DILLON CONSULTING

DIV DEVELOPMENT (BARRIE) LIMITED

Proposed Residential Subdivision, City of Barrie, Part of Lot 20 Concession 11

Transportation Impact Study (Revised)

August 2023 — 22-5338

August 21, 2023

DIV Development (Barrie) Limited
130 Adelaide St. W., #2200
Toronto, ON
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Attention: Ms. Shahd Elshafei

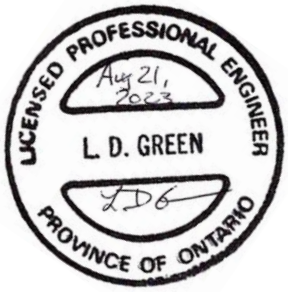
Proposed Residential Subdivision, City of Barrie, Part of Lot 20 Concession 11, Transportation Impact Study

Please find enclosed a copy of our transportation impact study prepared for the proposed residential subdivision located at the above-noted location in the city of Barrie.

Should you have any questions or wish to discuss our findings, please contact me at (613) 608-1778, or at *dgreen@dillon.ca*.

Yours sincerely,

DILLON CONSULTING LIMITED



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Project Manager

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Dillon Consulting Limited

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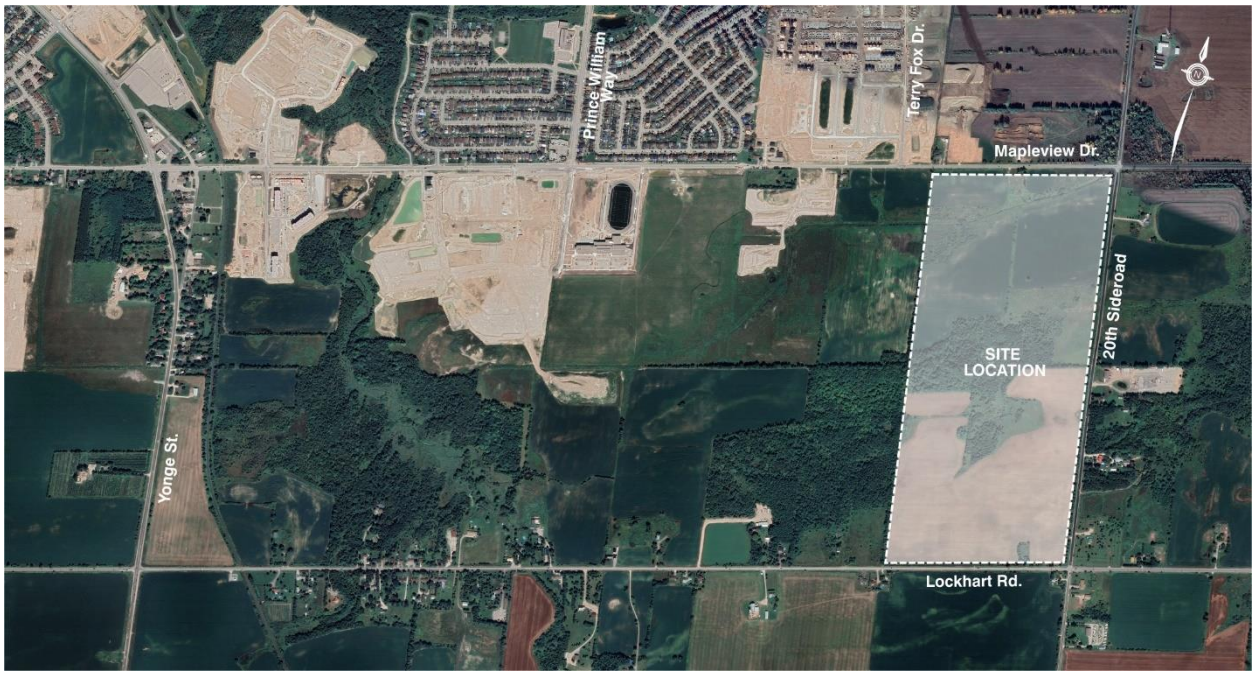
1.0 Introduction

1.1 Purpose

Dillon Consulting Limited (Dillon) has been retained by DIV Development (Barrie) Limited to prepare a transportation impact study (TIS) for a draft plan of subdivision in the city of Barrie. The subject lands are located along the west side of 20th Sideroad between Mapleview Drive and Lockhart Road, and are currently undeveloped. The application seeks to permit a residential subdivision containing approximately 560 single-detached dwellings and approximately 440 townhouse dwellings within the subject lands, as well as ancillary blocks for parkland, natural heritage lands and an elementary school. The number of planned dwelling units are subject to change and may range from 827 to 1067 total units.

Figure 1 shows the location of the site.

Figure 1: Site Location



1.2 Proposed Development

The proposed subdivision is located in southeast Barrie, in the southeast corner of the area formerly known as Hewitt's Secondary Plan. The subdivision encompasses a block of land approximately 600 metres wide along the west side of 20th Sideroad between Mapleview Drive and Lockhart Road. A natural heritage area extends east-west across the parcel and bisects it into a northern portion and southern portion.

The northern portion is proposed to provide approximately 272 single-family lots and 216 townhouse units. It will have direct access to Mapleview Drive on the north side and 20th Sideroad on the east side, as well as two roadway connections into the proposed residential lands immediately to the west.

The southern portion is proposed to contain approximately 288 single-family lots and 224 townhouse units. Blocks are also designated for an elementary school and adjacent park. The south portion will have direct access to 20th Sideroad on the east side and Lockhart Road on the south side; the plan also allows for a potential future local road connection into the lands to the west.

In total, the site accommodates approximately 560 single-family lots and 440 townhouse units, however the unit count may change as the plan of subdivision works its way through the planning process.

No roadways within the subdivision are proposed to cross the natural heritage area, although the lotting includes allowance for potential pedestrian connections.

The proposed draft plan of subdivision is provided in ***Appendix A***.

1.3 Scope of Analysis

Based on discussions with staff at the City of Barrie, the TIS is focused on the following items:

- A review of the proposed access points to the surrounding arterial road network, including the following:
  - Anticipated turning movement volumes at each intersection;
  - Recommended lane configurations and traffic control measures at each intersection;
  - Anticipated traffic operations at each intersection during the AM and PM peak hours; and
  - Sightlines for motorists exiting the subdivision at each intersection.
- A review of the proposed internal roadway network, including the following:
  - Anticipated traffic volumes at key locations within the network;
  - Recommended road classifications and cross-sections for the internal streets; and
  - A high-level review of potential traffic calming measures and locations.

