections is provided in Appendix A.

A roundabout is proposed in the centre of the site to act as a traffic calming and landscape feature for the project. All other intersections are expected to operate under two-way stop control with the stop control associated with the side street approach.

The development plan also includes a north-south walking trail through the site. The proposed trail will run from Aurora Road in the north, through an adjacent land parcel and connect to a north-south walkway within the site that continues south to Lakeshore Road. Within the site the trail / walkway will be adjacent to the existing woodlot / drainage course.

3.0 TRANSPORTATION NETWORK

3.1 AREA ROAD NETWORK

The existing road network, lane configurations, signal controls and intersection turning restrictions in the site's environs are shown in Figure 2. A brief description of the area road network is included in the following section.

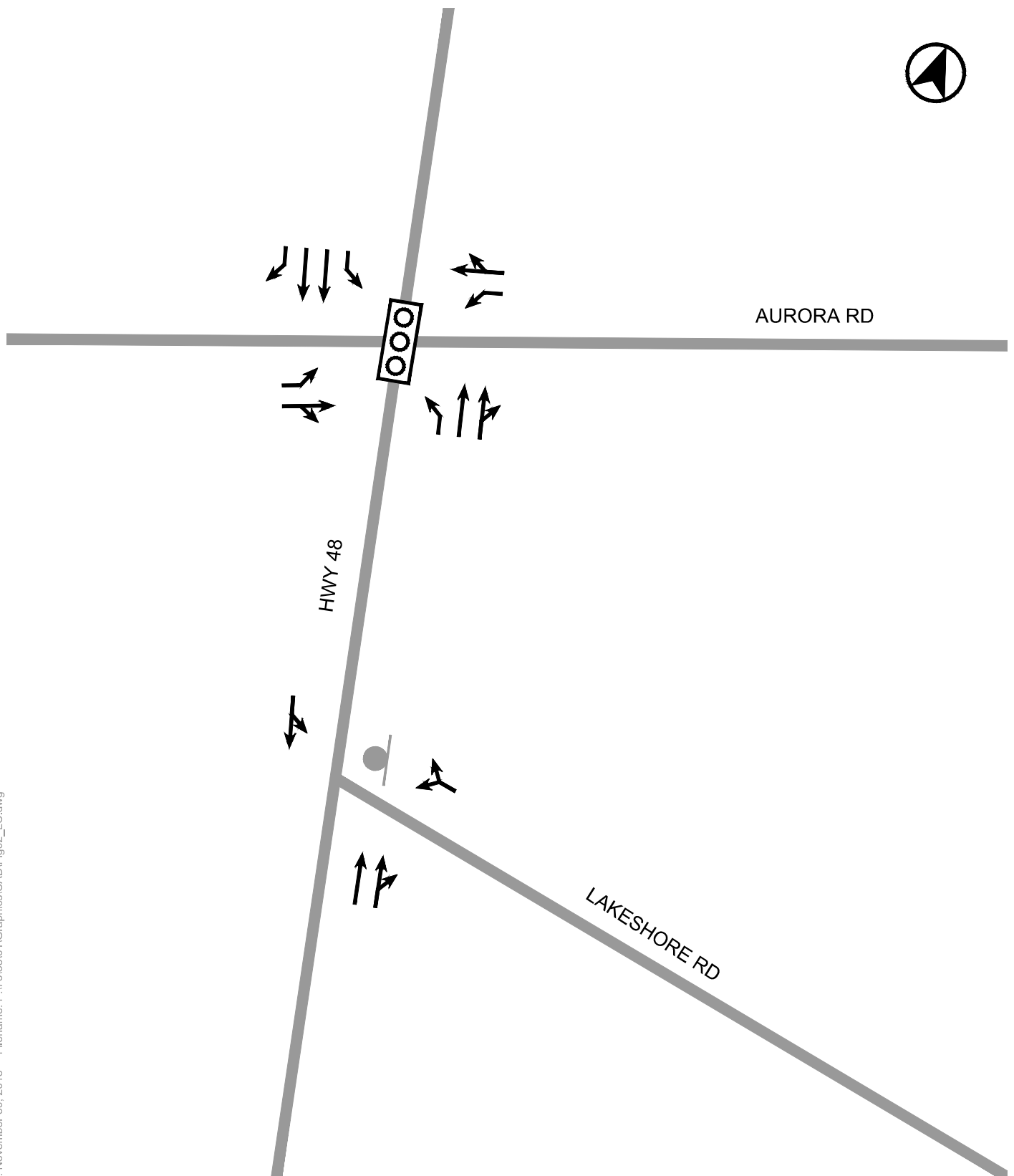
Highway 48 is a north - south oriented major arterial road located west of the site which provides a major link from Markham to Highway 12 in Township of Brock. In the site vicinity, Highway 48 has a 2-lane cross section (per direction), with dedicated left-turn lanes and a southbound right-turn lane at Highway 48 and Aurora Road intersection. Highway 48 has a posted speed limit of 60 kilometre per hour within the site's environs and increases to 80 kilometre per hour approximately 220 m north of Highway 48 / Aurora Road intersection.

Aurora Road, also named as York Regional Road 15, runs east / west, being situated approximately 200 metres to the north of the site. It changes into Wellington Street once it passes west of Highway 404 in Aurora, and connects Whitchurch – Stouffville with Aurora and King City. In the site vicinity, Aurora Road has a 2-lane cross section, with dedicated left-turn lanes at Highway 48 / Aurora Road intersection and at McMullen Drive. The posted speed limit through the village of Ballantrae is 60 kilometre per hour.

Lakeshore Road is a local road that runs along the southern site boundary. It extends from Highway 48 to Ninth Line and passes through the community of Musselman's Lake with connection to Aurora Road to the north and Bloomington Road to the south, via the Ninth Line. Lakeshore Road operates generally in the east-west direction with a 40 kilometre per hour speed limit and a 2-lane rural cross section.

3.2 EXISTING TRANSIT NETWORK

The site is not located in proximity to any transit services. The closest transit service is the Lincolnville GO Station located 8.8 kilometres southeast of the site on the intersection of Tenth Line and Bethesda Side Road. The Lincolnville GO Station is a 15 minute drive from the site, and provides parking for commuters. The station provides services to the rest of the Greater Toronto Area with the Stouffville Line GO Train, 70 Stouffville Train Meet Bus Service and 71 Stouffville Train-Bus Service. The Highway 404 / Aurora Road GO Bus Station is situated approximately 6 km to the west (a 12 minute drive from the site) providing access to downtown Toronto.



EXISTING LANE CONFIGURATION AND TRAFFIC CONTROL



3.3 AREA CYCLING AND PEDESTRIAN FACILITIES AND INFRASTRUCTURE

Currently, there is a narrow paved shoulder along Aurora Road for cycling and pedestrian use in the vicinity of Ballantrae. This route extends east along Aurora Road to York-Durham Line, and extends west to Highway 404 to become a separated sidewalk. A separated sidewalk exists along the north side of Aurora Road from the public school on the east to Greyfield Drive on the western edge of the community.

As part of the Whitchurch-Stouffville Transportation Master Plan, new cycling facilities are planned. Aurora Road is designated to be a part of a region-wide Greenbelt cycling route. In-boulevard cycling facility is proposed for the section of Highway 48 in the vicinity of the site and Lakeshore Road will be designated as shared route.

There are existing or proposed active transportation routes along the cycling route, which will provide safer cyclist access to the nearby hamlet of Ballantrae, Stouffville GO Station, as well as the town centres of Newmarket, Aurora, and Stouffville.

3.4 PROPOSED PEDESTRIAN / TRAIL INFRASTRUCTURE

The proposed development includes a new walking trail through the site that will connect from Lake Shore Road to Aurora Road. The proposed walking trail will generally run alongside the drainage course within the site. Two additional east-west trail connections will also be provided linking the residential areas in the NW and NE areas of the plan to the proposed main north-south trail. The proposed trail in the community master plan is illustrated in Figure 3.

3.5 EXISTING AREA TRAVEL CHARACTERISTICS

BA Group has reviewed the travel mode choice characteristics of residents within the local area based upon data from the 2016 Transportation Tomorrow Survey (TTS). The corresponding mode split for the area is shown below in Table 1.

TABLE 1 EXISTING AREA TRAVEL MODE SPLIT

Travel Mode	Morning Outbound	Afternoon Inbound
Auto Driver	73%	80%
Auto Passenger ²	12%	12%
Transit ³	14%	7%
Walk	1%	1%
Cycle	0%	0%
Total	100%	100%

Notes:

1. Reflects all trips made to/from residential land uses within 2006 TTS Zones 2716 and 2717 during the weekday morning and afternoon peak hour periods.
2. Includes auto passenger and taxi passenger.
3. Includes solely GO transit only, joint GO transit and local transit, and school bus.

3.6 FUTURE AREA ROAD NETWORK

On May 15th 2018 the Town of Whitchurch-Stouffville Council approved a new Transportation Master Plan (TMP). The TMP was prepared by HDR Inc. and is dated February 2017. A figure illustrating the recommended road link in the TMP is provided in Figure 4. Relevant excerpts from the TMP is attached in Appendix B, along with a letter prepared by BA Group, dated December 6th 2017 providing input to the Town in response to the draft TMP. The TMP is required to be implemented by an amendment to the Town Official Plan.

The TMP recommends a new north-south public road connecting between Lakeshore Road and Aurora Road that would bisect the proposed development site. The rationale for the new road connection in the TMP is to provide an alternative connection to the external arterial road network (i.e. Aurora Road) for traffic on Lakeshore Road and, in doing so, relieve anticipated delays for traffic experienced by the westbound left turn on Lakeshore Road at Highway 48. In this regard, the unsignalized capacity analysis in the TMP estimated by 2031, without the road link, the westbound left turn delays will be 44 seconds and 27 seconds during the weekday morning and weekday afternoon peak hours, respectively.

The December 6, 2017 BA Group letter reviewed the benefits of the potential proposed north-south road link in the TMP from a traffic capacity perspective. In that submission BA Group concluded that the proposed TMP road link was not required from a traffic capacity perspective and would deliver minimal benefit to the area road network.

This report provides additional analysis with respect to the impact and benefits of the recommended road link through a sensitivity analysis. As a base assumption however this road link has not been assumed to be in place by the study horizon year.

Figure 3 on the following page illustrates the proposed concept plan for the site including the proposed internal trail.



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PROPOSED TRAIL INFRASTRUCTURE WITHIN COMMUNITY MASTER PLAN



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Figure 3



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CONCEPTUAL NEW ROAD LINK IN TRANSPORTATION MASTER PLAN



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Figure 4

4.0 VEHICLE PARKING CONSIDERATIONS

4.1 ZONING BY-LAW REQUIREMENT

The Town of Whitchurch-Stouffville currently has Zoning By-Law 2010-001-ZO in effect. According to the parking regulations outlined in the by-law, a total of two (2) off-street parking spaces are required per residential dwelling unit. As a result of this regulation, 282 overall parking spaces are required for the residential uses of the development.

4.2 PROPOSED PARKING SUPPLY

Vehicle parking is proposed within the driveway and garage of each lot with each unit having a two car driveway and a two car garage. Based on the 141 proposed single family detached dwellings, the resulting parking supply for the development is 564 spaces which is sufficient to accommodate the Zoning By-law requirements.

5.0 LOADING CONSIDERATIONS

5.1 ZONING BY-LAW REQUIREMENT

The Town of Whitchurch Stouffville Zoning By-law does not require loading for the proposed detached residential units.

5.2 MANOEUVRING ANALYSIS

An AutoTrack swept path analysis was undertaken to test vehicular swept paths of a waste collection vehicle to ensure that waste vehicles can acceptably negotiate the proposed road geometry. The swept path analysis was undertaken using the assumed pavement widths as outlined in the two internal street cross sections proposed.

The swept path analysis utilized a design vehicle comparable to a City of Aurora refuse vehicle measuring 12.0 metres in length, and 2.5 metres in width.

It is anticipated that waste pickup will occur in the following fashion: the rear or side-loading vehicle will briefly stop along the driveway of each home, and individual family waste bins will be emptied into the truck compactor. The proposed street network has been tested accordingly, and designed to ensure an appropriate turnaround facility is available at the terminus of each street, via either a cul-de-sac or hammerhead turnaround.

Based on the analysis the proposed road geometry will acceptably accommodate the swept paths of the anticipated refuse collection vehicles. A copy of the swept path analysis is provided in Appendix C.

6.0 VEHICLE TRAFFIC FORECASTS

6.1 STUDY AREA

The following intersections are considered in the traffic analyses undertaken as part of this study:

- Highway 48 and Aurora Road
- Highway 48 and Lakeshore Road
- Lakeshore Road and Site access

Traffic operations analyses have been undertaken for weekday morning and afternoon peak hour periods, which reflect the busiest periods of traffic activity on the area road network.

6.2 HORIZON YEAR

It is estimated that it will take approximately 2 years to build-out the development corresponding to a build-out year of 2020. A five (5) year post-build-out horizon of 2025 has been considered for the purposes of the traffic / transportation analysis undertaken herein.

Background developments have been assumed to be built by this horizon year (2025).

6.3 ANALYSIS SCENARIOS

Traffic operations have been undertaken for the following three main baseline analysis conditions:

1. *Existing traffic conditions:*
 - o Considering the prevailing levels of activity on the area street network and existing street configuration.
2. *Future background traffic conditions:*
 - o Considering existing levels of activity in addition to anticipated changes due to the construction and occupancy of other development proposals in the area.
3. *Future total traffic conditions:*
 - o Considering future background levels of activity and any activity changes relating to development of the site.

A brief description of the three sets of analyses undertaken is provided in the following sections.

6.4 EXISTING TRAFFIC VOLUMES

Base existing traffic volumes were established for the weekday morning and afternoon street peak hours for intersections within the study area, based on traffic count information collected by, Spectrum Traffic Data Inc., on behalf of BA Group on February 23, 2017.

The existing traffic count information was reviewed in detail to ensure a general consistency between intersections. Conservative (positive) adjustments were made to the through movement volumes at various intersections within the study area to provide a balanced and representative traffic volume base for the purposes of the traffic operations analyses undertaken as part of this assessment.

It is also noted that existing 2017 traffic volumes were increased to include 1 year of corridor growth in order to reflect 2018 conditions. The growth rate was applied consistent with the future growth rate outlined in the section below.

Resultant existing traffic volumes during the morning and afternoon peak hours on the area street system surrounding the proposed development site are illustrated in Figure 5.

6.5 FUTURE BACKGROUND TRAFFIC VOLUMES

6.5.1 Corridor Traffic Growth

According to the Whitchurch-Stouffville Transportation Master Plan done by HDR Inc., the annual growth rate along arterial routes across the Town of Whitchurch-Stouffville is, on average, 2%. Therefore, a conservative 2% growth factor was applied to estimate future traffic growth on Aurora Road.

The assumed growth rate was applied to the 7 years time horizon from the 2018 traffic counts to the 2025 horizon year to obtain future background traffic volumes.

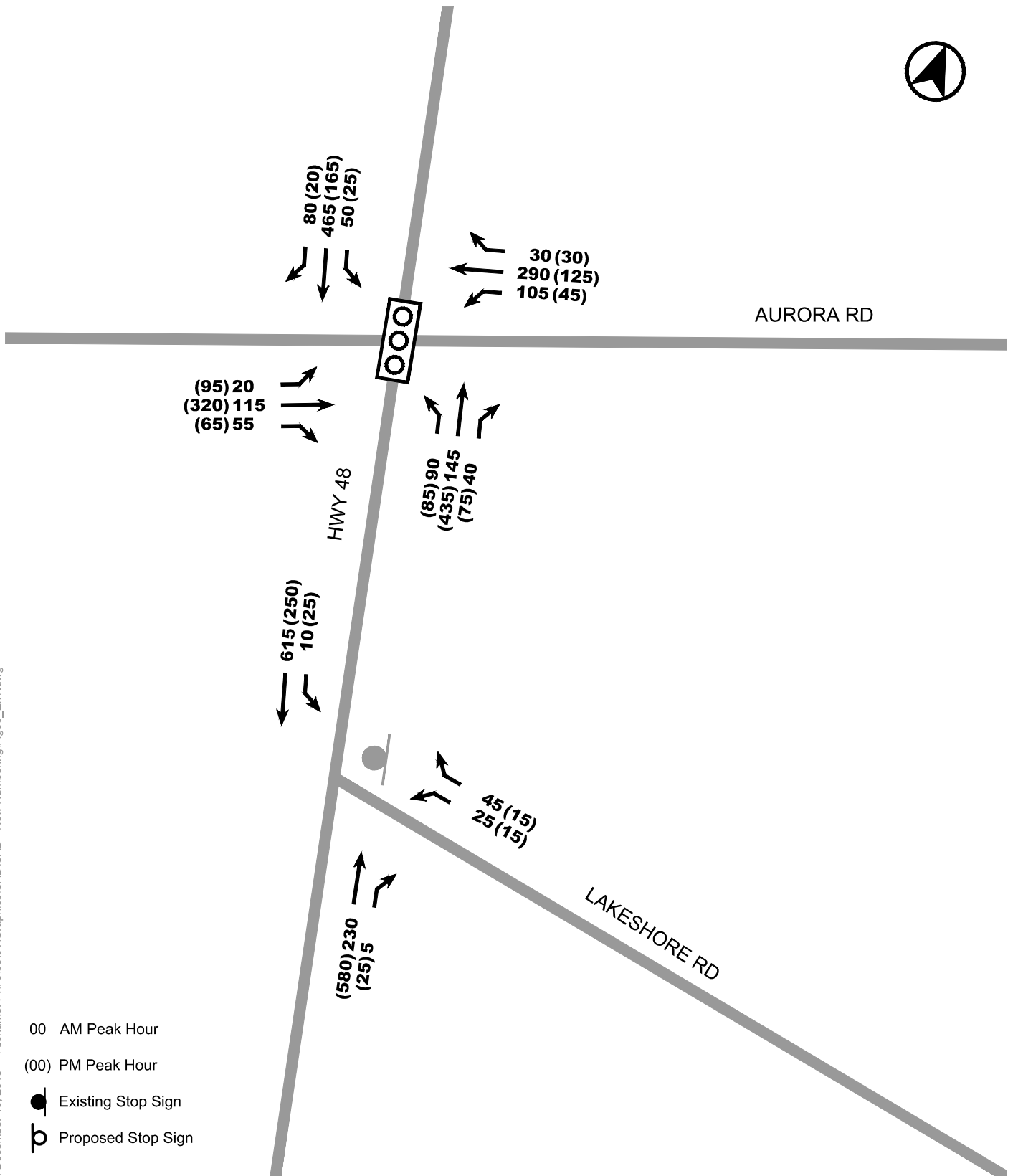
The corridor growth traffic volumes are presented in Figure 6.

6.5.2 Site Specific Background Development

A review of development proposals in the area that are approved but not yet built or are in the process of approval with the Town of Whitchurch-Stouffville was undertaken. Currently, three background development proposals were considered based upon discussions with the Town of Whitchurch-Stouffville Development Services staff and review of the Town of Whitchurch-Stouffville Residential Activity Map. The respective sources of related traffic assignment incorporated in this study is shown in **Table 2**. The resultant sum of the site specific background traffic allowances are set out in Figure 7.

TABLE 2 SITE SPECIFIC BACKGROUND DEVELOPMENTS

Development Address	Scope	Study	Status
5194, 5208, 5222, 5232 Aurora Road & 115288 Highway 48	54 townhouse units	GHD Group July 2015	Proposed Draft Plan
Northeast of Aurora Road / Highway 48	88 single detached units	Dionne Bacchus & Associates February 15, 2017	Proposed Draft Plan
Northeast corner of Aurora Road / Highway 48	Office: 9,924 square ft. GFA General shopping or retail: 28,105 square ft. GFA	Poulos & Chung Ltd. November 2015	Proposed Draft Plan



EXISTING TRAFFIC

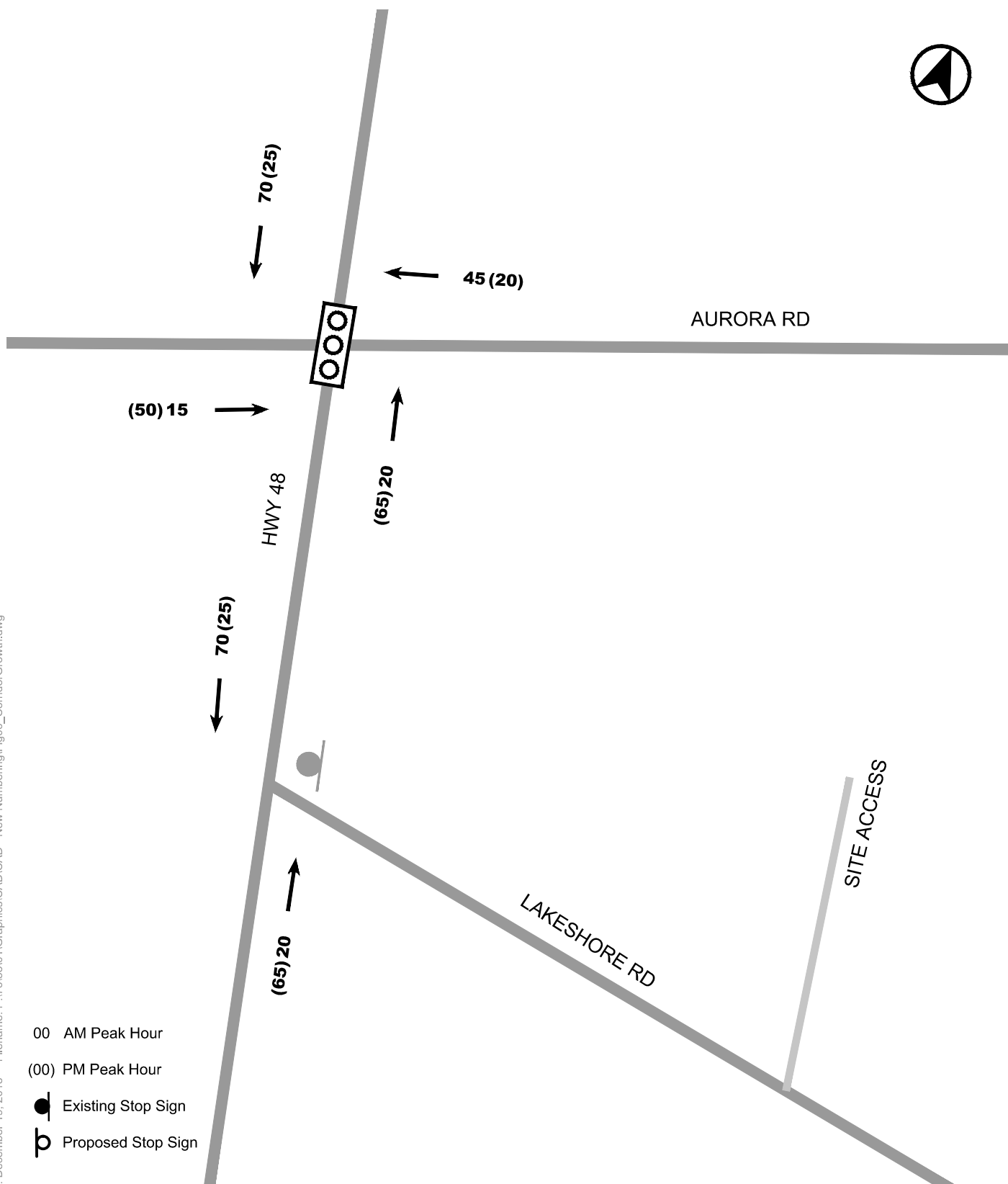


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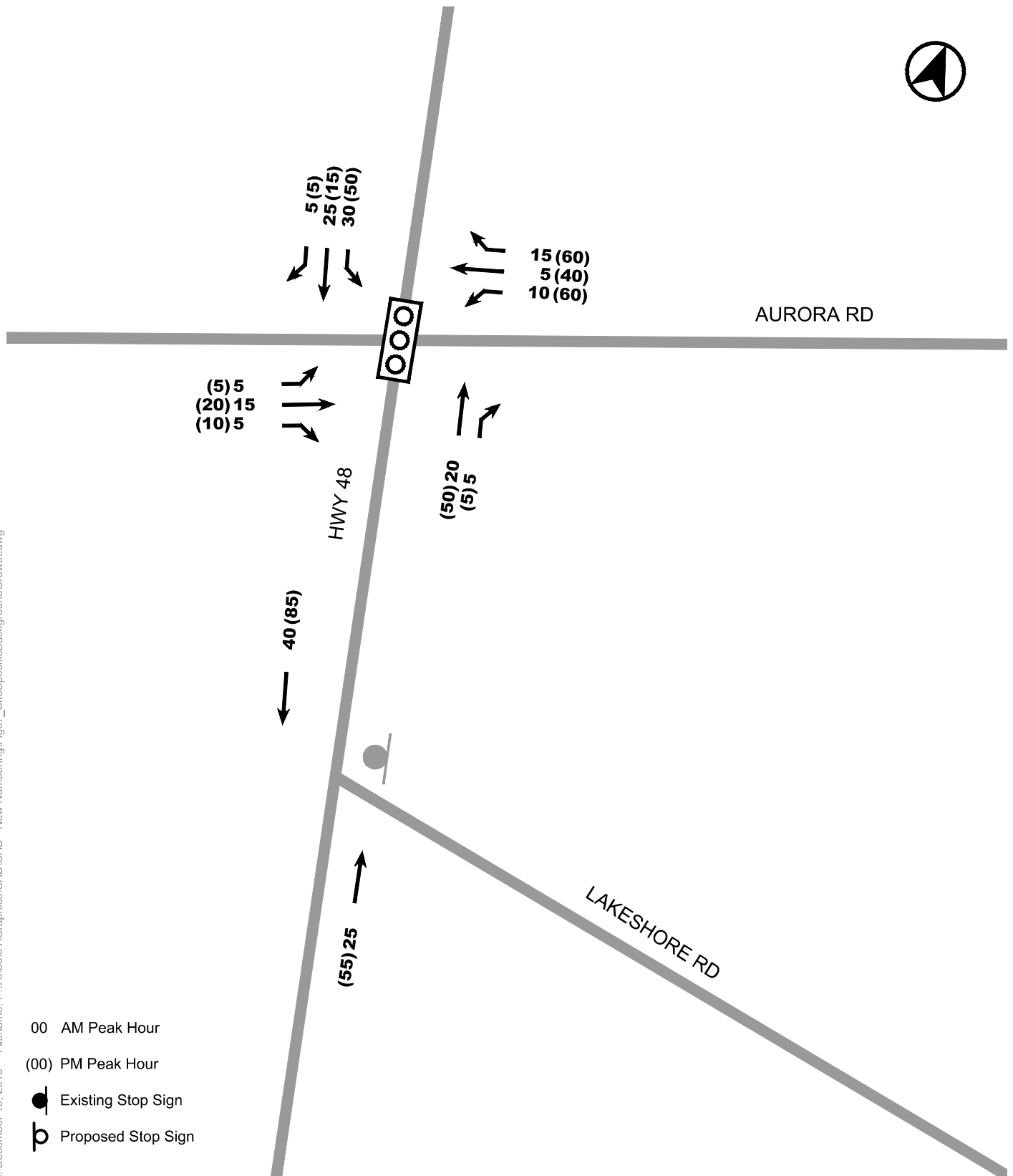
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CORRIDOR GROWTH TRAFFIC FORECAST

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SITE SPECIFIC BACKGROUND TRAFFIC

6.5.3 Future Background Traffic Volumes

Future Background Traffic volumes have been established for the morning and afternoon peak hour periods by adding Existing Traffic volumes with corridor traffic growth allowances and the site specific background allowances. Resultant Future Background traffic volumes are presented in Figure 8.

6.6 SITE TRAFFIC TRIP GENERATION

Site development traffic was estimated through a review of trip generation characteristics of existing neighbourhoods in Ballantrae, and through a comparison to trip rates from the Institute of Transportation Engineers Trip Generation Manual.

Trip generation characteristics from the area were obtained from automatic traffic recording (ATR) counts that were set up to record traffic entering/exiting existing homes located on Fletcher Boulevard in the southeast quadrant of Aurora Road / Highway 48 on March 21, 2018. Two counts were conducted: one immediately south of the intersection of Fletcher Boulevard / Aurora Road, and immediately west of the intersection of Fletcher Boulevard / Highway 48. The residential units located along Fletcher Boulevard between these two locations were counted to complete the trip generation for the area. Trip rates were also obtained from a previous transportation review on a development in a nearby site in Ballantrae at Lakeshore Road and Treeview Avenue.

Trip rates from the ITE Trip Generation Manual were also consulted. The estimated site trip generation is summarized in Table 3.

TABLE 3 RESIDENTIAL TRIP GENERATION RATES

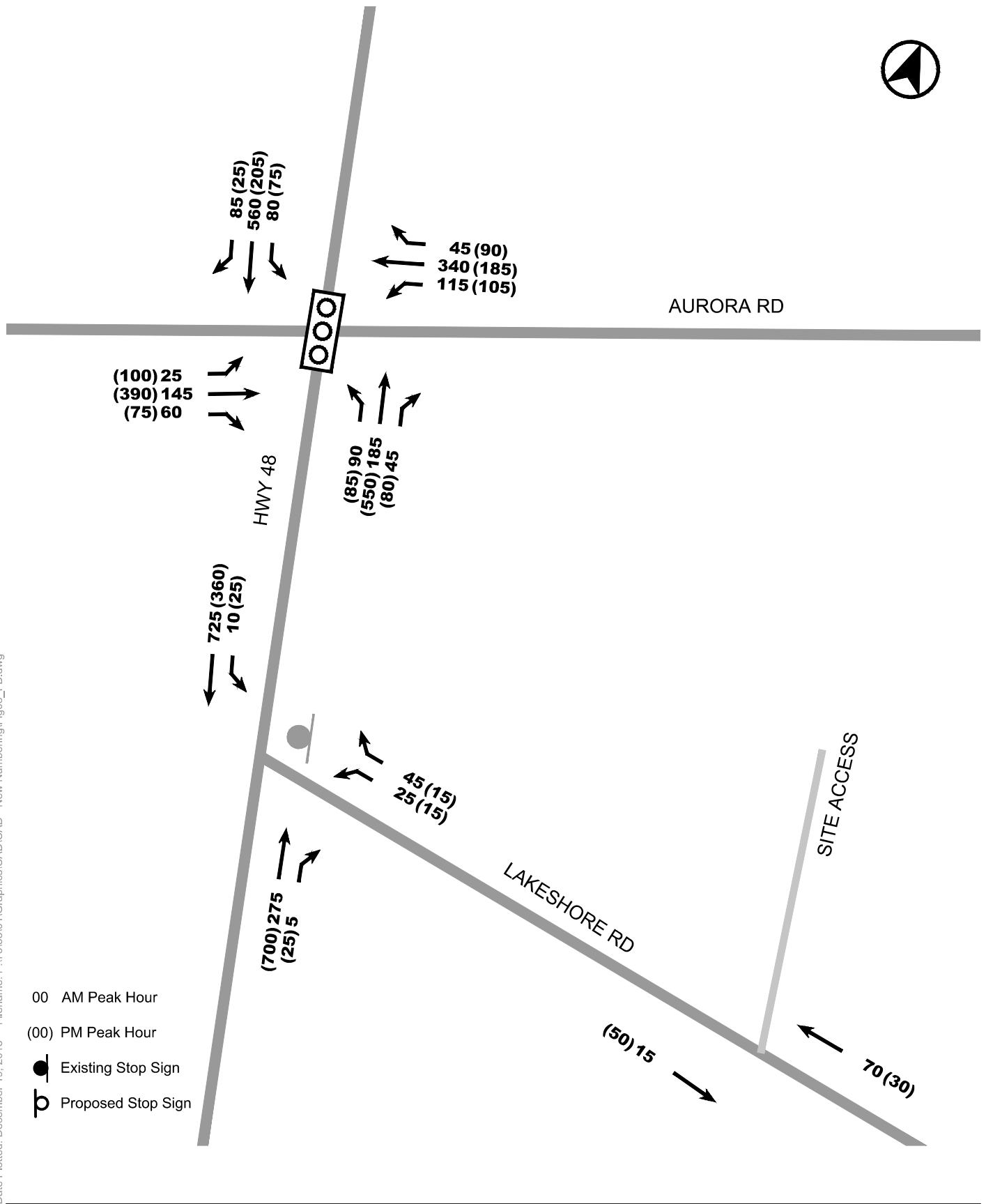
Subject Site (14 units)	AM Peak Hour			PM Peak Hour		
	In	Out	2-Way	In	Out	2-Way
Fletcher Road Trip Generation Survey ¹	0.17	0.44	0.61	0.43	0.27	0.69
Lakeshore Rd. & Treeview Ave. Trip Generation Survey ²	0.31	0.56	0.88	0.56	0.38	0.94
ITE Land Use Code 210 Trip Rates (Single-Family Detached Housing) ³	0.24	0.67	0.91	0.67	0.38	1.04
Selected Rate	0.26	0.56	0.80	0.55	0.34	0.89
Number of Trips (141 proposed lots)	35	80	115	80	50	130

1. Based upon a BA Group survey from March 21, 2018 of 108 houses on Fletcher Blvd and Aurora Road, and Fletcher Blvd and Highway 48.

2. Survey completed on May 24, 2012.

3. Rates calculated by fitted curve equation. Based on ITE Trip Generation Manual 10th Edition rates.

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FUTURE BACKGROUND TRAFFIC

Based upon a review of the comparable residential building trip generation rates, the following trip rates were adopted for this study:

1. 0.80 weekday morning peak hour two-way trips per unit (0.26 in, 0.56 out)
2. 0.89 weekday afternoon peak hour two-way trips per unit (0.55 in, 0.34 out)

The proposed development is expected to generate in the order of 115 two-way trips during the morning and 130 two-way trips in the afternoon peak hours.

6.7 TRIP DISTRIBUTION AND ASSIGNMENT

Residential site traffic has been assigned onto the area road network based upon a review of travel information provided by the 2016 TTS. The TTS data provides information on origin and destination patterns of trips within Central Ontario and is broken down into geographical zones. Trips destined to/from zones in the subject site area (2006 TTS Zones 2717 and 2718) were analyzed to determine the trip distribution pattern for the proposed developments. Detailed output TTS data and distribution assumptions are included in Appendix D.

The distribution of inbound and outbound traffic for the proposed development is presented in Table 4.

TABLE 4 SITE TRAFFIC DISTRIBUTION

Directional Orientation	Morning / Afternoon Peak Hour	
	Inbound	Outbound
To / From the north – Highway 48	15%	5%
To / From the south – Highway 48	40%	55%
To / From the east – Aurora road	5%	5%
To / From the west – Aurora road	40%	35%

Notes:

1. Based upon morning peak period residential outbound trips.
2. Based upon afternoon peak period residential inbound trips.
3. TTS zones 2717 and 2718.

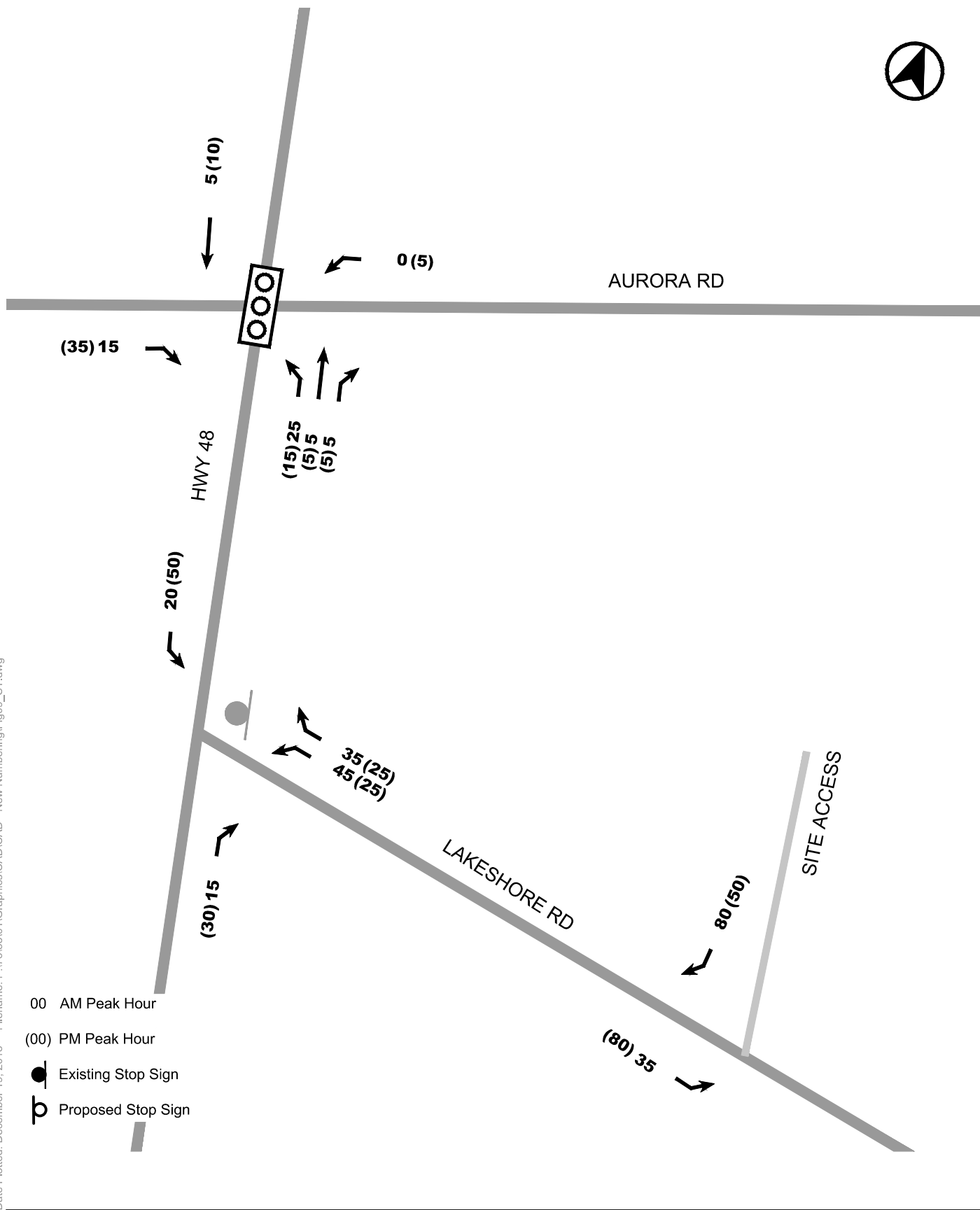
New traffic generated by the proposed development was assigned onto the area road network based on the directional distribution outlined in Table 4; with consideration given to local and collector street routing opportunities in the area as well as the existing / projected delays associated with specific turning movements.

Site traffic volumes for weekday morning and afternoon street peak hours are illustrated in Figure 9.