Intersection analyses have been undertaken for the site access points to Mapleview Drive, 20th Sideroad and Lockhart Road. Based on discussions with City staff, the study area does not include other adjacent intersections on the arterial road network (e.g., Mapleview Drive at 20th Sideroad; Lockhart Road at 20th Sideroad) or intersections within the subdivision itself.

The analyses of the boundary road intersections have been prepared for the AM and PM peak hours of a typical weekday. The traffic forecasts on the internal street network also include weekday 24-hour volumes.

Traffic projections have been prepared for the 2031 and 2041 horizon years, corresponding to the horizon years in the City's long-range transportation model.

2.0 Transportation Context

2.1 Existing Road Network

The following describes the roadways within the study area. Unless noted, all roads are under the jurisdiction of the City of Barrie.

Mapleview Drive is an arterial road that begins near Lake Simcoe in the east and extends westerly across southern Barrie. It has a full interchange at Highway 400 approximately 7 km west of the site. Within the study area it currently has a two-lane rural cross-section, although sections to the west have been urbanized (curb and gutter; sidewalk; on-street bicycle lanes) where the adjacent lands have been developed. It has a 60 km/h posted speed limit throughout the study area.

Lockhart Road is a two-lane arterial road that is parallel to and 1.34 km south of Mapleview Drive. It similarly begins near Lake Simcoe in the east and extends to the west, however terminating in a cul-de-sac just east of Highway 400. Trips destined to the west side of Highway 400 are accommodated by traveling north to Mapleview Drive or south to McKay Road. It has a two-lane rural cross-section. The posted speed limit is 80 km/h along the site frontage; approximately 400 metres to the west, the speed limit decreases to 60 km/h.

20th Sideroad is a two-lane arterial road under the jurisdiction of the Town of Innisfil. It begins in the north at Big Bay Point Road just south of Kempenfelt Bay, and extends south through the town of Innisfil. In the study area, it forms the boundary between Barrie and Innisfil; south of the study area, it travels along the current west limits of Innisfil's main urban area. It has a two-lane rural cross-section and an 80 km/h posted speed limit throughout the study area.

2.2 Planned Roadway Modifications

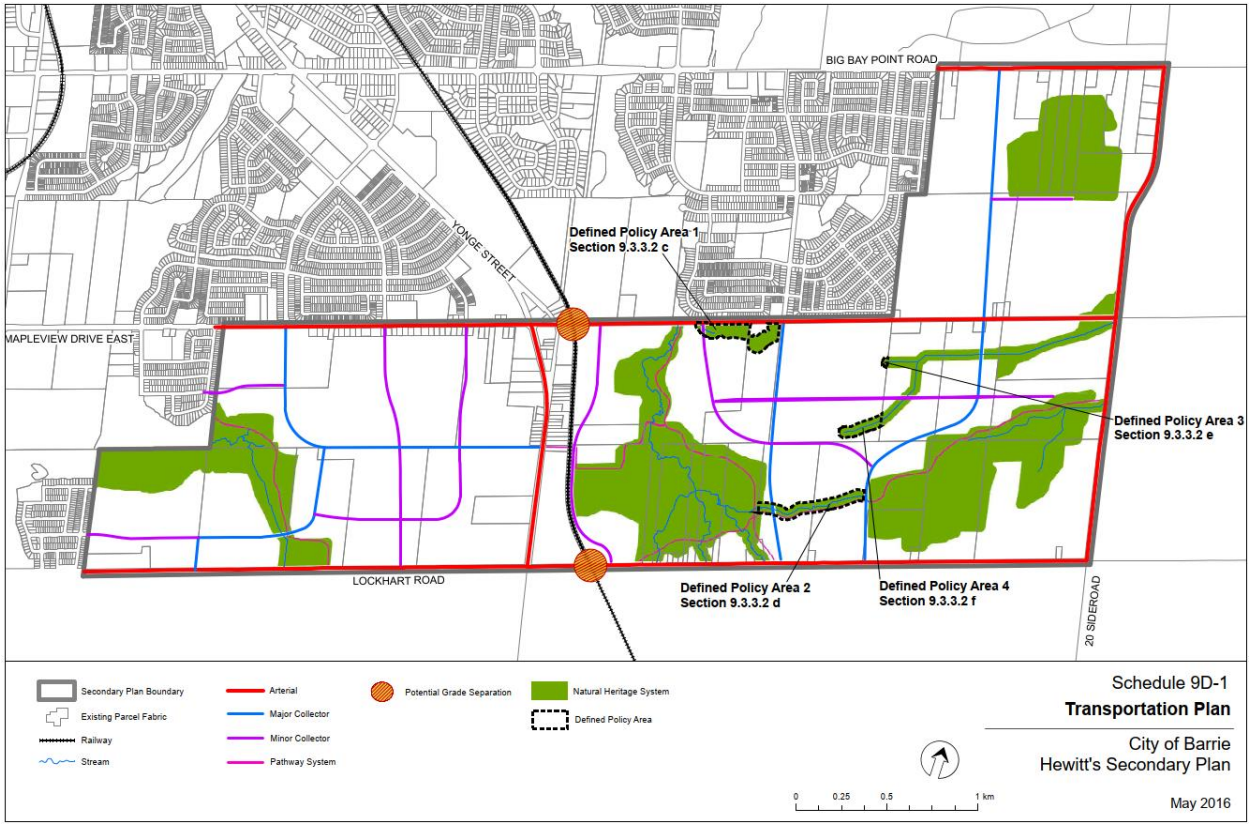
The City of Barrie's 2019 Transportation Master Plan (TMP) identified the widening of Mapleview Drive to a five-lane cross-section (including a two-way left turn lane or median) as far east as Terry Fox Drive by 2031, and a three-lane cross-section (also including a two-way left turn lane or median) from that point for a short distance easterly, which was likely intended to accommodate access to the subject lands. The eastern limit of the three-lane section approximately corresponds to the proposed Street "C" intersection. From that point easterly, the existing two-lane cross-section would be maintained.

No road widenings are proposed on either Lockhart Road or 20th Sideroad. The Town of Innisfil has plans to reconstruct 20th Sideroad in 2024; however, the section being reconstructed is well south of Lockhart Road and will not directly impact the study area.