6.8 FUTURE TOTAL TRAFFIC VOLUMES

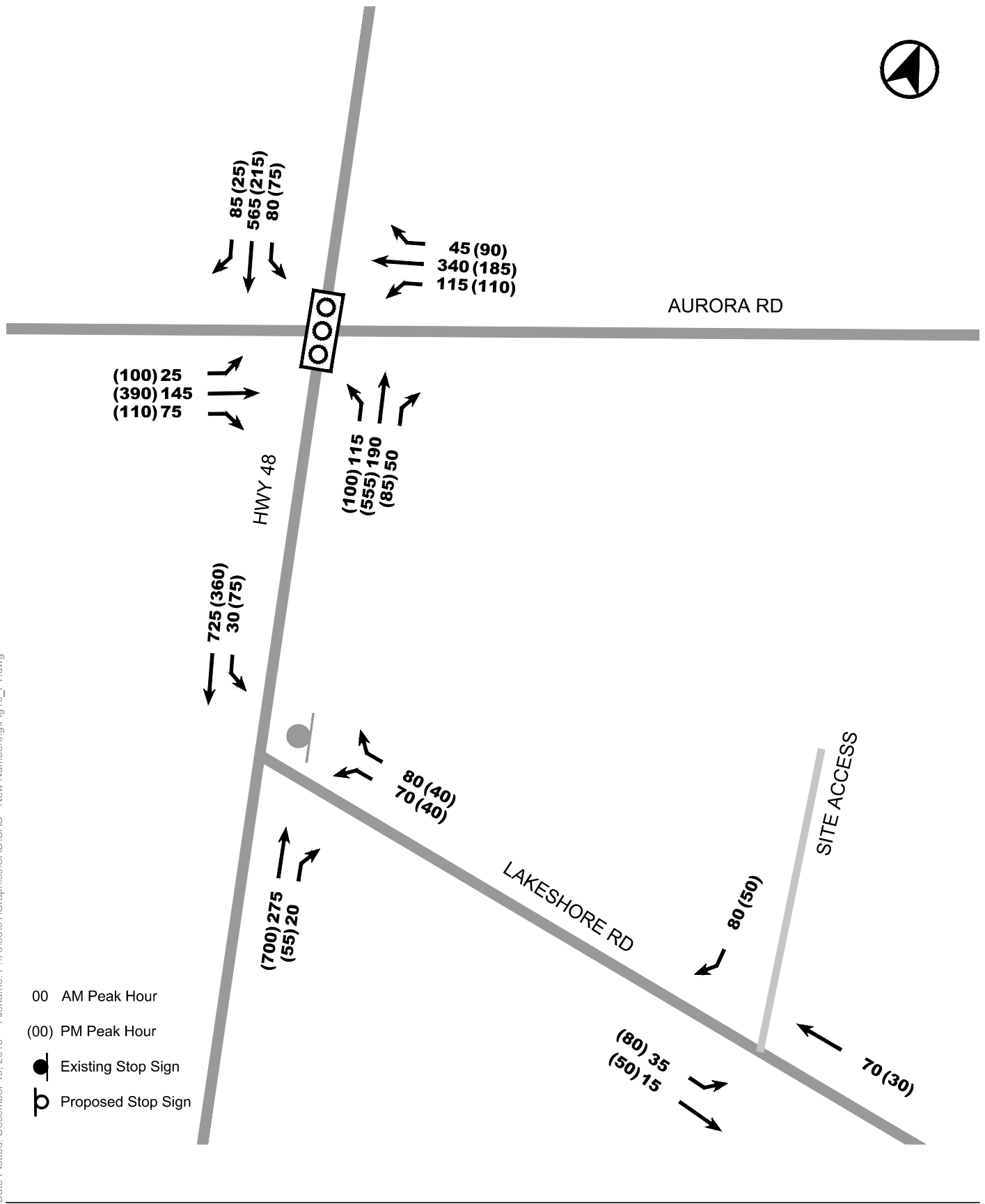
Future total traffic was developed by adding the Site traffic to future background traffic. Figure 10 summarizes future total traffic volumes for weekday morning and afternoon peak hours.

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SITE TRAFFIC

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TOTAL FUTURE TRAFFIC



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Figure 10

7.0 TRAFFIC OPERATIONS ANALYSIS

7.1 METHODOLOGY

Traffic operations analyses have been completed using the Synchro 9 capacity analysis software in accordance with the methodologies outlined in the Highway Capacity Manual 2010 (HCM 2010).

For signalized intersections, the volume to capacity ratio (V/C ratio) is an indicator of the capacity utilization for the key movements in the intersection. A V/C ratio of 1.0 indicates that certain governing traffic movements through the intersection are operating at or near maximum capacity. The primary overall level of service (LOS) indicator is delay-based, both on individual movements and expressed as an average for all vehicles processed. Many busy urban intersections operate at LOS D to E, which reflect average (control) delays in the range of 35 to 80 seconds.

For unsignalized intersections, level of service (LOS) characterizes operational conditions for key movements in terms of delay within the traffic stream. LOS A represents a good level of service with short delays. LOS F represents a poor level of service with long delays. The V/C ratio is an indicator of the capacity utilization for key movements at the intersection and resultant residual capacity potential.

7.2 INTERSECTION ANALYSIS

Table 5 summarizes capacity analysis results for the Highway 48 and Aurora Road intersection. Synchro 9 worksheets including detailed input parameters and output results are attached in Appendix E.

TABLE 5 HIGHWAY 48 AND AURORA ROAD TRAFFIC OPERATIONS ANALYSIS RESULTS

Movement	Existing Traffic			Future Background Traffic			Future Total Traffic		
	V/c	Delay (s)	LOS	V/c	Delay (s)	LOS	V/c	Delay (s)	LOS
EBL	0.07 (0.19)	10.38 (11.7)	B (B)	0.10 (0.23)	11.3 (12.5)	B (B)	0.10 (0.23)	11.3 (12.5)	B (B)
EBTR	0.23 (0.49)	8.7 (14.3)	A (B)	0.27 (0.60)	9.90 (16.4)	A (B)	0.29 (0.65)	9.70 (17.3)	A (B)
WBL	0.21 (0.14)	11.9 (11.6)	B (B)	0.23 (0.40)	12.3 (17.2)	B (B)	0.24 (0.47)	12.4 (19.8)	B (B)
WBTR	0.41 (0.20)	13.4 (9.80)	B (A)	0.50 (0.36)	14.7 (11.0)	B (B)	0.50 (0.36)	14.7 (11.0)	B (B)
NBL	0.36 (0.23)	20.5 (16.9)	C (B)	0.43 (0.23)	23.6 (18.6)	C (B)	0.55 (0.28)	28.6 (17.8)	C (B)
NBTR	0.18 (0.45)	12.0 (16.9)	B (B)	0.22 (0.56)	12.6 (16.6)	B (B)	0.23 (0.56)	12.4 (18.7)	B (B)
SBL	0.14 (0.10)	15.8 (15.8)	B (B)	0.23 (0.41)	17.2 (23.7)	B (C)	0.23 (0.14)	17.3 (16.8)	B (B)
SBT	0.41 (0.15)	17.4 (15.0)	B (B)	0.49 (0.18)	18.4 (15.3)	B (B)	0.49 (0.19)	18.5 (15.3)	B (B)
SBR	0.14 (0.04)	4.6 (0.3)	A (A)	0.15 (0.05)	5.30 (1.3)	A (B)	0.15 (0.16)	5.40 (4.90)	A (A)
Overall	0.41 (0.49)	13.8 (14.5)	B (B)	0.50 (0.60)	14.9 (16.2)	B (B)	0.55 (0.65)	15.3 (16.2)	B (B)

Notes:

- 00(00) – Weekday Morning Peak Hour (Weekday Afternoon Peak Hour)

Under existing, future background and future total conditions, the intersection operates at an acceptable level of service during the weekday morning and afternoon peak traffic hours with overall v/c ratios of 0.65 or less. No signal timing adjustments are required or recommended to accommodate forecast site traffic volumes.

Therefore, based on this analysis, the traffic generated by the proposed 5452 Lakeshore road development can be acceptably accommodated at the Highway 48 and Aurora Road intersection.

7.3 UNSIGNALISED INTERSECTIONS

The results of the capacity analysis performed for the unsignalized intersections in the study area are presented in Table 6. Synchro 9 worksheets including detailed input parameters and output results are attached in Appendix E.

TABLE 6 UNSIGNALIZED INTERSECTION TRAFFIC OPERATIONS ANALYSIS RESULTS

Intersection / Movement	Existing Traffic		Future Background Traffic		Future Total Traffic	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Highway 48 and Lakeshore Rd						
WBLR	13.7 (16.4)	B (C)	15.6 (20.8)	C (C)	24.4 (31.9)	C (D)
SBTL	7.7 (9.1)	A (A)	7.8 (9.6)	A (A)	7.9 (10)	A (A)
Site Driveway and Lakeshore Rd						
EBTL					7.4 (7.4)	A (A)
SBLR					9.0 (8.6)	A (A)

Notes:

1. 00(00) – Weekday Morning Peak Hour (Weekday Afternoon Peak Hour)

Under existing, future background and future total conditions, all of the unsignalized intersections within the study area operate acceptably with levels of service ranging between LOS A and LOS D. The key impacted movement is the westbound left turn from Lakeshore Road onto southbound Highway 48. This movement is forecast to operate with a LOS of C under future background conditions during both the weekday morning peak hour and the weekday afternoon peak hour. With the addition of site related traffic the LOS during the weekday morning peak hour will remain the same (LOS C) but will change to a LOS of D during the weekday afternoon peak hour. Notwithstanding the change in the LOS, the forecast LOS of D for the westbound left turn movement is appropriate for a peak hour condition.

Therefore, based on this analysis, the traffic generated by the proposed development can be acceptably accommodated at all local area unsignalized intersections.

8.0 TMP ROAD LINK ANALYSIS

8.1 BASIS OF TMP JUSTIFICATION

The primary basis for recommending the new road link in the TMP appears to be to direct site related traffic from the proposed development site to Aurora Road thereby minimizing the impact of the site on Lakeshore Road. The TMP also estimates that existing traffic on Lakeshore Road will also receive a benefit of the new road link with a 16% reduction in trips forecast on Lakeshore Road which was noted represents an equivalent traffic redistribution of 700 vehicles per day.

With respect to operational impacts, the TMP estimates that the westbound approach at Lakeshore Road and Highway 48 will operate with a LOS of E to D under build-out 2031 traffic volumes during the weekday morning and weekday afternoon peak hours, respectively, without the new road link. Notwithstanding that a LOS of E to D represents an acceptable operating condition for an unsignalized movement during a peak hour condition, the TMP report further estimates that the new connection would only result in a delay reduction of approximately 5 second in the morning peak hour and 2 seconds in the weekday afternoon peak hour to the westbound movements at Lakeshore Road at Highway 48. This impact is noted in the TMP as being a “marginal” improvement to the operation of the Lakeshore Road / Highway 48 intersection, but the road link is still recommended in the TMP due to the traffic model not accounting for the “lack of gaps” in the southbound traffic stream on Highway 48.

8.2 SENSITIVITY ANALYSIS

Given that the basis for the justification of the new road link appears to be tied to the forecast operation of the westbound approach at Lakeshore Road / Highway 48, a complementary sensitivity analysis was undertaken by BA Group to assess the impact of the new north-south road recommended in the TMP utilizing a calibrated unsignalized analysis that does take into account the gap capacity of Highway 48.

For the purposes of the sensitivity analysis the new north-south road was assumed to be provided through the site connecting between Lakeshore Road and Aurora Road as illustrated in Figure 4.

8.2.1 Traffic Volume Adjustments

Existing Traffic Redistribution

A portion of existing traffic volumes on Lakeshore Road were redirected to the new north-south road in order to utilize the conceptual new road link. Specifically traffic volumes on Lakeshore Road that are oriented to/from Aurora Road to the west (e.g. Highway 404) were redirected to the new north-south street to access Aurora Road. Traffic volumes on Lakeshore Road that are oriented to/from the south on Highway 48 were left place as the new road link offers no benefit for traffic arriving and departing to and from the south.

Site Traffic Adjustments

The residential vehicular trip distribution is the same as discussed in Section 6.7 however the existing and Site's vehicular traffic have been reassigned to road network incorporating the anticipated shift in traffic to the proposed new north-south connection from Lake Shore Road and Aurora Road. The resulting assignment of site traffic volumes are illustrated in Figure 11. Future total traffic volumes at intersections adjacent to the facility, including site-related traffic volumes, are illustrated in Figure 12.

8.3 ANALYSIS RESULTS

The sensitivity analysis was undertaken utilizing the calibrated unsignalized methodology based on the delay studies performed in the field at Highway 48 and Lakeshore Road. The resulting analysis is summarized in Table 7. Synchro 9 worksheets including detailed input parameters and output results are attached in Appendix E.

TABLE 7 UNSIGNALIZED INTERSECTION TRAFFIC OPERATIONS ANALYSIS RESULTS

Intersection / Movement	Existing Traffic		Future Total Traffic Scenario A <i>Without road link</i>		Future Total Traffic Scenario B <i>With road link</i>	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
WBLR			24.4 (31.9)	C (D)	20.2 (25.7)	C (D)
SBTL			7.9 (10)	A (A)	7.9 (9.8)	A (A)

Based on the calibrated unsignalized analysis the operation of the westbound approach of Lakeshore Road under future total (build-out) traffic volumes is improved significantly compared to the 2031 TMP results for the weekday morning peak hour and weekday afternoon peak hour. Similar to the TMP, the impact new road connection appears to have a marginal benefit to the westbound approach of Lakeshore Road. The estimated reduction of delay to the westbound left turn during the peak hours is in the order of 4 seconds.

On this basis, the road link contemplated in the TMP will have a minimal benefit to the delays at Lakeshore Road and Highway 48. Moreover the analysis that takes into the gaps in the traffic stream on Highway 48 indicates that the delays forecast in the TMP may significantly overstate the need for the new road link.

8.4 TRAFFIC DIVERSION BENEFIT ASSESSMENT

Another justification for the new road presented in the TMP was that the new road link will divert approximately 700 vehicle trips per day of non-development traffic from Lakeshore Road to the new road link.

To review this finding BA Group undertook a traffic count on Lakeshore Road to review daily traffic volumes over a 7 day period in February 2017. The count, which was done via a tube counter placed on Lakeshore Road just east of Highway 48, is summarized in Table 8.

TABLE 8 DAILY TRAFFIC VOLUMES

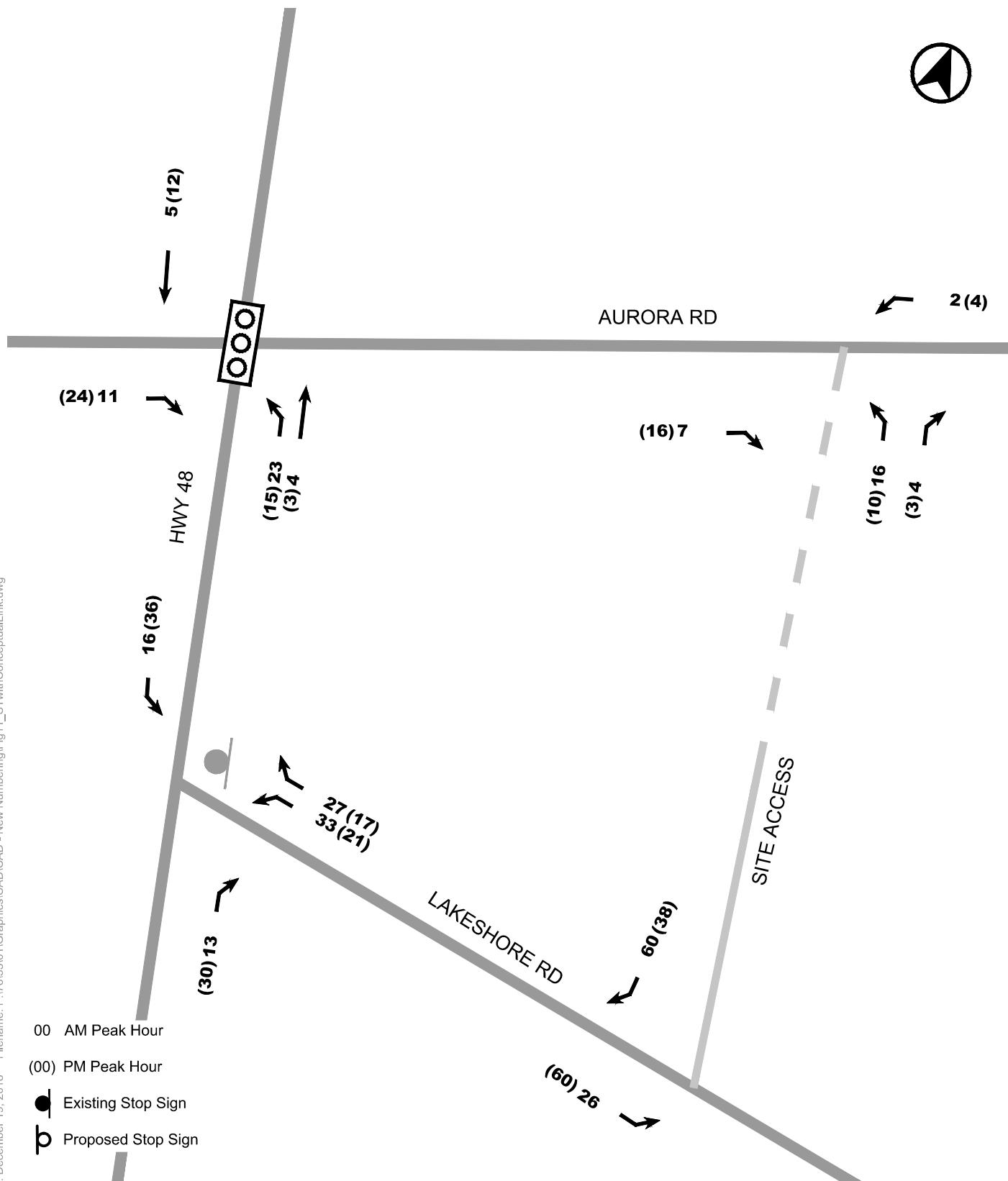
Wednesday, Feb 23, 2017	Thursday, Feb 24, 2017	Friday Feb 25, 2017	Saturday, Feb 26, 2017	Sunday, Feb 27, 2017	Monday, Feb 28, 2017	Tuesday, Feb 29, 2017
1021 veh/day	1069 veh/day	926 veh/day	912 veh/day	967 veh/day	963 veh/day	1004 veh/day
Average: 980 veh/day						

Based on the daily traffic counts undertaken it appears that the forecasted 700 veh/day diversion of existing traffic to the new road link in the TMP implies that approximately 70% of traffic of the actual observed total existing volumes would be diverted to the new road link.

The turning movement count for Lakeshore Road / Highway 48 undertaken by BA Group shows that westbound traffic on Lakeshore Road at Highway 48 is split evenly in terms of traffic turning left to go to/from the south on Highway 48 vs. trips that turn right to travel north on Highway 48. This even split suggest that it is unlikely that the majority of existing traffic on Lakeshore (i.e. up to 70% as indicated in the TMP) will divert to the new road link as a significant proportion of traffic on Lakeshore turns left to go south and therefore would not see any benefit of using the new road link.

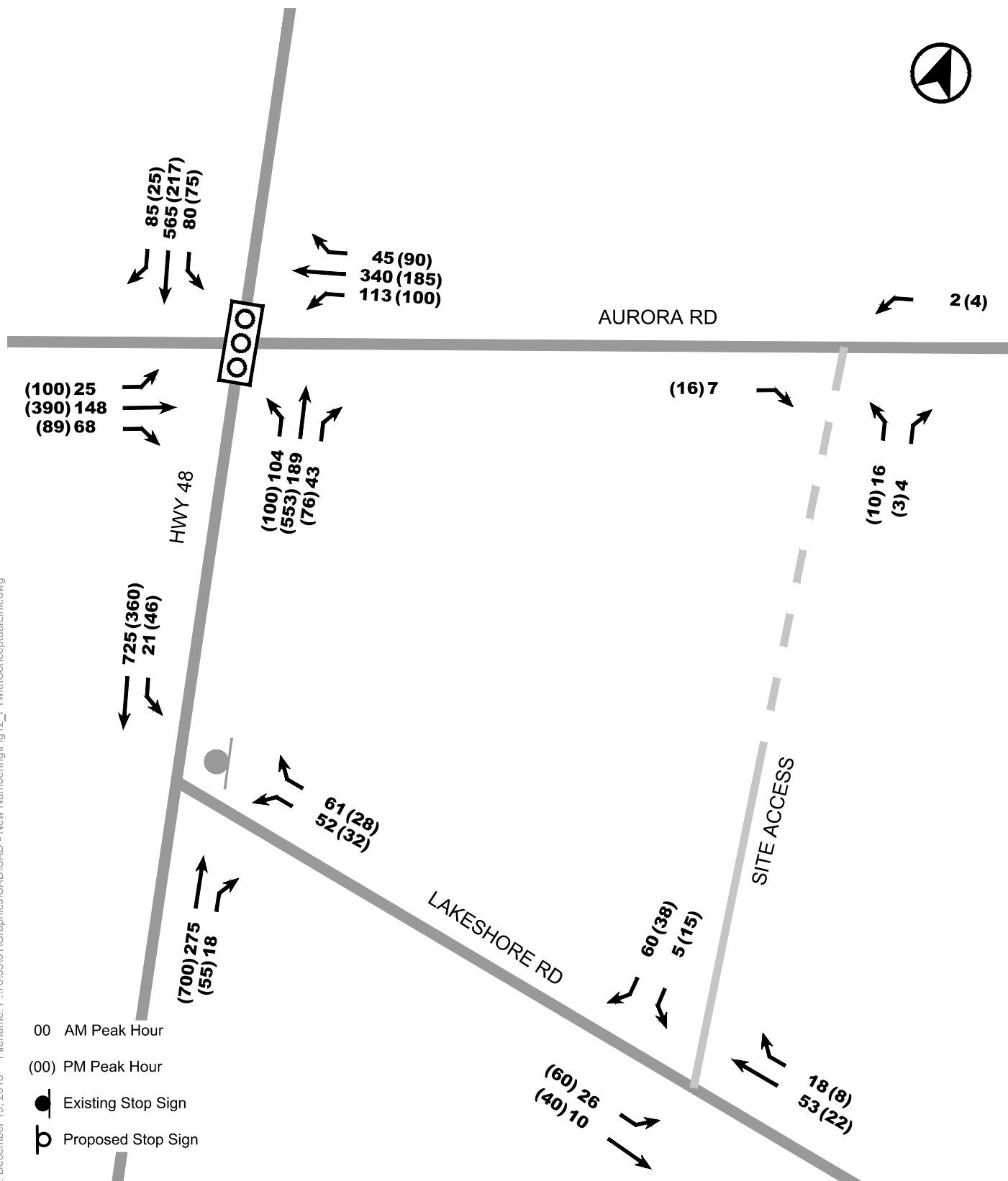
Based on the foregoing the recommended new north-south road link shown the TMP is not required to build out the proposed development. The site can be built out and acceptable traffic conditions can be maintained.