2.3 Collector Road Network

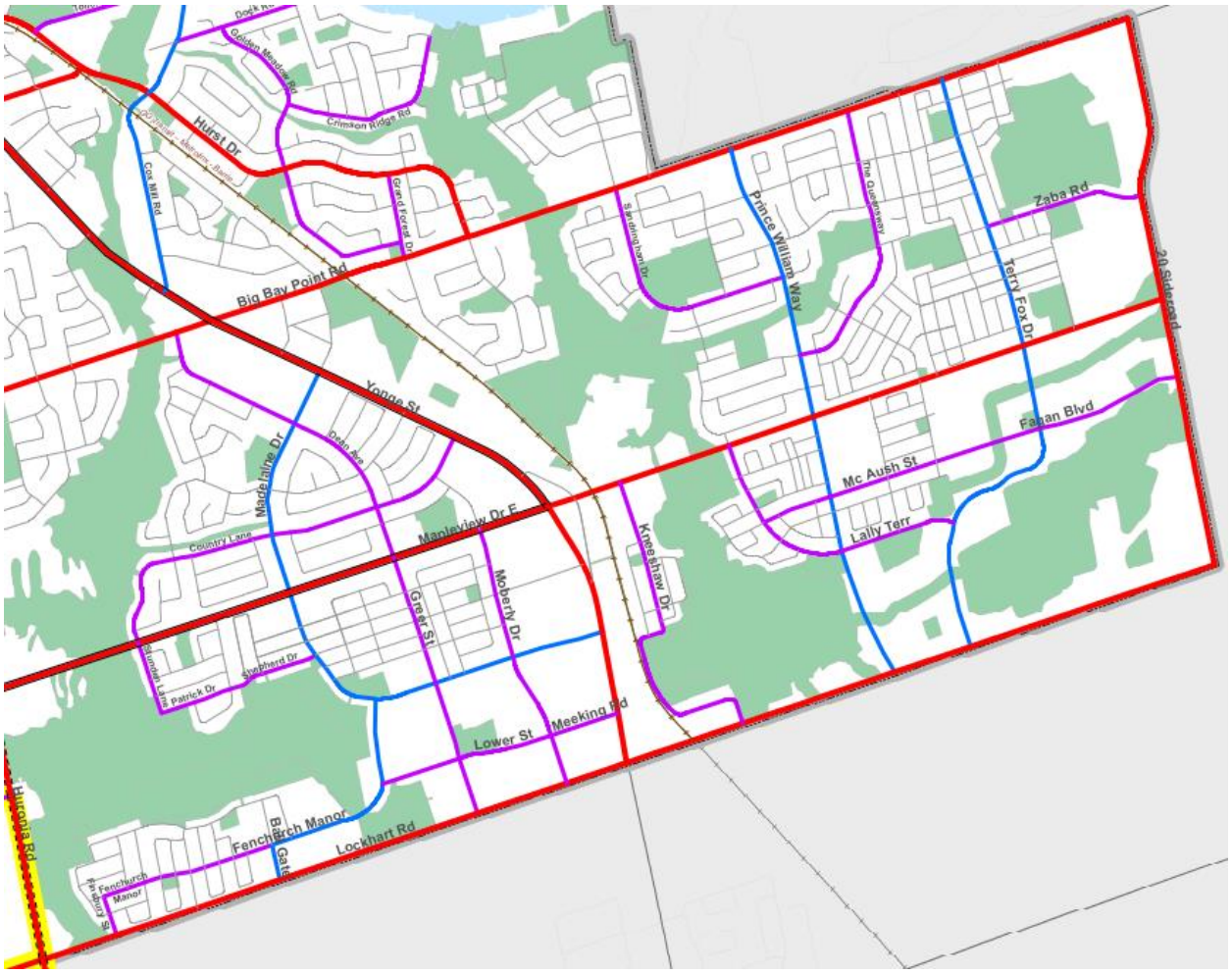
The collector road network within the site and surrounding lands were originally developed as part of the Hewitt's Secondary Plan, which predominantly encompassed the area between Mapleview Drive and Lockhart Road east of Lovers Creek. ***Figure 2*** illustrates the transportation plan developed as part of the Hewitt's Secondary Plan. The network included a new north-south major collector within the lands just to the west of the subject site (Terry Fox Drive), and an east-west minor collector north of the natural heritage area (known as Street "A" in this study). No collector roads were anticipated to cross the natural heritage area within the subject lands, and no collector roads were designated within the southern area of the site.

Figure 2: Hewitt's Secondary Plan — Proposed Transportation Plan



The Hewitt's Secondary Plan lands were subsequently incorporated into the City's updated Official Plan. ***Figure 3*** is an excerpt from the Official Plan's "mobility network" schedule (Map 4B) illustrating the road network by functional classification. The primary change to the road network in and around the subject lands was the extension of the east-west collector road (Street "A", or Fagan Boulevard) to a terminus at 20th Sideroad.

Figure 3: 2023 Official Plan Transportation Network



Road Classification

- Provincial Highway
- Existing Highway Interchange
- Proposed Highway Interchange
- County Road
- Arterial
- Major Collector
- Minor Collector
- Parkway
- Local Road
- Freight Supportive Corridor

2.4 Active Transportation Facilities

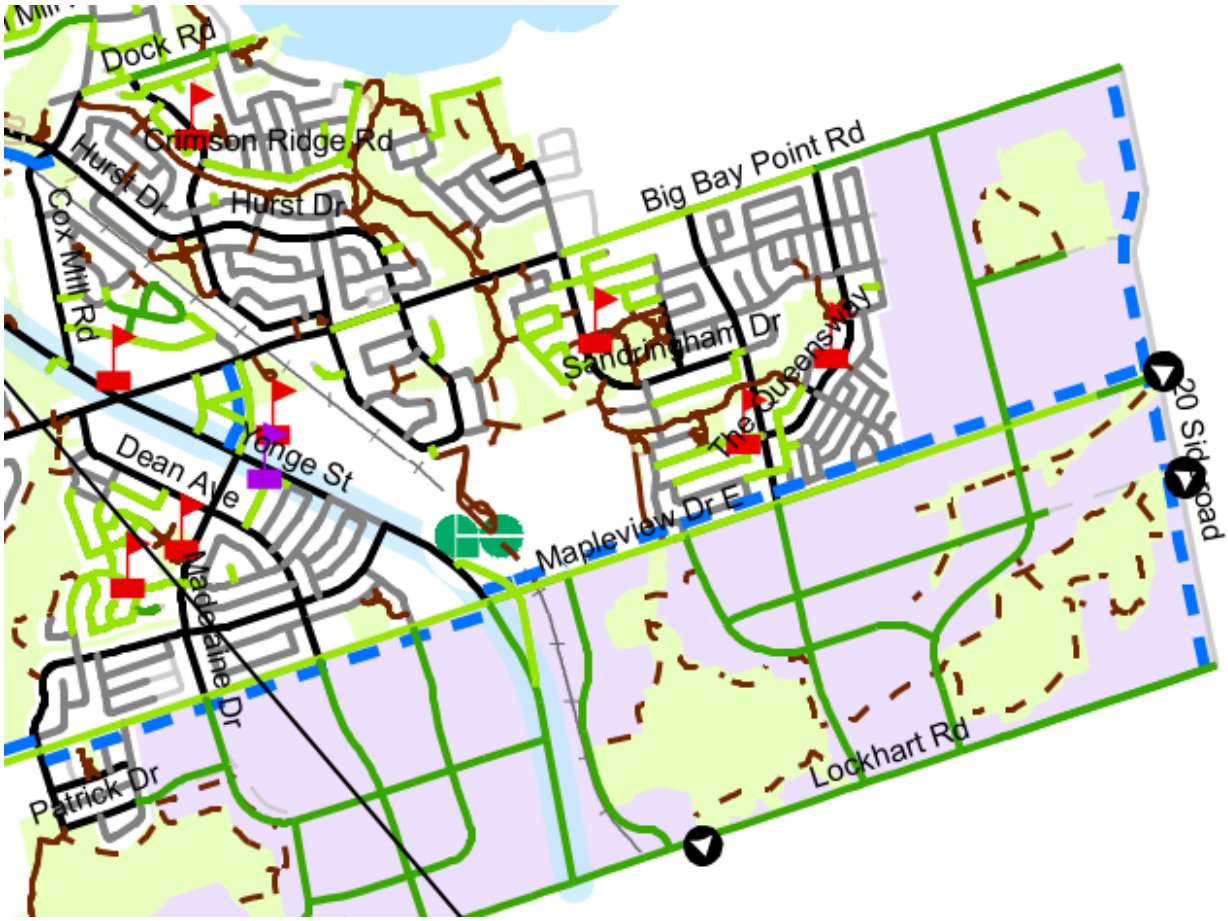
The subject lands and surroundings are currently undeveloped and no active transportation facilities exist on the boundary road network.

The City's 2019 Transportation Master Plan recommended new active transportation facilities in the Hewitt's Secondary Plan area as the area builds out. **Figure 4** and **Figure 5** illustrate the TMP's recommended pedestrian and cycling facilities, respectively.

The TMP recommended the following active transportation measures:

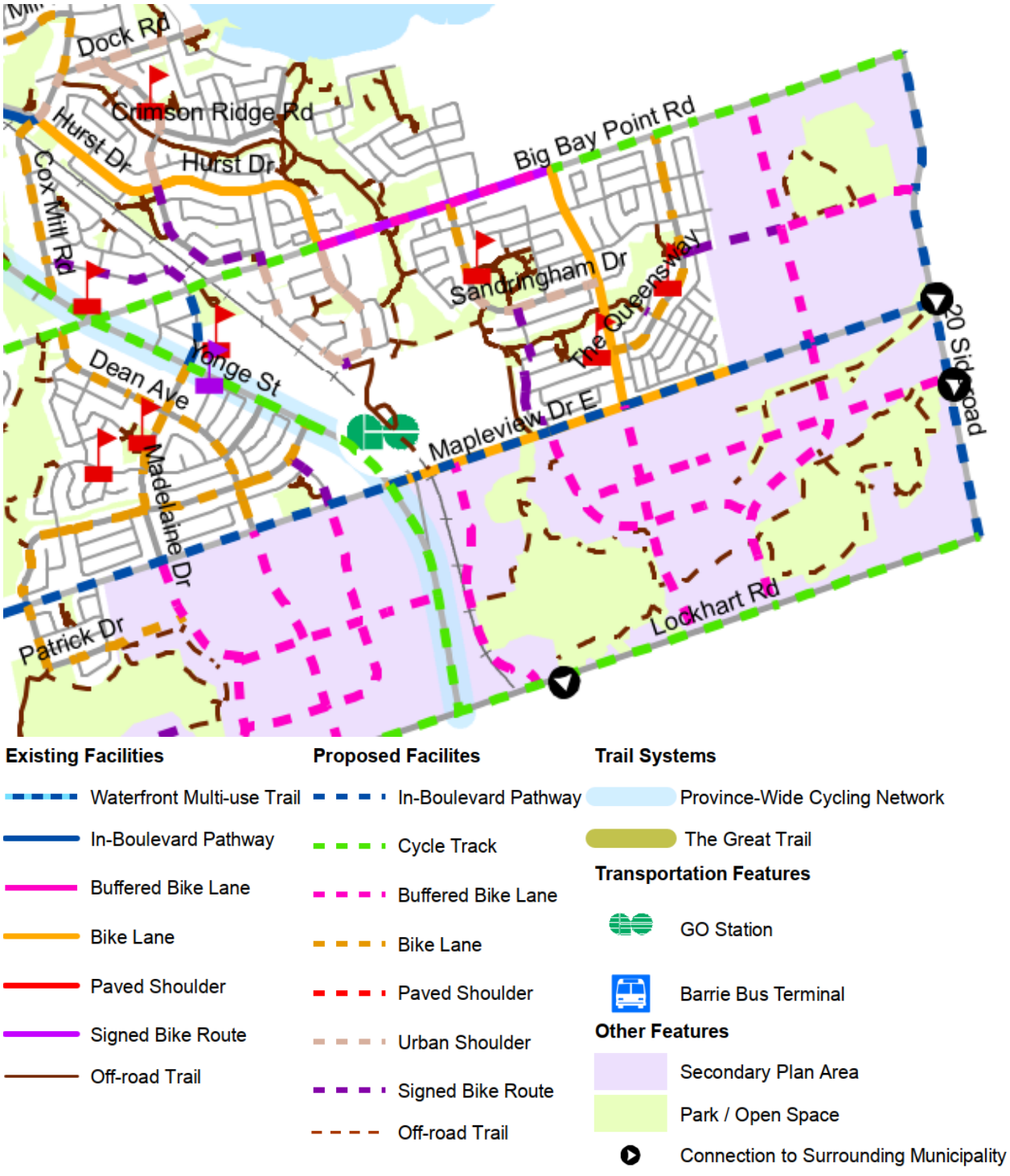
- Along Mapleview Drive, sidewalks were recommended along one or both sides of the street, in addition to in-boulevard multi-use paths.
- Along Lockhart Road, sidewalks were recommended on both sides of the street, in addition to cycle tracks.
- Along 20th Sideroad, in-boulevard multi-use paths were recommended.
- The new north-south collector (Terry Fox Drive) west of the site was recommended to have sidewalks on both sides of the street and buffered bicycle lanes;
- The new east-west collector (Street "A") was recommended to have sidewalks on both sides of the street and buffered bicycle lanes; and
- A network of off-street active transportation trails was proposed through the natural heritage areas within the site, including a north-south crossing that would connect the north and south sections of the subdivision.