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SITE TRAFFIC VOLUMES WITH CONCEPTUAL NORTH-SOUTH ROAD LINK

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FUTURE TOTAL VOLUMES WITH NEW NORTH-SOUTH ROAD LINK

9.0 TRANSPORTATION DEMAND MANAGEMENT (TDM)

Consistent with the York Region Mobility Plan Guidelines, the proposed development will include a Transportation Demand Management (TDM) Plan that will attempt to influence the way people travel to and from the site through a comprehensive suite of TDM strategies.

These measures will include the application of various strategies to reduce congestion and minimize the overall reliance on single-occupant vehicle (SOV) while promoting the use of more active and sustainable modes of transportation.

9.1 TRAVEL MODE CHARACTERISTICS

The existing travel characteristics for the area around the site was reviewed using information provided by the 2016 Transportation Tomorrow Survey (TTS). Modal choice travel characteristics for residential land uses in the area for the peak period inbound and outbound directions are summarized in **Table 9**.

TABLE 9 EXISTING AREA TRAVEL MODE SPLIT

Travel Mode	Morning Outbound	Afternoon Inbound
Auto Driver	73%	80%
Auto Passenger ²	12%	12%
Transit ³	14%	7%
Walk	1%	1%
Cycle	0%	0%
Total	100%	100%

Notes:

1. Reflects all trips made to/from residential land uses within 2006 TTS Zones 2716 and 2717 during the weekday morning and afternoon peak hour periods.
2. Includes auto passenger and taxi passenger.
3. Includes solely GO transit only, joint GO transit and local transit, and school bus.

Based on the most recent TTS data, 73% to 80% of the residents living in the area regularly drive during the peak travel period, meaning a great majority of the trips made during the peak hour is via car. This travel mode choice is due to the area's limited access to transit services, and cycling or pedestrian facilities. However, the planned region-wide trail system may help in encouraging residents to use alternative travel modes.

It is also noteworthy that 7-14% of peak period traffic in the surrounding area currently utilizes GO Transit which is an indication that there is an opportunity to encourage use of GO Transit for future residents of the development.

9.2 PROPOSED TDM PLAN

Strategies must be adopted to encourage the use of alternate sustainable travel modes, increase vehicle occupancy, and cooperate with the future region-wide trail system. Based upon the site transportation context and proposed land uses, the recommended TDM strategies have been selected for the proposed development.

9.2.1 Sustainable Transportation Information

The provision of information on trails, cycling and transit maps to residents encourages the use of these alternative modes by helping educate people about their options.

Proposed Strategy:

Marketing programs aimed at new residential unit purchasers should be implemented to ensure that new residents have comprehensive information on travel choices in the area now and in the future.

The developer proposes to coordinate with the Transportation Planning department of the Region of York, should they elect, to issue maps and travel information provided by the Region to new residents as part of a new homeowners package. These programs will also be made available at the sales centre for the new lots and will also be available to residents after the dwelling units are occupied.

9.2.2 Coordination / Distribution of Presto Cards

The York Region's current Development Charge By-law currently includes the provision of pre-loaded Presto Cards for any unit or household registered after January 1st 2013. The site is eligible to receive pre-loaded Presto Cards from the Region as part of the York Region's TDM credit in the current development charge.

Consistent with the above policy, the Region of York may provide pre-loaded Presto cards to the individual lots within the proposed development in order to encourage the use of GO Transit by future homeowners.

Proposed Strategy:

The developer will coordinate with the Region of York with respect to providing pre-loaded Presto cards to the purchasers of the homes, should the Region elect to provide them. The cards will be issued to new homeowners at, or soon after occupancy of the unit.

9.2.3 Pedestrian Connections

High quality pedestrian connections within the site and with pedestrian facilities outside of the site can be an important design feature in the effort to ensure viability of non-automotive modes of travel. Thus, it is critical for pedestrian and sidewalk infrastructure to enhance the pedestrian experience especially as it relates to safety and convenience. Children and elder residents should feel comfortable walking within the site. These good pedestrian connections will also connect with the future region-wide trail system such that residents have easy access to the shops, restaurants, and services in the nearby hamlet of Ballantrae.

Proposed Strategy:

The development will include a proposed new north-south walking trail that connects Lakeshore Road to Aurora Road. The proposed walking trail will generally run north-south in the middle of the site alongside the drainage course within the site. Two additional east-west trail connections will also be provided linking the residential areas in the NW and NE areas of the plan to the proposed main north-south trail. The proposed trail in the community master plan is illustrated in Figure 3.

9.3 TDM CHECKLIST

See Table 10 for the preliminary TDM checklist for the site.

TABLE 10 PROPOSED TDM IMPLEMENTATION PLAN

Proposed TDM Strategy	Responsibility	Cost Estimate	Approximate Timing
Sustainable Commuting Information			
Provide sustainable transportation information to new home purchasers as part of home buyers package to promote sustainable travel options.	Developer to coordinate with York Region (Transportation Planning) to obtain materials and provide to home purchasers.	\$250 ¹	After home purchase / during construction
Presto Cards			
Provide one pre-loaded Presto card to each new unit owner / resident	York Region (Transportation Planning) to provide Presto Cards to Developer (if applicable). Developer to provide / mail presto cards to home buyers.	\$250 ²	Occupancy
Pedestrian Infrastructure			
Provide a north-south pedestrian trail/walkway through the site connecting Lakeshore Road to Aurora Road.	Developer	Included in Construction ³	Construction

Notes:

1. York Region responsible for providing promotional materials to the developer. Nominal allowance of \$250 to cover cost of distributing materials provided by the Region that would be provided to 14 homeowners.
2. Presto Cards Funded through TDM Allowances within York Region Development Charges Fund. Amount to be determined. Nominal allowance of \$250 to cover mailing costs.
3. Cost of sidewalks included as part of construction. To be constructed as part of the project.

10.0 EMERGENCY VEHICLE ACCESS CONSIDERATIONS

The development plan includes a single point of vehicle access to/from Lakeshore Road into the community. In order to ensure that appropriate emergency vehicle access is maintained, a second access point to/from Lakeshore Road will be provided for emergency vehicles only in order to ensure appropriate and safe access opportunities are provided into the site in the event the primary vehicle access is blocked.

The location of the emergency vehicle access will be confirmed through discussions with Town of Whitchurch-Stouffville Fire Services but is currently proposed through a dedicated block in the plan (Block 150) located at the southwest corner of the plan that will connect between Street C and Lakeshore Road.

11.0 SUMMARY AND CONCLUSIONS

BA Group is retained by Alcorn and Associates to undertake a Transportation Study to review the impact of a proposed residential development on the north side of Lakeshore Road in the village of Ballantrae. The following provides a summary of the key conclusions arising from our review.

Context and Development Proposal

1. The proposed development is located on Lakeshore Road in the village of Ballantrae which is part of the Town of Whitchurch-Stouffville.
2. Mode split for the area based on the 2016 Transportation Tomorrow Survey indicates an approximate 78% auto driver, 12% auto passenger, 14% transit and 1% walk overall travel mode choice split for home-based trips.
3. The development proposal is for 141 detached residential homes located within a gated community consisting of private condominium roads.
4. Access to the site is proposed via a single driveway connection to/from Lakeshore Road, located approximately in the middle of the site. The proposed driveway will have a gatehouse located just inside the property line.
5. The internal road network will be made up of private streets. Two types of street cross sections are proposed. The main street (Street A) within the site, which connects to Lakeshore Road, will have a 13.0 metre right of way and a 9.5m pavement. All other streets will have an 11.0 metre right-of-way and a 7.5m pavement.

Parking Considerations

6. The Town of Whitchurch-Stouffville's Zoning By-Law 2010-001-ZO requires that each unit provide 2 parking spaces per unit.
7. Each unit within the development plan will have a two car garage with a two-car driveway. The resulting total parking supply is 564 spaces per unit. The proposed on-site parking supply is therefore sufficient to meet the Zoning By-law requirements.

Loading Considerations

8. The Town of Whitchurch Stouffville Zoning By-law 2010-001-ZO does not require loading for the proposed detached residential units.
9. To ensure waste collection vehicles can appropriately traverse the site, a vehicle manoeuvring analysis was undertaken using a typical refuse collection vehicle to ensure that the internal road network can appropriately accommodate large vehicles including refuse vehicles. Based on our review the proposed street design is sufficient to accommodate refuse collection.

Site Traffic Forecast

10. The proposed development will generate in the order of 115 and 130 two-way vehicle trips during the morning and afternoon peak hour periods, respectively.

Traffic Volumes

11. Existing traffic activity levels on the area road network surrounding the site were established based upon traffic count information conducted by BA Group in February 2017 and the addition of 1 year of 2% corridor growth in order to reflect 2018 conditions.
12. An annual corridor traffic growth rate of 2.0% was used to determine future background traffic in order to be conservative.

Traffic Operations

13. All of the signalized and unsignalized intersections within the study area operate acceptably today and will continue to do so in the future considering net new traffic from other area developments and the FarSight Lands development. Site related impacts at the area intersections are small.
14. Traffic volumes generated by the proposed development can, based upon the above, be acceptably accommodated on the area street intersections and street system without the need for any road infrastructure improvements.

Analysis of Recommended New Road Link in Whitchurch-Stouffville TMP

15. A sensitivity analysis was undertaken to review the benefits of a conceptual new north-south road that is recommended in the recently completed Whitchurch-Stouffville TMP.
16. The supplementary analysis indicates the new road link will provide minimal benefit to the area road network in terms of delay reductions at Lakeshore / Highway 48 and the impacts estimated in the TMP and used as the justification for the new road may have been overstated.
17. The road link identified in the TMP is not required to accommodate the build-out of the site from a transportation perspective.

Transportation Demand Management

18. A Transportation Demand Management (TDM) plan has been developed for the site to encourage sustainable transportation patterns to the extent possible for the site. The following list summarizes the TDM strategies that are proposed.
- Should the Region of York Transportation Planning department choose to provide mobility transportation information as part of its residential TDM program, the developer will mail and/or provide the information pamphlets to new owners at the time of unit purchase (or shortly thereafter) to make new residents aware of the mobility options in the area.
 - Should the Region of York Transportation Planning department choose to provide pre-loaded PRESTO cards to new purchasers, the developer will distribute the PRESTO cards to unit purchasers to encourage residents to try GO Transit.
 - The developer is proposing to provide a new north-south walking trail through the site connecting Lakeshore Road to Aurora Road.

Emergency Vehicle Access

19. The development plan includes a single point of vehicle access to/from Lakeshore Road into the community. In order to ensure that appropriate emergency vehicle access is maintained, a second access point to/from Lakeshore Road will be provided for emergency vehicles only in order to ensure appropriate and safe access opportunities are provided into the site in the event the primary vehicle access is blocked.
20. The location of the emergency vehicle access will be confirmed through discussions with Town of Whitchurch-Stouffville Fire Services but is currently proposed through a dedicated block in the plan (Block 150) located at the southwest corner of the plan that will connect between Street C and Lakeshore Road.

Overall

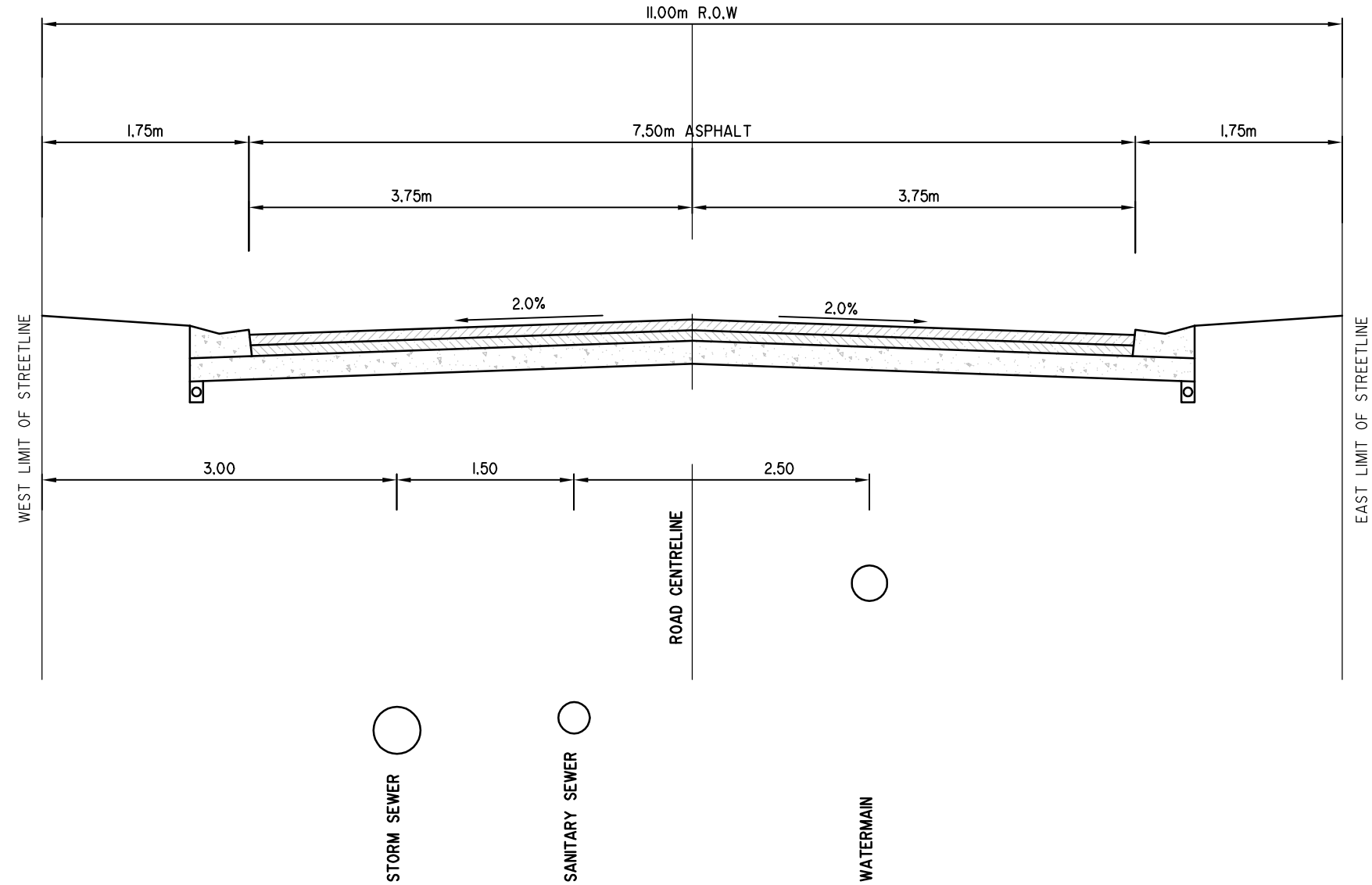
21. Based on the foregoing, it is our opinion that the proposed development will function well in terms of traffic access and circulation. Traffic volumes attributable to the subject development can be accommodated on the existing road network.

APPENDIX A:

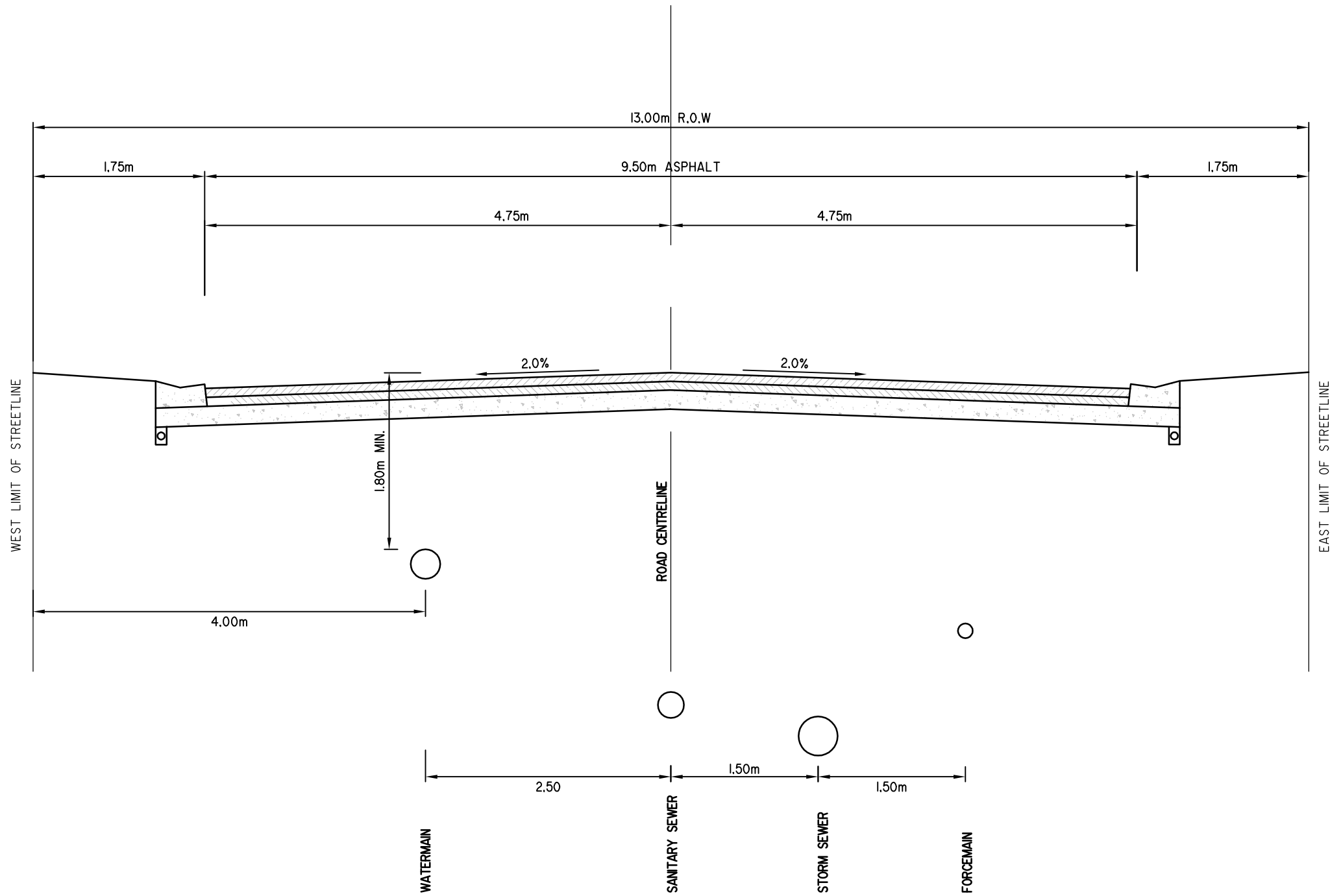
Proposed Street Cross Sections



PLOT DATE: 7/22/2008 10:46 AM CAD FILE: P:\13\286\Drawing Files\Phase 1\Figure\VFSSR - May 2008\386 Fig XX ROW Cross Section-Jul 10.dwg



11.00m R.O.W
(TYPICAL)
SCALE 1:50



13.00m R.O.W
WITH FORCEMAIN (TYPICAL)
SCALE 1:50

TYPICAL ROAD CROSS SECTIONS



SABOURIN KIMBLE
& ASSOCIATES LTD.
CONSULTING ENGINEERS

PROJECT NUMBER

13:286

FIGURE NUMBER

APPENDIX B:

Excerpts from Whitchurch-Stouffville 2018 TMP



6.3.2.1 RECOMMENDATION

Recommendation #11:

Advance discussions with the appropriate transit agency (YRT or GO/Metrolinx):

1. Dial-a-Ride 'Zone Bus' for in-Town services, particularly within Stouffville
2. Maintain Regional Transit connections via YRT Routes 9 and 15:
3. Expand Regional Express Rail (RER) for all-way 2-way GO Rail service to Stouffville and Lincolnville GO stations

Timing: Short-term

6.3.3 New Connection from Lakeshore Road to Aurora Road

A new connection has been proposed between Lakeshore Road and Aurora Road to provide an alternate connection to the arterial road network from Lakeshore Road. The potential location of the proposed road is illustrated in **Exhibit 6-8** and **Exhibit 6-9** relative to aerial imagery and the Ballantrae-Musselman Lake Secondary Plan, respectively. As seen in **Exhibit 6-8**, there is currently no north-south connection to Aurora Road from the Musselman Lake community, with access provided via Highway 48 or 9th Line. In **Exhibit 6-9**, the new connection is illustrated in relation to the Ballantrae-Musselman Lake and Environs Secondary Plan, which identifies a future residential area. The proposed road would pass through and provide access to Aurora Road for the future residential area identified in light yellow in the Plan. **Exhibit 6-9** also shows the proposed road connecting to Aurora Road at an existing unsignalized intersection. Should the lands identified in the Secondary Plan be developed, a future traffic impact study would determine the required intersection controls.