Figure 4: Planned Pedestrian Facilities



Source: Barrie Transportation Master Plan, Appendix B: Active Transportation Strategy, June 2019. Map ES2: Draft Sidewalk and Multi-Use Trail Network (excerpt)

Figure 5: Planned Cycling Facilities

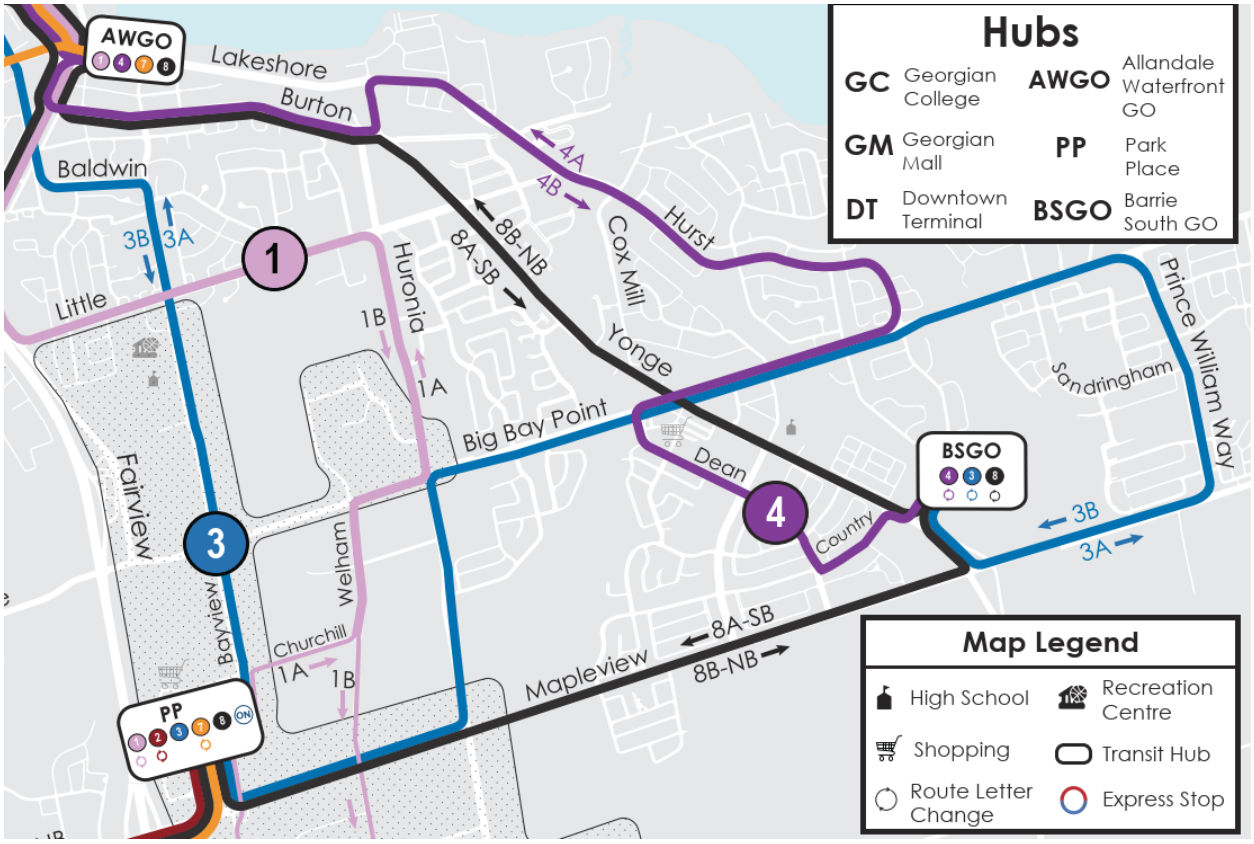


Source: Barrie Transportation Master Plan, Appendix B: Active Transportation Strategy, June 2019. Map ES1: Draft Cycling and Multi-Use Trail Network (excerpt)