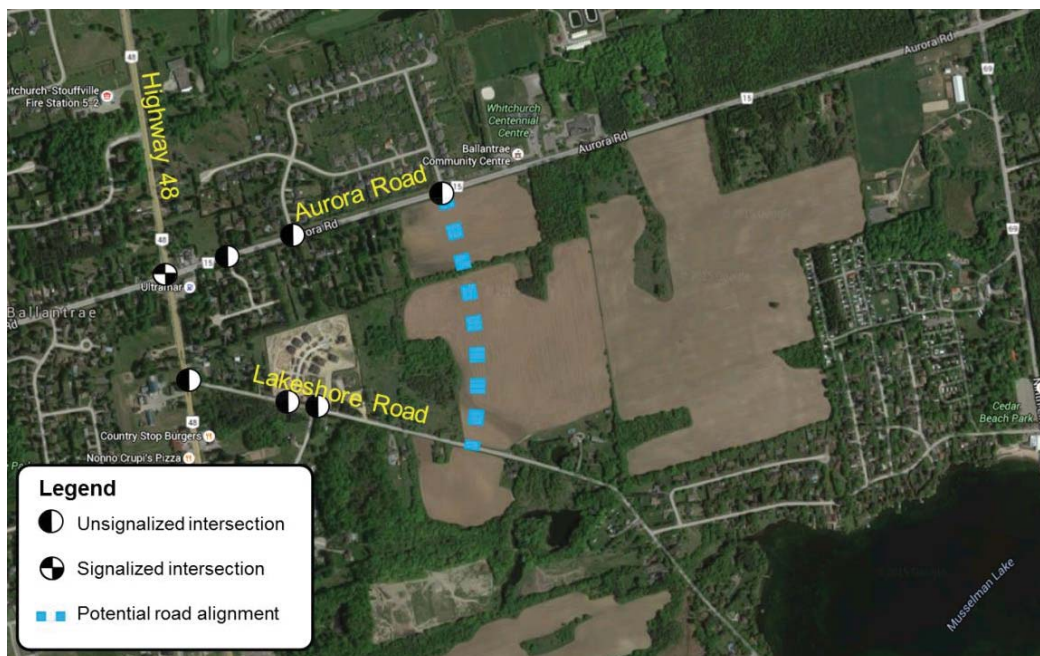


Exhibit 6-8: New Connection between Lakeshore Road and Aurora Road

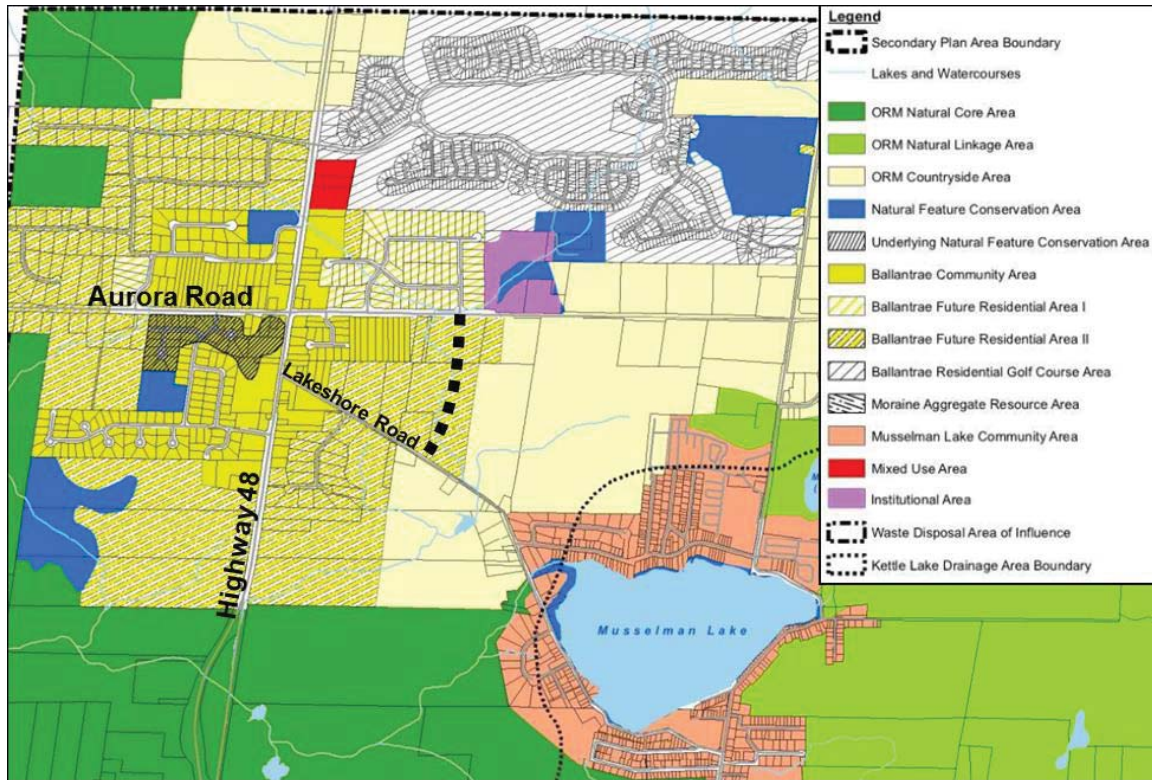


Exhibit 6-9: Lakeshore Road Connection in relation to Ballantrae Secondary Plan

Preliminary travel demand forecasting estimates a 16% reduction in trips towards Highway 48 with the new connection. Excluding any potential new development adjacent to the new connection, it is anticipated that about 700 vehicles per day would use it to access Aurora Road. The intersection capacity for both scenarios was further assessed by applying the 16% reduction to 2031 intersection turning movements (calculated based upon a growth factor being applied to existing turning movement counts – details in **Appendix C – 2031 Traffic Analysis**). The analysis is summarized in **Table 6-6**.

Table 6-6: Highway 48 at Lakeshore Road – New Link Sensitivity

Intersection and Movement	AM Peak Hour			PM Peak Hour		
	Delay	LOS	v/c	Delay	LOS	v/c
Highway 48 @ Lakeshore Road						
Westbound Left-right	44.3	E	0.49	27.1	D	0.19
Southbound Left-through	0.4	A	0.01	1.7	A	0.06
Highway 48 @ Lakeshore Road – with new connection (16% diversion)						
Westbound Left-right	39.1	E	0.40	25.4	D	0.16
Southbound Left-through	0.4	A	0.01	1.4	A	0.05

Key: Delay – Average delay per vehicle shown in seconds
LOS – Level of Service
v/c – Volume to Capacity Ratio

Based on this analysis, the reduced volumes will result in a marginal improvement to unsignalized intersection operations at Highway 48 and Lakeshore Road, as estimated by the traffic model. However it is important to note that the traffic model does not account for the lack of gaps in southbound traffic to safely make a westbound left-turn in the AM peak. As such we would anticipate a higher diversion of traffic to the new connection at Aurora Road should the westbound left-turn continue to be challenging in the future.

6.3.3.1 RECOMMENDATION

Recommendation #12:

Because of these benefits to the transportation network within Ballantrae-Musselman Lake and the benefit to potential future development, the new connection between Lakeshore Road and Aurora Road is recommended to be added to the Town's list of road improvements for Development Charges. A Schedule C Class EA should also be completed to confirm the need and justification, preliminary design and potential environmental impacts.

Timing: To be included in the Town's next Development Charges Study, and Schedule C Class EA to be completed by 2021.

6.3.4 Tenth Line Capacity Improvements

As identified in **Section 3.6.4**, 10th Line south of Hoover Park Drive is approaching capacity. Improving this section of 10th Line will allow traffic wishing to access Highway 404 or Highway 7 or 407, to disperse along 19th Avenue instead of driving through Stouffville. Improving 10th Line here will generally improve travel choices and reduce congestion for traffic in this part of Stouffville. Volume to capacity ratios with and without a capacity improvement (in this case a widening to four lanes was modeled) are illustrated in **Exhibit 6-10**.



Exhibit 6-10: 2031 Traffic Forecast with and without 10th Line Widening

December 06, 2016

Michele Kennedy, Clerk
Town of Whitchurch-Stouffville
111 Sandiford Drive,
Stouffville, ON
L4A 0z8

RE: Review of Proposed New Ballantrae Road Link in the Stouffville Transportation Master Plan

Dear Mr. Alcorn:

BA Group has been retained by Farsight Homes provide transportation advisory services in relation to a property owned by Farsight Homes in Town of Whitchurch-Stouffville, Ontario. The site is located at 5426, 5452, and 5584 Lakeshore Road (herein referred to as 'Farsight lands') in the village of Ballantrae.

The subject 16.26 hectare site is designated Residential within the Ballantrae-Musselman Lake Secondary Plan with available water and sewer services. The planning for these lands by the owner has been ongoing since 2014. A pre-application consultation process was commenced with the Town in August 2016 with required studies confirmed which are underway support the required planning approval applications.

A plan of subdivision of 130 single detached units has been prepared for the site and has been presented to the Town. The planned development has been prepared substantially in conformity with the present Town Official Plan and approved Transportation plan.

The Town of Whitchurch Stouffville recently is in the process of seeking feedback on an updated Transportation Master Plan (TMP) prepared by HDR. The draft TMP was issued for public review in May 2016. This letter provides a review and comment on the components of the TMP that relate to the above noted land holdings owned by Farsight Homes.

That draft TMP includes a recommendation to construct a new north-south public street in Ballantrae between Lakeshore Road and Aurora Road. The conceptual road would be located approximately 700m east of Highway 48. The potential public road, as illustrated in the TMP, would bisect the lands owned by Farsight Homes. It is noted that this road alignment is mostly situated within the regional flood plain between Lakeshore Road and Aurora Road.

BA Group has reviewed the draft TMP report and the appendices that are available on the Town's website. Our comments with respect to the proposed new road link based on our review of the TMP documentation are set out below.

1. The primary rationale for the new road connection appears to be to provide an alternative connection to the external arterial road network in order to relieve the delays experienced by the westbound left turn on Lakeshore Road at Highway 48. In this regard, the unsignalized capacity analysis in the TMP estimated by 2031, without the road link, the westbound left turn delays will be 44 seconds and 27 seconds during the weekday morning and weekday afternoon peak hours, respectively. This level of delay, which corresponds to a Level of Service (LOS) of E in the morning and D in the afternoon, is not in our opinion overly concerning or in need of mitigation considering the result is being presented for a peak hour condition at the built-out state (i.e. at 2031). In our opinion, the new road link is not required.
2. Notwithstanding whether the overall delays are indicative of a need for improvement, the TMP report further estimates that the new connection would only result in a delay reduction of 5 second in the morning peak hour and 2 seconds in the weekday afternoon peak hour. As noted in Appendix C of the draft TMP, this represents a very marginal improvement compared to the scenario without the new road link. Our opinion is that this road link delivers minimal benefit for multi-million Town expenditure, and is not required.
3. Page 5 of Appendix C in the TMP notes that the 2031 traffic forecasts without the new road link were presented without factoring calibration. In this regard the 2031 forecast identified a westbound peak hour volume of 165 vehicles whereas the TMP notes that volumes are more likely to be in the order of 105 vehicles per hour, or roughly 36% lower than what was estimated by the model. We concur that the 2031 model results are overly conservative. We would supplement this however by noting that the model may be even more overestimated than indicated above. A review of the peak hour volumes shown on Page 2 of Appendix C indicates that westbound traffic under existing conditions is actually 77 vehicles per hour. Given that the model explicitly did not account for future development in the area, the 2031 volumes along Lakeshore Road should approximate existing volumes. As such it is our opinion that the 2031 "without" road link traffic forecast could be more than 50% overstated. Seeing that the model forecasts were used to identify the reduction of traffic on Lakeshore (estimated to be a 16% reduction in the TMP), this would imply that the new road link would be diverting only 10-15 peak-direction hourly vehicles. Again it is our opinion that the potential new road link will deliver minimal benefit and is not warranted.
4. Based upon traffic counts undertaken by BA Group on Lake Shore Road in 2012, we estimate that existing daily traffic on that portion of Lakeshore Road is in the order of 700-1000 vehicles per day. Assuming that, without accounting for any new development, future volumes on Lakeshore Road should remain relatively stable. As such the TMP's estimate that 700 daily trips would use the new road link implies that virtually all existing traffic on Lake Shore Road would utilize the new connection. In our opinion it is unlikely that this level of diversion would be the case as Lakeshore Road will remain the most direct route for many of those using it (i.e. more than half of traffic travels to the north and is not affected by the delays for the westbound left turn).

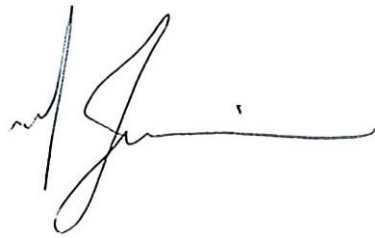
Based on our analysis of the materials provided in the TMP it is our opinion that the new road link between Lakeshore Road and Aurora Road is unwarranted as it would provide, at best, minimal benefit to the existing network, at substantive Town cost and negative impact to the Farsight project. It should therefore not be a required piece of infrastructure in the TMP.

Any need/justification for the new road link attributable to the proposed development should (and will) be reviewed as part of the site specific technical analysis / planning that will be undertaken in support of those lands.

We trust that the above analysis is helpful and will receive the appropriate consideration when finalizing the TMP policies. Should there be any questions with respect to the foregoing, please feel free to contact the undersigned.

Sincerely,

BA Consulting Group Ltd.

A handwritten signature in black ink, appearing to read 'Mark Jamieson', with a long horizontal stroke extending to the right.

Mark Jamieson, P. Eng., MBA
Senior Associate

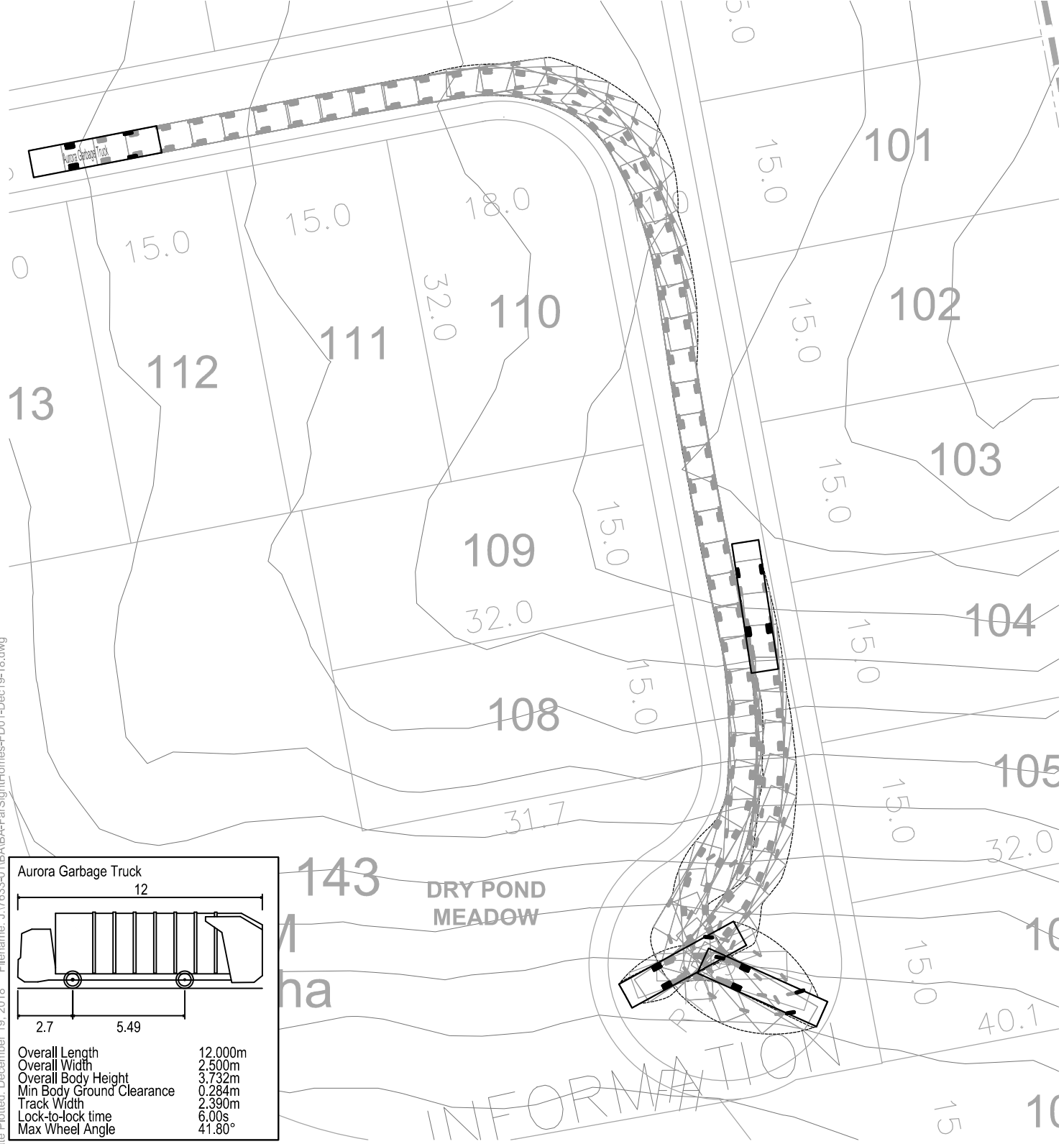
Copy: Sahar Tolami, BA Consulting Group

APPENDIX C:

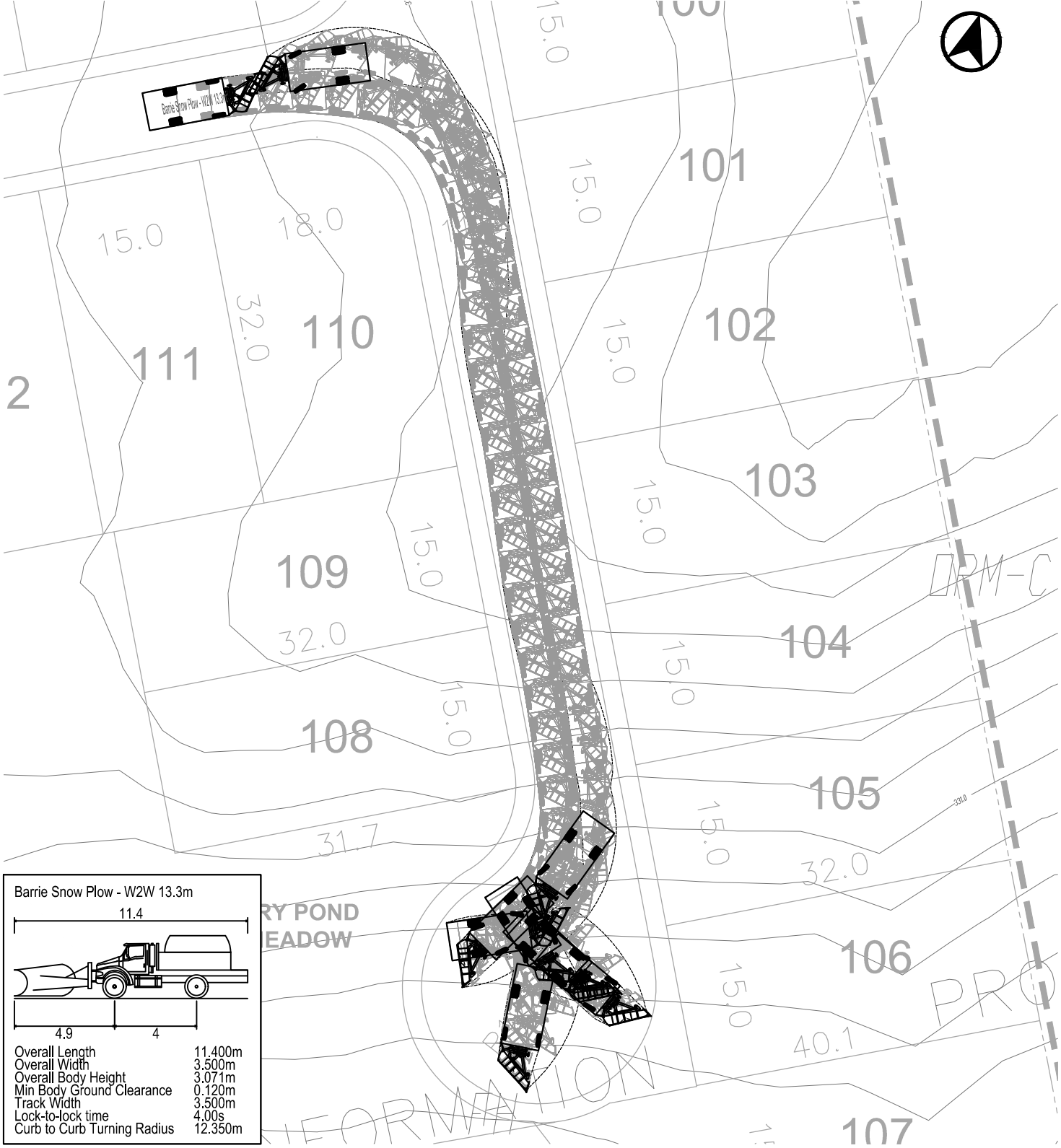
Refuse Vehicle Swept Path Analysis



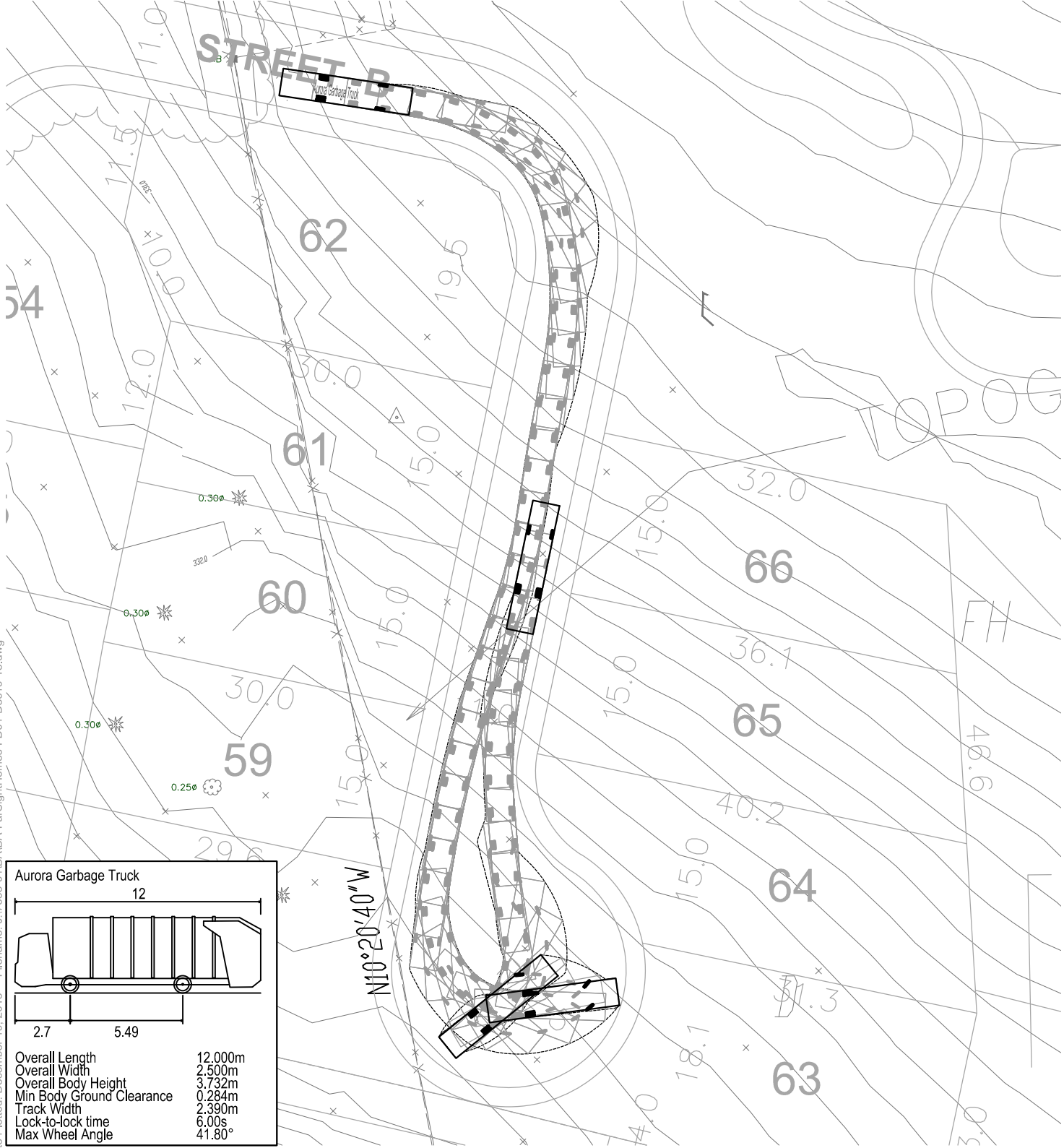
AURORA GARBAGE TRUCK



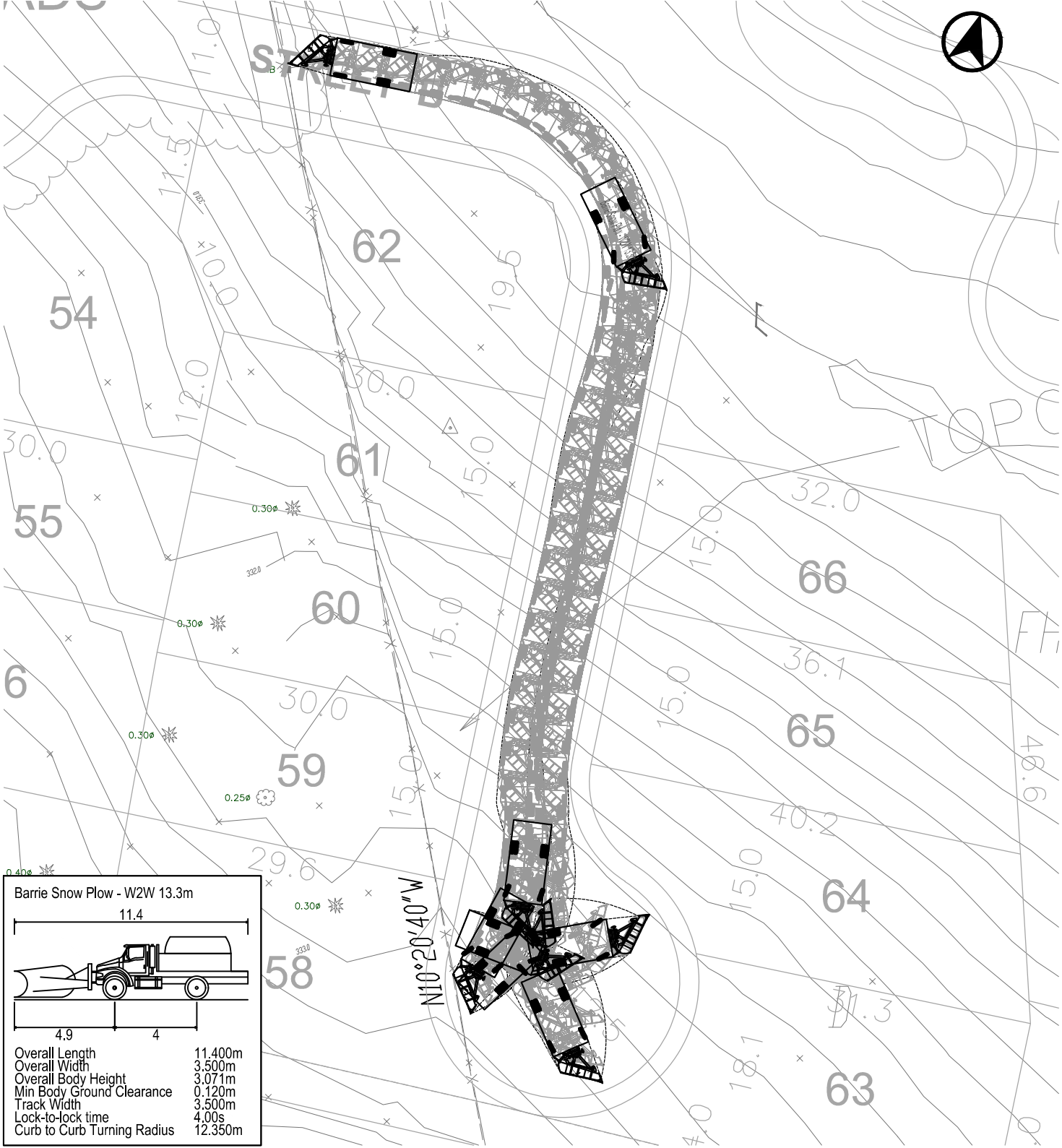
BARRIE SNOW PLOW



AURORA GARBAGE TRUCK



BARRIE SNOW PLOW



BALLANTRAE
VEHICLE MANOEUVRING DIAGRAM
STREET 'B' CUL-DE-SAC
GARBAGE TRUCK / SNOW PLOW ACCESS



Project: FAR SIGHT HOMES
Project No. 7633-01
Date: APRIL 11, 2017
Revised: -

Scale 0 5 10 15 20m
1:500
Drawing No. VMD-02

APPENDIX D:

Transportation Tomorrow Survey (TTS) Worksheets



Thu Jul 05 2018 15:41:02 GMT-0400 (Eastern Daylight Time) - Run Time: 2149ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: Planning district of destination - pd_dest

Column: 2006 GTA zone of origin - gta06_orig

Filters:

(2006 GTA zone of origin - gta06_orig In 2717,
and

Start time of trip - start_time In 630-930

and

Trip purpose of origin - purp_orig In H

Trip 2016

Table:

					Route Selections					Route Selections							Comments
	2717	2718	Combined	%	SB HWY 48	NB HWY 48	WB Aurora	EB Aurora	SB 9th	NB 9th	SB HWY 48	NB HWY 48	WB Aurora	EB Aurora	SB 9th	NB 9th	
PD 1 of Toronto	200	14	214	10%	70%		30%				7%	0%	3%	0%	0%	0%	Most by GO
PD 3 of Toronto	19	0	19	1%	80%		20%				1%	0%	0%	0%	0%	0%	Most by GO
PD 4 of Toronto	0	9	9	0%	80%		20%				0%	0%	0%	0%	0%	0%	
PD 9 of Toronto	0	53	53	2%	30%		70%				1%	0%	2%	0%	0%	0%	
PD 10 of Toronto	28	0	28	1%	30%		70%				0%	0%	1%	0%	0%	0%	
PD 11 of Toronto	27	0	27	1%	30%		70%				0%	0%	1%	0%	0%	0%	
PD 13 of Toronto	0	56	56	3%	30%		70%				1%	0%	2%	0%	0%	0%	
PD 16 of Toronto	115	0	115	5%	30%		70%				2%	0%	4%	0%	0%	0%	
Uxbridge	55	14	69	3%				100%			0%	0%	0%	3%	0%	0%	
Newmarket	30	36	66	3%		80%	20%				0%	2%	1%	0%	0%	0%	
Aurora	71	56	127	6%			100%				0%	0%	6%	0%	0%	0%	
Richmond Hill	104	0	104	5%	30%		70%				1%	0%	3%	0%	0%	0%	
Whitchurch-Stouffville				0%							0%	0%	0%	0%	0%	0%	
2708	34	89	123	6%	100%						6%	0%	0%	0%	0%	0%	
2709	67	0	67	3%	100%						3%	0%	0%	0%	0%	0%	
2712	41	0	41	2%	100%						2%	0%	0%	0%	0%	0%	
2714	19	0	19	1%	100%						1%	0%	0%	0%	0%	0%	
2715	41	22	63	3%	100%						3%	0%	0%	0%	0%	0%	
2717	120	0	120	6%	35%	50%	15%				2%	3%	1%	0%	0%	0%	
2718	115	15	130	6%		10%	50%	40%			0%	1%	3%	2%	0%	0%	
Markham	175	275	450	21%	100%						21%	0%	0%	0%	0%	0%	
Vaughan	194	0	194	9%	20%		80%				2%	0%	7%	0%	0%	0%	
Mississauga	79	0	79	4%	80%		20%				3%	0%	1%	0%	0%	0%	
			2173	100%							55%	5%	35%	5%	0%	0%	100%

Whitchurch-Stouffville 437 126 563 Does equal sum of zones in the PD

Mon Apr 17 2017 10:56:59 GMT-0400 (Eastern Daylight Time) - Run Time: 3411ms

Cross Tabulation Query Form - Trip - 2011

Row: Planning district of origin - pd_orig

Column: 2006 GTA zone of destination - gta06_dest

Filters:

2006 GTA zone of destination - gta06_dest In 2717,2718

and

Start time of trip - start_time In 1530-1829

and

Trip purpose of destination - purp_dest In H,

Trip 2011

Table:

					Route Selections						Route Selections						Comments
	2717	2718	Combined	%	SB HWY 48	NB HWY 48	WB Aurora	EB Aurora	SB 9th	NB 9th	SB HWY 48	NB HWY 48	WB Aurora	EB Aurora	SB 9th	NB 9th	
PD 1 of Toronto	232	14	246	13%			100%				0%	0%	13%	0%	0%	0%	Most by GO
PD 4 of Toronto	7	39	46	2%			100%				0%	0%	2%	0%	0%	0%	Most by GO
PD 10 of Toronto	17	0	17	1%	50%		50%				0%	0%	0%	0%	0%	0%	
PD 11 of Toronto	27	0	27	1%	40%		60%				1%	0%	1%	0%	0%	0%	
PD 13 of Toronto	57	84	141	7%	40%		60%				3%	0%	4%	0%	0%	0%	
PD 16 of Toronto	115	0	115	6%	60%		40%				4%	0%	2%	0%	0%	0%	
Uxbridge	44	0	44	2%		50%		50%			0%	1%	0%	1%	0%	0%	
Scugog	0	9	9	0%				100%			0%	0%	0%	0%	0%	0%	
Pickering	0	15	15	1%	50%			50%			0%	0%	0%	0%	0%	0%	
East Gwillimbury	5	0	5	0%		90%	10%				0%	0%	0%	0%	0%	0%	
Newmarket	0	19	19	1%		100%					0%	1%	0%	0%	0%	0%	
Aurora	17	9	26	1%	30%		70%				0%	0%	1%	0%	0%	0%	
Richmond Hill	101	14	115	6%	50%	50%					3%	3%	0%	0%	0%	0%	
Whitchurch-Stouffville											0%	0%	0%	0%	0%	0%	
2703	19	0	19	1%	50%		50%				0%	0%	0%	0%	0%	0%	
2704	19	0	19	1%	50%		50%				0%	0%	0%	0%	0%	0%	
2708	0	125	125	6%	100%						6%	0%	0%	0%	0%	0%	
2709	113	35	148	8%	100%						8%	0%	0%	0%	0%	0%	
2712	24	0	24	1%	100%						1%	0%	0%	0%	0%	0%	
2717	114	0	114	6%	30%	30%	10%				2%	2%	2%	1%	0%	0%	
2718	115	45	160	8%		50%	20%	30%			0%	4%	2%	2%	0%	0%	
Mississauga	79	0	79	4%	50%		50%				2%	0%	2%	0%	0%	0%	
Markham	212	200	412	21%	50%		50%				11%	0%	11%	0%	0%	0%	
King	17	0	17	1%	50%		50%				0%	0%	0%	0%	0%	0%	
			1942	100%							40%	15%	40%	5%	0%	0%	100%

Whitchurch-Stouffville 404 205 609 Does equal sum of zones in the PD

APPENDIX E:

Detailed Synchro Capacity Analysis Worksheets



Timings

3: HWY48/HWY 48 & Aurora Road

07-09-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations									
Traffic Volume (vph)	20	115	105	290	90	145	50	465	80
Future Volume (vph)	20	115	105	290	90	145	50	465	80
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.07	0.23	0.21	0.41	0.36	0.18	0.14	0.41	0.14
Control Delay	10.8	8.7	11.9	13.4	20.5	12.0	15.8	17.4	4.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.8	8.7	11.9	13.4	20.5	12.0	15.8	17.4	4.6
LOS	B	A	B	B	C	B	B	B	A
Approach Delay		8.9		13.0		14.8		15.5	
Approach LOS		A		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.41

Intersection Signal Delay: 13.8

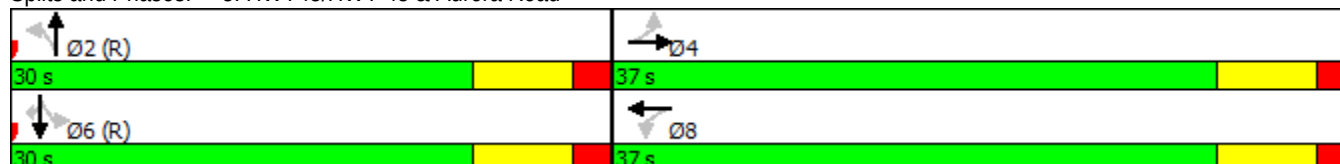
Intersection LOS: B

Intersection Capacity Utilization 58.1%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

07-09-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	115	55	105	290	30	90	145	40	50	465	80
Future Volume (veh/h)	20	115	55	105	290	30	90	145	40	50	465	80
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1387	1776	1900	1845	1817	1900	1727	1656	1900	1727	1810	1810
Adj Flow Rate, veh/h	22	124	59	113	312	32	97	156	43	54	500	86
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	37	7	7	3	3	3	10	16	16	10	5	5
Cap, veh/h	366	528	251	579	752	77	298	880	236	450	1232	551
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	768	1138	541	1183	1621	166	766	2456	658	1093	3438	1538
Grp Volume(v), veh/h	22	0	183	113	0	344	97	98	101	54	500	86
Grp Sat Flow(s),veh/h/ln	768	0	1679	1183	0	1787	766	1574	1540	1093	1719	1538
Q Serve(g_s), s	1.3	0.0	4.4	4.3	0.0	8.6	7.3	2.9	3.0	2.4	7.3	2.5
Cycle Q Clear(g_c), s	9.9	0.0	4.4	8.6	0.0	8.6	14.6	2.9	3.0	5.4	7.3	2.5
Prop In Lane	1.00		0.32	1.00		0.09	1.00		0.43	1.00		1.00
Lane Grp Cap(c), veh/h	366	0	780	579	0	830	298	564	552	450	1232	551
V/C Ratio(X)	0.06	0.00	0.23	0.20	0.00	0.41	0.33	0.17	0.18	0.12	0.41	0.16
Avail Cap(c_a), veh/h	366	0	780	579	0	830	298	564	552	450	1232	551
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.2	0.0	10.8	13.4	0.0	11.9	21.6	14.7	14.8	16.6	16.1	14.6
Incr Delay (d2), s/veh	0.3	0.0	0.7	0.8	0.0	1.5	2.9	0.7	0.7	0.5	1.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	2.2	1.5	0.0	4.6	1.8	1.3	1.4	0.8	3.6	1.2
LnGrp Delay(d),s/veh	15.5	0.0	11.5	14.1	0.0	13.4	24.5	15.4	15.5	17.2	17.1	15.2
LnGrp LOS	B		B	B		B	C	B	B	B	B	B
Approach Vol, veh/h		205			457			296			640	
Approach Delay, s/veh		11.9			13.6			18.4			16.9	
Approach LOS		B			B			B			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		16.6		11.9		9.3		10.6				
Green Ext Time (p_c), s		3.3		4.4		5.7		4.5				
Intersection Summary												
HCM 2010 Ctrl Delay				15.6								
HCM 2010 LOS				B								
Notes												