2.5 Transit Network

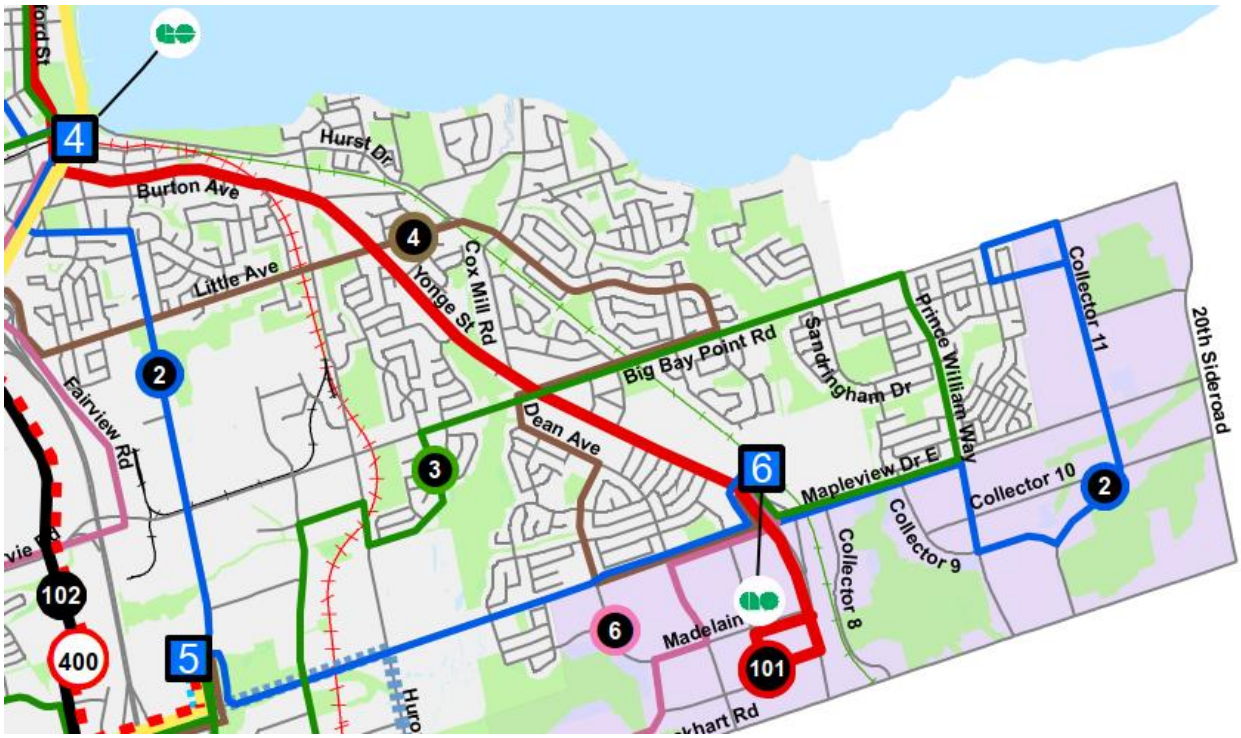
The subject lands and surroundings are generally undeveloped and as such are not currently served by Barrie Transit. ***Figure 6*** illustrates the existing transit network in southeast Barrie. The closest route to the subject site is Route 3, which begins at the Barrie South GO station and heads east on Mapleview Drive to Prince William Way, where it turns to the north on route to the Park Place bus hub, Allandale Waterfront GO station and downtown Barrie. Service operates seven days per week at half-hourly intervals. The closest stop to the subject lands is at Mapleview Drive and Prince William Way, approximately 1.25 km west of the northwest corner of the proposed subdivision.

Figure 6: Existing Transit Network



The City's 2019 Transportation Master Plan identified a preliminary 2041 network concept that would expand the service area into the Hewitt's Secondary Plan development lands. ***Figure 7*** illustrates this 2041 network concept. The subject site would be most closely served by a route extending east from Barrie South GO station via Mapleview Drive, turning south at Prince William Way, then heading east and north via future Terry Fox Drive ("Collector 11"). This routing would be approximately 100 metres west of the northern section of the site. The southern section of the site would rely on a trail crossing of the natural heritage lands for access to this route.

Figure 7: Proposed 2041 Transit Network Concept



Source: Barrie Transportation Master Plan, Appendix A: Transit Technical Memorandum, April 2019. Figure 5-1: Proposed 2041 Transit Route Network Concept (excerpt)

2.6 Existing Modal Split

The existing modal split for employment trips in the surrounding area was determined from data in the 2016 Transportation Tomorrow Survey (TTS) database. The modal split was calculated for AM and PM peak period trips destined to/from the residential lands east of Huronia Road, where the trip purpose of the origin or destination was home.

Table 1 presents the modal splits derived from the TTS database. In most cases, approximately 90% to 95% of trips are auto-oriented (either as driver or passenger). During the AM peak period, the outbound auto-oriented modal split is lower (81%) due to the effect of trips to school being made by walking or via school bus.

Table 1: Existing Modal Split

Travel mode	AM peak period		PM peak period	
	In	Out	In	Out
Auto driver	85%	70%	79%	70%
Auto passenger	10%	11%	11%	26%
Local transit	0%	1%	1%	0%
GO transit	0%	1%	2%	0%
School bus	2%	8%	2%	0%
Walk	3%	8%	5%	1%
Cycle	0%	0%	0%	3%

3.0 Traffic Volume Projections

Traffic forecasts within the site and at the site access intersections were prepared as follows:

- The volume of traffic generated within the proposed subdivision during the AM peak hour, PM peak hour and weekday 24-hour period was calculated;
- The traffic volumes were distributed directionally and then assigned to the internal road network and the four external access points; and
- Through traffic volumes on the boundary road network were established using output from the City's long-range transportation model.

3.1 Trip Generation

The number of vehicle trips generated within the proposed subdivision were estimated using trip generation rates published by the Institute of Transportation Engineers (ITE) in the *Trip Generation Manual* (11th edition). Trips were generated using data for the following land use codes:

- 210 Single-Family Detached Housing (applied to all single detached lots); and
- 215 Single-Family Attached Housing (applied to all townhouse units).

Table 2 presents the trip generation rates that were applied, and the number of trips generated within the site.

Table 2: Trip Generation

	# units	AM peak hour			PM peak hour			24-hour		
		Total	In	Out	Total	In	Out	Total	In	Out
Single detached units										
Trip generation rate; % in/out		0.7	25%	75%	0.94	63%	37%	9.43	50%	50%
Northern area	272	190	47	143	255	160	95	2,565	1,280	1,285
Southern area	288	198	49	149	272	172	100	2,717	1,356	1,361
Total subdivision	**560**	**388**	**96**	**292**	**527**	**332**	**195**	**5,282**	**2,636**	**2,646**
Townhouse units										
Trip generation rate; % in/out		0.48	25%	75%	0.57	59%	41%	7.2	50%	50%
Northern area	216	104	26	78	123	72	51	1,554	777	777
Southern area	224	107	27	80	127	74	53	1,613	805	808
Total subdivision	**440**	**211**	**53**	**158**	**250**	**146**	**104**	**3,167**	**1,582**	**1,585**
All units										
Northern area	488	294	73	221	378	232	146	4,119	2,057	2,062
Southern area	512	305	76	229	399	246	153	4,330	2,161	2,169
Total subdivision	**1,000**	**599**	**149**	**450**	**777**	**478**	**299**	**8,449**	**4,218**	**4,231**

Note: The trip generation calculations were prepared based on an earlier iteration of the draft plan with 956 units, compared to the 960 units proposed in the current version of the draft plan. The trips were not recalculated to reflect the additional unit, since the difference would be negligible.

3.2 Trip Distribution and Assignment

The following directional distribution was applied to the residential trips based on analyses prepared for other nearby subdivisions, with adjustments to reflect the specific site context:

- 65% to/from the west;
- 10% to/from the east;
- 10% to/from the north; and
- 15% to/from the south.