Intersection

Int Delay, s/veh 1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	25	45	230	5	10	615
Future Vol, veh/h	25	45	230	5	10	615
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	0	7	16	40	0	6
Mvmt Flow	27	48	247	5	11	661

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	930	247	0
Stage 1	247	-	-
Stage 2	683	-	-
Critical Hdwy	6.4	6.27	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.363	-
Pot Cap-1 Maneuver	299	780	-
Stage 1	799	-	-
Stage 2	505	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	295	780	-
Mov Cap-2 Maneuver	295	-	-
Stage 1	799	-	-
Stage 2	498	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.7	0	0.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	491	1331
HCM Lane V/C Ratio	-	-	0.153	0.008
HCM Control Delay (s)	-	-	13.7	7.7
HCM Lane LOS	-	-	B	A
HCM 95th %tile Q(veh)	-	-	0.5	0

Timings

3: HWY48/HWY 48 & Aurora Road

07-09-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations									
Traffic Volume (vph)	95	320	45	125	85	435	25	165	20
Future Volume (vph)	95	320	45	125	85	435	25	165	20
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.19	0.49	0.14	0.20	0.23	0.45	0.10	0.15	0.04
Control Delay	11.7	14.3	11.6	9.8	16.9	16.9	15.8	15.0	0.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.7	14.3	11.6	9.8	16.9	16.9	15.8	15.0	0.3
LOS	B	B	B	A	B	B	B	B	A
Approach Delay		13.8		10.2		16.9		13.7	
Approach LOS		B		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.49

Intersection Signal Delay: 14.5

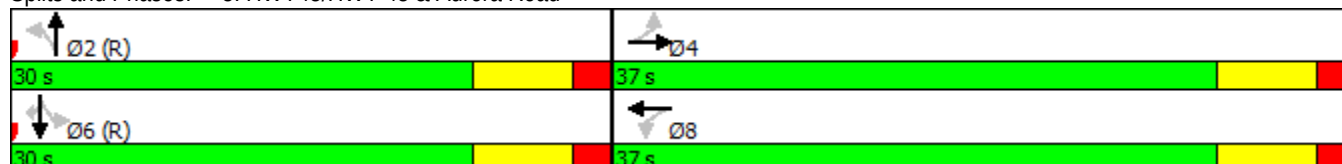
Intersection LOS: B

Intersection Capacity Utilization 63.4%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

07-09-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	95	320	65	45	125	30	85	435	75	25	165	20
Future Volume (veh/h)	95	320	65	45	125	30	85	435	75	25	165	20
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1869	1900	1776	1859	1900	1810	1839	1900	1827	1810	1545
Adj Flow Rate, veh/h	104	352	71	49	137	33	93	478	82	27	181	22
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	3	1	1	7	2	2	5	3	3	4	5	23
Cap, veh/h	597	701	141	383	672	162	475	1070	183	303	1232	470
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	1198	1510	305	915	1449	349	1141	2987	510	830	3438	1313
Grp Volume(v), veh/h	104	0	423	49	0	170	93	279	281	27	181	22
Grp Sat Flow(s),veh/h/ln	1198	0	1815	915	0	1798	1141	1747	1749	830	1719	1313
Q Serve(g_s), s	3.8	0.0	10.9	2.6	0.0	3.7	4.0	8.2	8.2	1.7	2.4	0.7
Cycle Q Clear(g_c), s	7.5	0.0	10.9	13.6	0.0	3.7	6.4	8.2	8.2	10.0	2.4	0.7
Prop In Lane	1.00		0.17	1.00		0.19	1.00		0.29	1.00		1.00
Lane Grp Cap(c), veh/h	597	0	842	383	0	834	475	626	627	303	1232	470
V/C Ratio(X)	0.17	0.00	0.50	0.13	0.00	0.20	0.20	0.45	0.45	0.09	0.15	0.05
Avail Cap(c_a), veh/h	597	0	842	383	0	834	475	626	627	303	1232	470
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	12.8	0.0	12.5	17.3	0.0	10.6	16.7	16.4	16.4	20.3	14.6	14.0
Incr Delay (d2), s/veh	0.6	0.0	2.1	0.7	0.0	0.6	0.9	2.3	2.3	0.6	0.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.0	5.9	0.7	0.0	2.0	1.4	4.3	4.4	0.4	1.2	0.3
LnGrp Delay(d),s/veh	13.5	0.0	14.7	18.0	0.0	11.2	17.7	18.7	18.8	20.8	14.8	14.2
LnGrp LOS	B		B	B		B	B	B	B	C	B	B
Approach Vol, veh/h		527			219			653			230	
Approach Delay, s/veh		14.4			12.7			18.6			15.5	
Approach LOS		B			B			B			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		10.2		12.9		12.0		15.6				
Green Ext Time (p_c), s		5.0		5.0		4.6		4.6				
Intersection Summary												
HCM 2010 Ctrl Delay				16.0								
HCM 2010 LOS				B								
Notes												

Intersection

Int Delay, s/veh 0.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	15	580	25	25	250
Future Vol, veh/h	15	15	580	25	25	250
Conflicting Peds, #/hr	2	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	0	12	4	0	13	5
Mvmt Flow	16	16	630	27	27	272

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	958	630	0
Stage 1	630	-	-
Stage 2	328	-	-
Critical Hdwy	6.4	6.32	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.408	-
Pot Cap-1 Maneuver	288	464	-
Stage 1	535	-	-
Stage 2	734	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	277	464	-
Mov Cap-2 Maneuver	277	-	-
Stage 1	535	-	-
Stage 2	707	-	-

Approach	WB	NB	SB
HCM Control Delay, s	16.4	0	0.8
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	347	902
HCM Lane V/C Ratio	-	-	0.094	0.03
HCM Control Delay (s)	-	-	16.4	9.1
HCM Lane LOS	-	-	C	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1

Timings

3: HWY48/HWY 48 & Aurora Road

07-09-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations									
Traffic Volume (vph)	25	145	115	340	90	185	80	560	85
Future Volume (vph)	25	145	115	340	90	185	80	560	85
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.10	0.27	0.23	0.50	0.43	0.22	0.23	0.49	0.15
Control Delay	11.3	9.9	12.3	14.7	23.6	12.6	17.2	18.4	5.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.3	9.9	12.3	14.7	23.6	12.6	17.2	18.4	5.3
LOS	B	A	B	B	C	B	B	B	A
Approach Delay		10.0		14.1		15.7		16.7	
Approach LOS		B		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.50

Intersection Signal Delay: 14.9

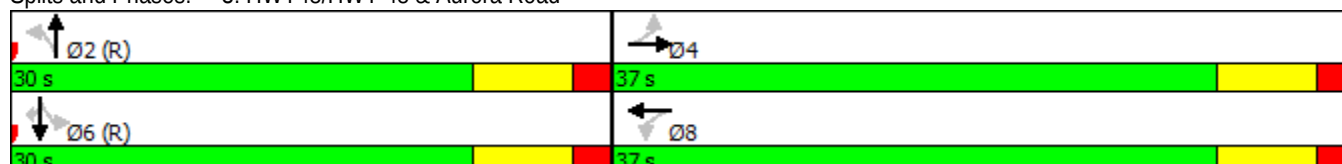
Intersection LOS: B

Intersection Capacity Utilization 64.3%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

07-09-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	145	60	115	340	45	90	185	45	80	560	85
Future Volume (veh/h)	25	145	60	115	340	45	90	185	45	80	560	85
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1387	1776	1900	1845	1810	1900	1727	1655	1900	1727	1810	1810
Adj Flow Rate, veh/h	27	156	65	124	366	48	97	199	48	86	602	91
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	37	7	7	3	3	3	10	16	16	10	5	5
Cap, veh/h	324	553	230	546	728	95	261	905	213	423	1232	551
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	721	1191	496	1143	1568	206	694	2526	596	1046	3438	1538
Grp Volume(v), veh/h	27	0	221	124	0	414	97	122	125	86	602	91
Grp Sat Flow(s),veh/h/ln	721	0	1687	1143	0	1773	694	1572	1549	1046	1719	1538
Q Serve(g_s), s	1.8	0.0	5.4	5.0	0.0	10.9	8.5	3.6	3.8	4.2	9.1	2.7
Cycle Q Clear(g_c), s	12.8	0.0	5.4	10.4	0.0	10.9	17.6	3.6	3.8	8.0	9.1	2.7
Prop In Lane	1.00		0.29	1.00		0.12	1.00		0.38	1.00		1.00
Lane Grp Cap(c), veh/h	324	0	783	546	0	823	261	563	555	423	1232	551
V/C Ratio(X)	0.08	0.00	0.28	0.23	0.00	0.50	0.37	0.22	0.22	0.20	0.49	0.17
Avail Cap(c_a), veh/h	324	0	783	546	0	823	261	563	555	423	1232	551
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	17.0	0.0	11.1	14.3	0.0	12.5	23.6	15.0	15.0	17.8	16.7	14.7
Incr Delay (d2), s/veh	0.5	0.0	0.9	1.0	0.0	2.2	4.0	0.9	0.9	1.1	1.4	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	2.7	1.7	0.0	5.8	1.9	1.7	1.7	1.3	4.5	1.2
LnGrp Delay(d),s/veh	17.5	0.0	12.0	15.3	0.0	14.7	27.6	15.8	15.9	18.9	18.1	15.3
LnGrp LOS	B		B	B		B	C	B	B	B	B	B
Approach Vol, veh/h		248			538			344			779	
Approach Delay, s/veh		12.6			14.9			19.2			17.9	
Approach LOS		B			B			B			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		19.6		14.8		11.1		12.9				
Green Ext Time (p_c), s		2.3		5.0		6.2		5.3				
Intersection Summary												
HCM 2010 Ctrl Delay			16.6									
HCM 2010 LOS			B									
Notes												

Intersection

Int Delay, s/veh 1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	25	45	275	5	10	725
Future Vol, veh/h	25	45	275	5	10	725
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	0	7	16	40	0	6
Mvmt Flow	27	48	296	5	11	780

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1097	296	0
Stage 1	296	-	-
Stage 2	801	-	-
Critical Hdwy	6.4	6.27	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.363	-
Pot Cap-1 Maneuver	238	732	-
Stage 1	759	-	-
Stage 2	445	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	234	732	-
Mov Cap-2 Maneuver	234	-	-
Stage 1	759	-	-
Stage 2	438	-	-

Approach	WB	NB	SB
HCM Control Delay, s	15.6	0	0.1
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	416	1277
HCM Lane V/C Ratio	-	-	0.181	0.008
HCM Control Delay (s)	-	-	15.6	7.8
HCM Lane LOS	-	-	C	A
HCM 95th %tile Q(veh)	-	-	0.7	0

Timings

3: HWY48/HWY 48 & Aurora Road

07-09-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations	↰	↱	↰	↱	↰	↱	↰	↱	↰
Traffic Volume (vph)	100	390	105	185	85	550	75	205	25
Future Volume (vph)	100	390	105	185	85	550	75	205	25
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.23	0.60	0.40	0.36	0.23	0.56	0.41	0.18	0.05
Control Delay	12.5	16.4	17.2	11.0	17.1	18.6	23.7	15.3	1.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.5	16.4	17.2	11.0	17.1	18.6	23.7	15.3	1.3
LOS	B	B	B	B	B	B	C	B	A
Approach Delay		15.7		12.7		18.4		16.2	
Approach LOS		B		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.60

Intersection Signal Delay: 16.2

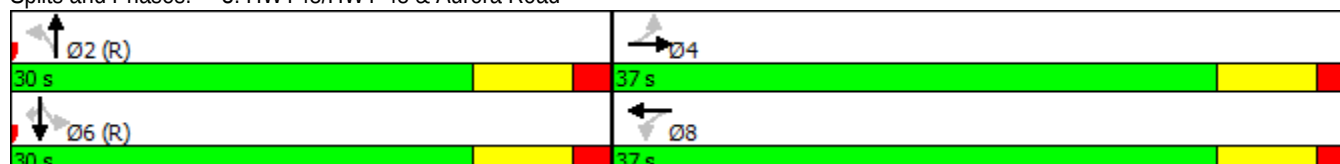
Intersection LOS: B

Intersection Capacity Utilization 72.7%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

07-09-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	100	390	75	105	185	90	85	550	80	75	205	25
Future Volume (veh/h)	100	390	75	105	185	90	85	550	80	75	205	25
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1869	1900	1776	1857	1900	1810	1840	1900	1827	1810	1545
Adj Flow Rate, veh/h	110	429	82	115	203	99	93	604	88	82	225	27
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	3	1	1	7	2	2	5	3	3	4	5	23
Cap, veh/h	482	708	135	322	548	267	449	1098	160	254	1232	470
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	1062	1526	292	844	1180	575	1091	3064	446	734	3438	1313
Grp Volume(v), veh/h	110	0	511	115	0	302	93	344	348	82	225	27
Grp Sat Flow(s),veh/h/ln	1062	0	1818	844	0	1755	1091	1748	1761	734	1719	1313
Q Serve(g_s), s	5.0	0.0	14.0	7.9	0.0	7.5	4.3	10.5	10.6	6.7	3.0	0.9
Cycle Q Clear(g_c), s	12.5	0.0	14.0	21.9	0.0	7.5	7.3	10.5	10.6	17.3	3.0	0.9
Prop In Lane	1.00		0.16	1.00		0.33	1.00		0.25	1.00		1.00
Lane Grp Cap(c), veh/h	482	0	844	322	0	815	449	626	631	254	1232	470
V/C Ratio(X)	0.23	0.00	0.61	0.36	0.00	0.37	0.21	0.55	0.55	0.32	0.18	0.06
Avail Cap(c_a), veh/h	482	0	844	322	0	815	449	626	631	254	1232	470
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.7	0.0	13.4	21.5	0.0	11.6	17.3	17.2	17.2	24.1	14.8	14.1
Incr Delay (d2), s/veh	1.1	0.0	3.2	3.1	0.0	1.3	1.0	3.4	3.4	3.3	0.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	7.7	2.1	0.0	3.9	1.4	5.7	5.7	1.6	1.5	0.4
LnGrp Delay(d),s/veh	16.8	0.0	16.6	24.6	0.0	12.9	18.3	20.6	20.6	27.4	15.1	14.3
LnGrp LOS	B		B	C		B	B	C	C	C	B	B
Approach Vol, veh/h		621			417			785			334	
Approach Delay, s/veh		16.6			16.1			20.4			18.1	
Approach LOS		B			B			C			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		12.6		16.0		19.3		23.9				
Green Ext Time (p_c), s		5.6		6.6		2.4		3.6				
Intersection Summary												
HCM 2010 Ctrl Delay				18.1								
HCM 2010 LOS				B								
Notes												

Intersection

Int Delay, s/veh 0.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	15	700	25	25	360
Future Vol, veh/h	15	15	700	25	25	360
Conflicting Peds, #/hr	2	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	0	12	4	0	13	5
Mvmt Flow	16	16	761	27	27	391

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1209	761	0
Stage 1	761	-	-
Stage 2	448	-	-
Critical Hdwy	6.4	6.32	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.408	-
Pot Cap-1 Maneuver	204	390	-
Stage 1	465	-	-
Stage 2	648	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	195	390	-
Mov Cap-2 Maneuver	195	-	-
Stage 1	465	-	-
Stage 2	619	-	-

Approach	WB	NB	SB
HCM Control Delay, s	20.8	0	0.6
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	260	804
HCM Lane V/C Ratio	-	-	0.125	0.034
HCM Control Delay (s)	-	-	20.8	9.6
HCM Lane LOS	-	-	C	A
HCM 95th %tile Q(veh)	-	-	0.4	0.1

Timings

3: HWY48/HWY 48 & Aurora Road

07-09-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations									
Traffic Volume (vph)	25	145	115	340	115	190	80	565	85
Future Volume (vph)	25	145	115	340	115	190	80	565	85
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.10	0.29	0.24	0.50	0.55	0.23	0.23	0.49	0.15
Control Delay	11.3	9.7	12.4	14.7	28.6	12.4	17.3	18.5	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.3	9.7	12.4	14.7	28.6	12.4	17.3	18.5	5.4
LOS	B	A	B	B	C	B	B	B	A
Approach Delay		9.9		14.1		17.6		16.8	
Approach LOS		A		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.55

Intersection Signal Delay: 15.3

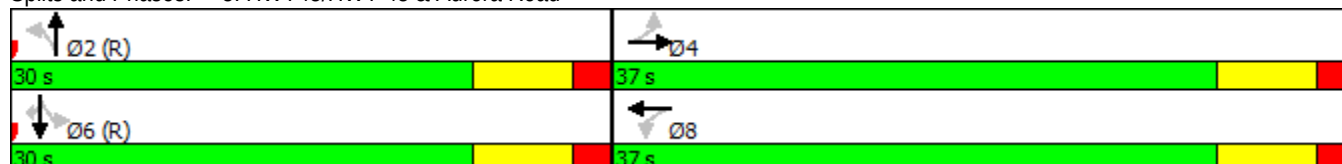
Intersection LOS: B

Intersection Capacity Utilization 65.8%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

07-09-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	145	75	115	340	45	115	190	50	80	565	85
Future Volume (veh/h)	25	145	75	115	340	45	115	190	50	80	565	85
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1387	1776	1900	1845	1810	1900	1727	1656	1900	1727	1810	1810
Adj Flow Rate, veh/h	27	156	81	124	366	48	124	204	54	86	608	91
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	37	7	7	3	3	3	10	16	16	10	5	5
Cap, veh/h	324	511	266	531	728	95	259	887	229	417	1232	551
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	721	1102	572	1127	1568	206	690	2476	640	1036	3438	1538
Grp Volume(v), veh/h	27	0	237	124	0	414	124	128	130	86	608	91
Grp Sat Flow(s),veh/h/ln	721	0	1674	1127	0	1773	690	1573	1543	1036	1719	1538
Q Serve(g_s), s	1.8	0.0	5.9	5.2	0.0	10.9	11.5	3.8	4.0	4.3	9.2	2.7
Cycle Q Clear(g_c), s	12.8	0.0	5.9	11.1	0.0	10.9	20.7	3.8	4.0	8.2	9.2	2.7
Prop In Lane	1.00		0.34	1.00		0.12	1.00		0.41	1.00		1.00
Lane Grp Cap(c), veh/h	324	0	777	531	0	823	259	563	553	417	1232	551
V/C Ratio(X)	0.08	0.00	0.31	0.23	0.00	0.50	0.48	0.23	0.24	0.21	0.49	0.17
Avail Cap(c_a), veh/h	324	0	777	531	0	823	259	563	553	417	1232	551
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	17.0	0.0	11.2	14.7	0.0	12.5	24.8	15.0	15.1	17.9	16.8	14.7
Incr Delay (d2), s/veh	0.5	0.0	1.0	1.0	0.0	2.2	6.2	0.9	1.0	1.1	1.4	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	2.9	1.7	0.0	5.8	2.6	1.8	1.8	1.3	4.6	1.2
LnGrp Delay(d),s/veh	17.5	0.0	12.2	15.7	0.0	14.7	31.0	16.0	16.1	19.1	18.2	15.3
LnGrp LOS	B		B	B		B	C	B	B	B	B	B
Approach Vol, veh/h		264			538			382			785	
Approach Delay, s/veh		12.8			15.0			20.9			17.9	
Approach LOS		B			B			C			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		22.7		14.8		11.2		13.1				
Green Ext Time (p_c), s		0.2		5.1		6.4		5.4				
Intersection Summary												
HCM 2010 Ctrl Delay				17.0								
HCM 2010 LOS				B								
Notes												

Intersection

Int Delay, s/veh 3.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	70	80	275	20	30	725
Future Vol, veh/h	70	80	275	20	30	725
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	0	7	16	40	0	6
Mvmt Flow	75	86	296	22	32	780

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1140	296	0
Stage 1	296	-	-
Stage 2	844	-	-
Critical Hdwy	6.4	6.27	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.363	-
Pot Cap-1 Maneuver	224	732	-
Stage 1	759	-	-
Stage 2	425	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	214	732	-
Mov Cap-2 Maneuver	214	-	-
Stage 1	759	-	-
Stage 2	406	-	-

Approach	WB	NB	SB
HCM Control Delay, s	24.4	0	0.3
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	344	1277
HCM Lane V/C Ratio	-	-	0.469	0.025
HCM Control Delay (s)	-	-	24.4	7.9
HCM Lane LOS	-	-	C	A
HCM 95th %tile Q(veh)	-	-	2.4	0.1

Intersection

Int Delay, s/veh 4.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	35	15	70	0	0	80
Future Vol, veh/h	35	15	70	0	0	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	Stop
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	38	16	76	0	0	87

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	76	0	0 168 76
Stage 1	-	-	- - 76 -
Stage 2	-	-	- - 92 -
Critical Hdwy	4.12	-	- - 6.42 6.22
Critical Hdwy Stg 1	-	-	- - 5.42 -
Critical Hdwy Stg 2	-	-	- - 5.42 -
Follow-up Hdwy	2.218	-	- - 3.518 3.318
Pot Cap-1 Maneuver	1523	-	- - 822 985
Stage 1	-	-	- - 947 -
Stage 2	-	-	- - 932 -
Platoon blocked, %	-	-	- - -
Mov Cap-1 Maneuver	1523	-	- - 801 985
Mov Cap-2 Maneuver	-	-	- - 801 -
Stage 1	-	-	- - 947 -
Stage 2	-	-	- - 909 -

Approach	EB	WB	SB
HCM Control Delay, s	5.2	0	9
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1523	-	-	-	985
HCM Lane V/C Ratio	0.025	-	-	-	0.088
HCM Control Delay (s)	7.4	0	-	-	9
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0.1	-	-	-	0.3

Timings

3: HWY48/HWY 48 & Aurora Road

07-09-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations									
Traffic Volume (vph)	100	390	110	185	100	555	25	215	75
Future Volume (vph)	100	390	110	185	100	555	25	215	75
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.23	0.65	0.47	0.36	0.28	0.56	0.14	0.19	0.16
Control Delay	12.5	17.3	19.8	11.0	17.8	18.7	16.8	15.3	4.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.5	17.3	19.8	11.0	17.8	18.7	16.8	15.3	4.9
LOS	B	B	B	B	B	B	B	B	A
Approach Delay		16.5		13.5		18.6		13.0	
Approach LOS		B		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 55

Control Type: Pretimed

Maximum v/c Ratio: 0.65

Intersection Signal Delay: 16.2

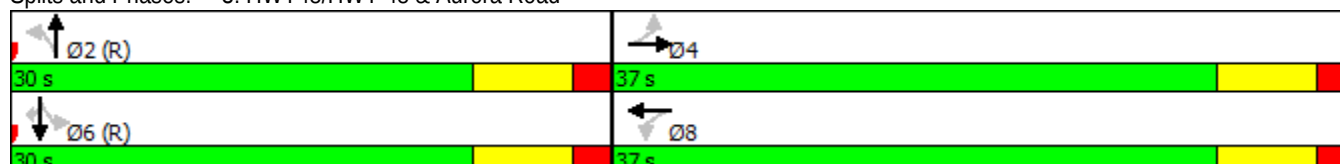
Intersection LOS: B

Intersection Capacity Utilization 75.4%

ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

07-09-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	100	390	110	110	185	90	100	555	85	25	215	75
Future Volume (veh/h)	100	390	110	110	185	90	100	555	85	25	215	75
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1865	1900	1776	1857	1900	1810	1840	1900	1827	1810	1545
Adj Flow Rate, veh/h	110	429	121	121	203	99	110	610	93	27	236	82
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	3	1	1	7	2	2	5	3	3	4	5	23
Cap, veh/h	482	650	183	293	548	267	427	1090	166	251	1232	470
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	1062	1400	395	814	1180	575	1027	3043	463	727	3438	1313
Grp Volume(v), veh/h	110	0	550	121	0	302	110	350	353	27	236	82
Grp Sat Flow(s),veh/h/ln	1062	0	1795	814	0	1755	1027	1748	1758	727	1719	1313
Q Serve(g_s), s	5.0	0.0	15.9	9.0	0.0	7.5	5.5	10.8	10.8	2.1	3.2	2.9
Cycle Q Clear(g_c), s	12.5	0.0	15.9	24.9	0.0	7.5	8.7	10.8	10.8	12.9	3.2	2.9
Prop In Lane	1.00		0.22	1.00		0.33	1.00		0.26	1.00		1.00
Lane Grp Cap(c), veh/h	482	0	833	293	0	815	427	626	630	251	1232	470
V/C Ratio(X)	0.23	0.00	0.66	0.41	0.00	0.37	0.26	0.56	0.56	0.11	0.19	0.17
Avail Cap(c_a), veh/h	482	0	833	293	0	815	427	626	630	251	1232	470
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.7	0.0	13.9	23.5	0.0	11.6	17.8	17.3	17.3	22.4	14.8	14.7
Incr Delay (d2), s/veh	1.1	0.0	4.1	4.3	0.0	1.3	1.5	3.6	3.6	0.9	0.3	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	8.7	2.4	0.0	3.9	1.7	5.8	5.8	0.5	1.6	1.1
LnGrp Delay(d),s/veh	16.8	0.0	18.0	27.7	0.0	12.9	19.3	20.8	20.8	23.3	15.2	15.5
LnGrp LOS	B		B	C		B	B	C	C	C	B	B
Approach Vol, veh/h		660			423			813			345	
Approach Delay, s/veh		17.8			17.2			20.6			15.9	
Approach LOS		B			B			C			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		12.8		17.9		14.9		26.9				
Green Ext Time (p_c), s		5.6		6.3		4.7		2.1				
Intersection Summary												
HCM 2010 Ctrl Delay				18.4								
HCM 2010 LOS				B								
Notes												

Intersection

Int Delay, s/veh 2.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	40	40	700	55	75	360
Future Vol, veh/h	40	40	700	55	75	360
Conflicting Peds, #/hr	2	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	0	12	4	0	13	5
Mvmt Flow	43	43	761	60	82	391

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1317	761	0
Stage 1	761	-	-
Stage 2	556	-	-
Critical Hdwy	6.4	6.32	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.408	-
Pot Cap-1 Maneuver	175	390	-
Stage 1	465	-	-
Stage 2	578	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	152	390	-
Mov Cap-2 Maneuver	152	-	-
Stage 1	465	-	-
Stage 2	502	-	-

Approach	WB	NB	SB
HCM Control Delay, s	31.9	0	1.7
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	219	804
HCM Lane V/C Ratio	-	-	0.397	0.101
HCM Control Delay (s)	-	-	31.9	10
HCM Lane LOS	-	-	D	A
HCM 95th %tile Q(veh)	-	-	1.8	0.3

Intersection

Int Delay, s/veh 4.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↓	
Traffic Vol, veh/h	80	50	30	0	0	50
Future Vol, veh/h	80	50	30	0	0	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	87	54	33	0	0	54

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	33	0	0 261 33
Stage 1	-	-	- 33 -
Stage 2	-	-	- 228 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	1579	-	0 728 1041
Stage 1	-	-	0 989 -
Stage 2	-	-	0 810 -
Platoon blocked, %	-	-	
Mov Cap-1 Maneuver	1579	-	- 687 1041
Mov Cap-2 Maneuver	-	-	- 687 -
Stage 1	-	-	- 989 -
Stage 2	-	-	- 764 -

Approach	EB	WB	SB
HCM Control Delay, s	4.6	0	8.6
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	1579	-	-	1041
HCM Lane V/C Ratio	0.055	-	-	0.052
HCM Control Delay (s)	7.4	-	-	8.6
HCM Lane LOS	A	-	-	A
HCM 95th %tile Q(veh)	0.2	-	-	0.2

Timings

3: HWY48/HWY 48 & Aurora Road

12-19-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations									
Traffic Volume (vph)	25	145	113	340	104	190	80	565	85
Future Volume (vph)	25	145	113	340	104	190	80	565	85
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.10	0.28	0.23	0.50	0.50	0.22	0.23	0.49	0.15
Control Delay	11.3	9.8	12.3	14.7	26.1	12.9	17.2	18.5	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.3	9.8	12.3	14.7	26.1	12.9	17.2	18.5	5.4
LOS	B	A	B	B	C	B	B	B	A
Approach Delay		10.0		14.1		17.0		16.8	
Approach LOS		A		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.50

Intersection Signal Delay: 15.2

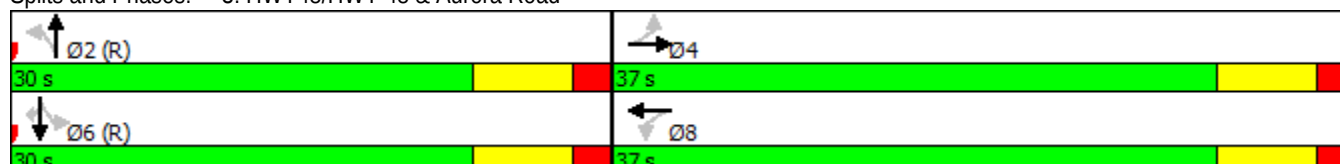
Intersection LOS: B

Intersection Capacity Utilization 65.2%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

12-19-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	145	68	113	340	45	104	190	42	80	565	85
Future Volume (veh/h)	25	145	68	113	340	45	104	190	42	80	565	85
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1387	1776	1900	1845	1810	1900	1727	1653	1900	1727	1810	1810
Adj Flow Rate, veh/h	27	156	73	122	366	48	112	204	45	86	608	91
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	37	7	7	3	3	3	10	16	16	10	5	5
Cap, veh/h	324	531	249	538	728	95	259	921	199	422	1232	551
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	721	1145	536	1135	1568	206	690	2570	556	1044	3438	1538
Grp Volume(v), veh/h	27	0	229	122	0	414	112	123	126	86	608	91
Grp Sat Flow(s),veh/h/ln	721	0	1680	1135	0	1773	690	1571	1555	1044	1719	1538
Q Serve(g_s), s	1.8	0.0	5.7	5.0	0.0	10.9	10.1	3.7	3.8	4.2	9.2	2.7
Cycle Q Clear(g_c), s	12.8	0.0	5.7	10.7	0.0	10.9	19.4	3.7	3.8	8.0	9.2	2.7
Prop In Lane	1.00		0.32	1.00		0.12	1.00		0.36	1.00		1.00
Lane Grp Cap(c), veh/h	324	0	780	538	0	823	259	563	557	422	1232	551
V/C Ratio(X)	0.08	0.00	0.29	0.23	0.00	0.50	0.43	0.22	0.23	0.20	0.49	0.17
Avail Cap(c_a), veh/h	324	0	780	538	0	823	259	563	557	422	1232	551
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	17.0	0.0	11.1	14.4	0.0	12.5	24.3	15.0	15.0	17.8	16.8	14.7
Incr Delay (d2), s/veh	0.5	0.0	1.0	1.0	0.0	2.2	5.2	0.9	0.9	1.1	1.4	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	2.8	1.7	0.0	5.8	2.3	1.7	1.8	1.3	4.6	1.2
LnGrp Delay(d),s/veh	17.5	0.0	12.1	15.4	0.0	14.7	29.5	15.9	16.0	18.9	18.2	15.3
LnGrp LOS	B		B	B		B	C	B	B	B	B	B
Approach Vol, veh/h		256			536			361			785	
Approach Delay, s/veh		12.7			14.9			20.1			17.9	
Approach LOS		B			B			C			B	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		30.0		37.0		30.0		37.0				
Change Period (Y+Rc), s		7.0		* 6.9		7.0		* 6.9				
Max Green Setting (Gmax), s		23.0		* 30		23.0		* 30				
Max Q Clear Time (g_c+I1), s		21.4		14.8		11.2		12.9				
Green Ext Time (p_c), s		1.2		5.1		6.3		5.4				
Intersection Summary												
HCM 2010 Ctrl Delay				16.8								
HCM 2010 LOS				B								
Notes												

Intersection

Int Delay, s/veh 2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	52	61	275	16	21	725
Future Vol, veh/h	52	61	275	16	21	725
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	0	7	16	40	0	6
Mvmt Flow	56	66	296	17	23	780

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1121	296	0
Stage 1	296	-	-
Stage 2	825	-	-
Critical Hdwy	6.4	6.27	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.363	-
Pot Cap-1 Maneuver	230	732	-
Stage 1	759	-	-
Stage 2	434	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	223	732	-
Mov Cap-2 Maneuver	223	-	-
Stage 1	759	-	-
Stage 2	420	-	-

Approach	WB	NB	SB
HCM Control Delay, s	20.2	0	0.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	357	1277
HCM Lane V/C Ratio	-	-	0.34	0.018
HCM Control Delay (s)	-	-	20.2	7.9
HCM Lane LOS	-	-	C	A
HCM 95th %tile Q(veh)	-	-	1.5	0.1

Intersection

Int Delay, s/veh 4.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	26	10	53	18	5	60
Future Vol, veh/h	26	10	53	18	5	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	Stop
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	28	11	58	20	5	65

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	77	0	0 134 67
Stage 1	-	-	- 67 -
Stage 2	-	-	- 67 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	1522	-	- 860 997
Stage 1	-	-	- 956 -
Stage 2	-	-	- 956 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1522	-	- 844 997
Mov Cap-2 Maneuver	-	-	- 844 -
Stage 1	-	-	- 956 -
Stage 2	-	-	- 938 -

Approach	EB	WB	SB
HCM Control Delay, s	5.4	0	8.6
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1522	-	-	-	1080
HCM Lane V/C Ratio	0.019	-	-	-	0.065
HCM Control Delay (s)	7.4	0	-	-	8.6
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0.1	-	-	-	0.2

Timings

3: HWY48/HWY 48 & Aurora Road

12-19-2018



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations	↰	↱	↰	↱	↰	↱	↰	↱	↰
Traffic Volume (vph)	100	390	100	185	100	555	25	215	75
Future Volume (vph)	100	390	100	185	100	555	25	215	75
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA	Perm
Protected Phases		4		8		2		6	
Permitted Phases	4		8		2		6		6
Detector Phase	4	4	8	8	2	2	6	6	6
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	24.9	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0
Total Split (s)	37.0	37.0	37.0	37.0	30.0	30.0	30.0	30.0	30.0
Total Split (%)	55.2%	55.2%	55.2%	55.2%	44.8%	44.8%	44.8%	44.8%	44.8%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Total Lost Time (s)	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	31.1	31.1	31.1	31.1	24.0	24.0	24.0	24.0	24.0
Actuated g/C Ratio	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36
v/c Ratio	0.23	0.62	0.40	0.36	0.28	0.55	0.13	0.19	0.16
Control Delay	12.5	16.7	17.4	11.0	17.8	18.6	16.7	15.3	4.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.5	16.7	17.4	11.0	17.8	18.6	16.7	15.3	4.9
LOS	B	B	B	B	B	B	B	B	A
Approach Delay		16.0		12.7		18.5		13.0	
Approach LOS		B		B		B		B	

Intersection Summary

Cycle Length: 67

Actuated Cycle Length: 67

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.62

Intersection Signal Delay: 15.8

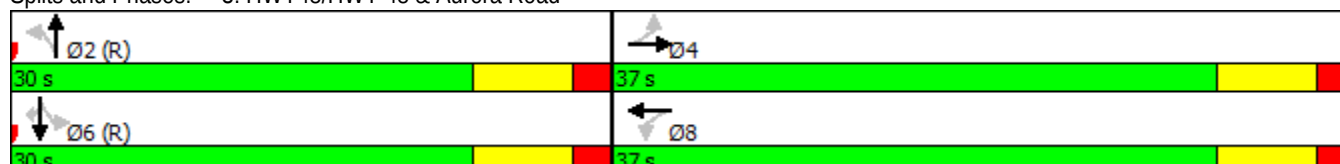
Intersection LOS: B

Intersection Capacity Utilization 73.1%

ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 3: HWY48/HWY 48 & Aurora Road



HCM 2010 Signalized Intersection Summary

3: HWY48/HWY 48 & Aurora Road

12-19-2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	100	390	89	100	185	90	100	555	73	25	215	75
Future Volume (veh/h)	100	390	89	100	185	90	100	555	73	25	215	75
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1867	1900	1776	1857	1900	1810	1841	1900	1827	1810	1545
Adj Flow Rate, veh/h	110	429	98	110	203	99	110	610	80	27	236	82
Adj No. of Lanes	1	1	0	1	1	0	1	2	0	1	2	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	3	1	1	7	2	2	5	3	3	4	5	23
Cap, veh/h	482	683	156	310	548	267	427	1114	146	256	1232	470
Arrive On Green	0.46	0.46	0.46	0.46	0.46	0.46	0.36	0.36	0.36	0.36	0.36	0.36
Sat Flow, veh/h	1062	1472	336	832	1180	575	1027	3110	407	736	3438	1313
Grp Volume(v), veh/h	110	0	527	110	0	302	110	342	348	27	236	82
Grp Sat Flow(s),veh/h/ln	1062	0	1808	832	0	1755	1027	1748	1769	736	1719	1313
Q Serve(g_s), s	5.0	0.0	14.8	7.7	0.0	7.5	5.5	10.5	10.5	2.0	3.2	2.9
Cycle Q Clear(g_c), s	12.5	0.0	14.8	22.5	0.0	7.5	8.7	10.5	10.5	12.6	3.2	2.9
Prop In Lane	1.00		0.19	1.00		0.33	1.00		0.23	1.00		1.00
Lane Grp Cap(c), veh/h	482	0	839	310	0	815	427	626	634	256	1232	470
V/C Ratio(X)	0.23	0.00	0.63	0.35	0.00	0.37	0.26	0.55	0.55	0.11	0.19	0.17
Avail Cap(c_a), veh/h	482	0	839	310	0	815	427	626	634	256	1232	470
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.7	0.0	13.6	22.1	0.0	11.6	17.8	17.2	17.2	22.2	14.8	14.7
Incr Delay (d2), s/veh	1.1	0.0	3.5	3.2	0.0	1.3	1.5	3.4	3.4	0.8	0.3	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	8.1	2.0	0.0	3.9	1.7	5.6	5.7	0.5	1.6	1.1
LnGrp Delay(d),s/veh	16.8	0.0	17.1	25.2	0.0	12.9	19.3	20.6	20.6	23.0	15.2	15.5
LnGrp LOS	B		B	C		B	B	C	C	C	B	B
Approach Vol, veh/h	637				412				800			
Approach Delay, s/veh	17.1				16.2				20.4			
Approach LOS	B				B				C			
Timer	1	2	3	4	5	6	7	8				
Assigned Phs	2		4		6		8					
Phs Duration (G+Y+Rc), s	30.0		37.0		30.0		37.0					
Change Period (Y+Rc), s	7.0		* 6.9		7.0		* 6.9					
Max Green Setting (Gmax), s	23.0		* 30		23.0		* 30					
Max Q Clear Time (g_c+I1), s	12.5		16.8		14.6		24.5					
Green Ext Time (p_c), s	5.6		6.4		4.8		3.4					
Intersection Summary												
HCM 2010 Ctrl Delay	17.9											
HCM 2010 LOS	B											
Notes												

Intersection

Int Delay, s/veh 1.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	32	28	700	55	45	360
Future Vol, veh/h	32	28	700	55	45	360
Conflicting Peds, #/hr	2	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	150	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	0	12	4	0	13	5
Mvmt Flow	35	30	761	60	49	391

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1252	761	0
Stage 1	761	-	-
Stage 2	491	-	-
Critical Hdwy	6.4	6.32	-
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.408	-
Pot Cap-1 Maneuver	192	390	-
Stage 1	465	-	-
Stage 2	619	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	177	390	-
Mov Cap-2 Maneuver	177	-	-
Stage 1	465	-	-
Stage 2	570	-	-

Approach	WB	NB	SB
HCM Control Delay, s	25.7	0	1.1
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	238	804
HCM Lane V/C Ratio	-	-	0.274	0.061
HCM Control Delay (s)	-	-	25.7	9.8
HCM Lane LOS	-	-	D	A
HCM 95th %tile Q(veh)	-	-	1.1	0.2

Intersection

Int Delay, s/veh 5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↓	↓
Traffic Vol, veh/h	60	40	22	8	15	38
Future Vol, veh/h	60	40	22	8	15	38
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	65	43	24	9	16	41

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	33	0	0 202 28
Stage 1	-	-	- 28 -
Stage 2	-	-	- 174 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	1579	-	- 787 1047
Stage 1	-	-	- 995 -
Stage 2	-	-	- 856 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1579	-	- 754 1047
Mov Cap-2 Maneuver	-	-	- 754 -
Stage 1	-	-	- 995 -
Stage 2	-	-	- 820 -

Approach	EB	WB	SB
HCM Control Delay, s	4.4	0	9.1
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1579	-	-	-	943
HCM Lane V/C Ratio	0.041	-	-	-	0.061
HCM Control Delay (s)	7.4	-	-	-	9.1
HCM Lane LOS	A	-	-	-	A
HCM 95th %tile Q(veh)	0.1	-	-	-	0.2