The site was divided into 16 internal zones for the purpose of trip assignment. The trips generated within each zone were assigned to one of the site access intersections, depending on the external origin/destination and the location of the zone within the site, and were then routed logically along the internal road network.

In the northern area of the subdivision, Streets "A", "D" and "I" will extend across the subdivision's west limits and will connect to a north-south collector road (Terry Fox Drive) that will provide an alternate route to Mapleview Drive and to Lockhart Road. Where appropriate, some site traffic was assigned to one of these streets rather than entering/exiting the site via the Street "C" and Mapleview Road intersection.

In the southern area of the subdivision, Street "K" similarly is shown as extending across the subdivision's west limits. However, the timing for the build-out of the lands to the west of Street "K" is less certain, and as such it was assumed that Street "K" would dead end at the site limits for the extent of the study period; therefore, all traffic was assigned to the study area arterial road intersections.

Figure 8 illustrates the projected site traffic volumes at the boundary road intersections. **Figure 9**, **Figure 10** and **Figure 11** illustrate the projected midblock volumes from the site traffic during the AM peak hour, the PM peak hour, and over a 24-hour period, respectively.

Figure 8: Site Traffic Volumes (Boundary Road Intersections)

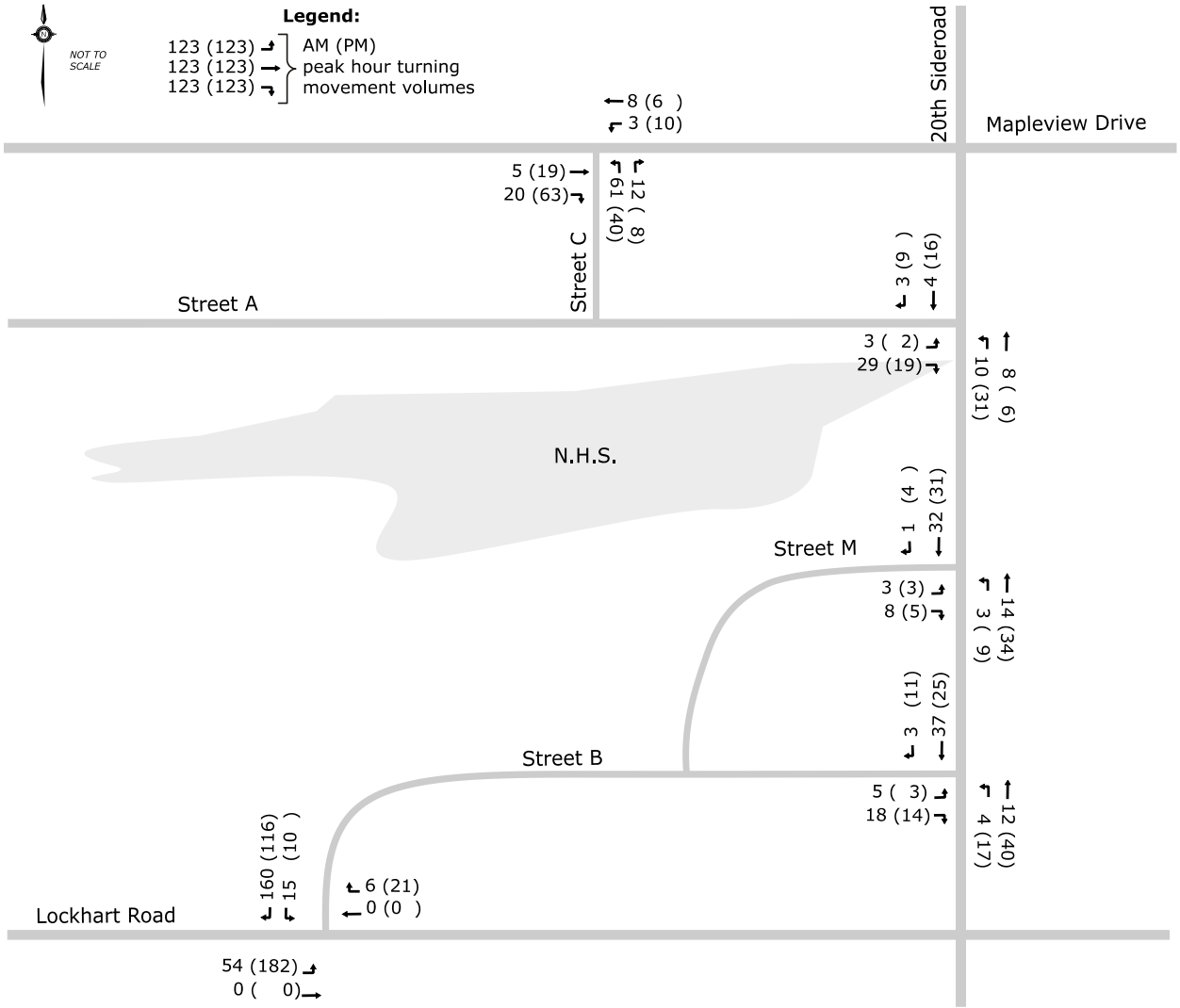


Figure 9: Internal AM Peak Hour Site Traffic Volumes

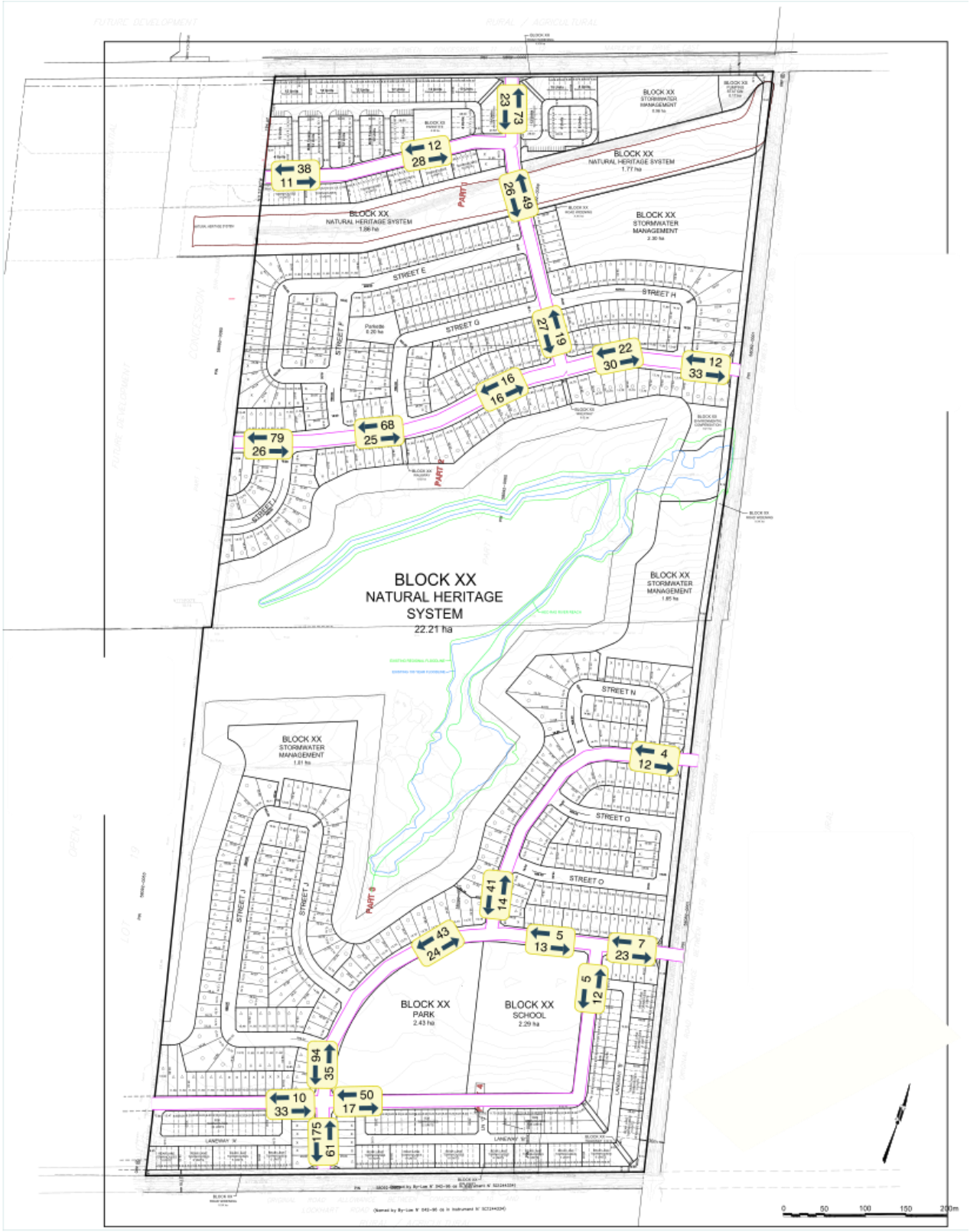


Figure 10: Internal PM Peak Hour Site Traffic Volumes

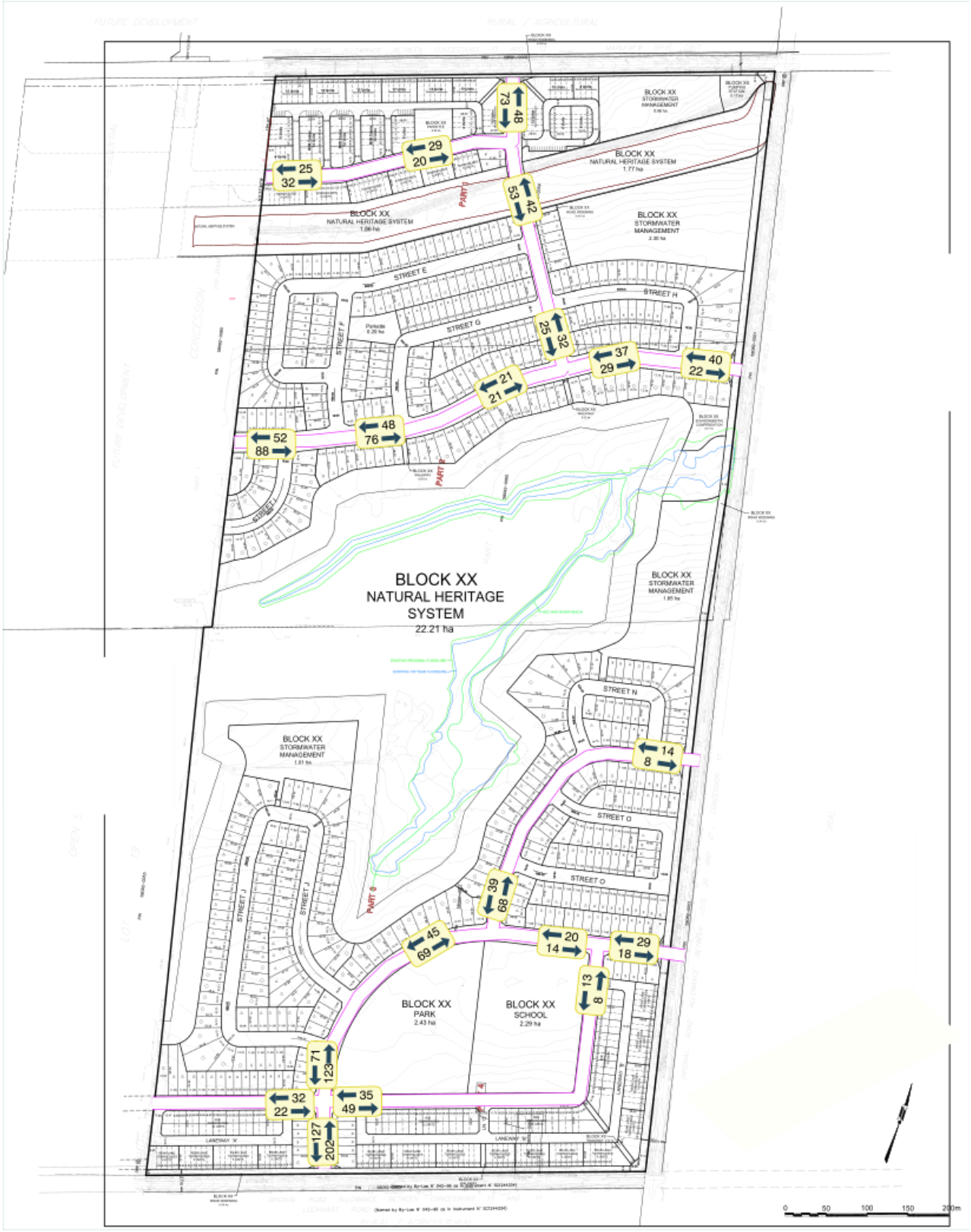
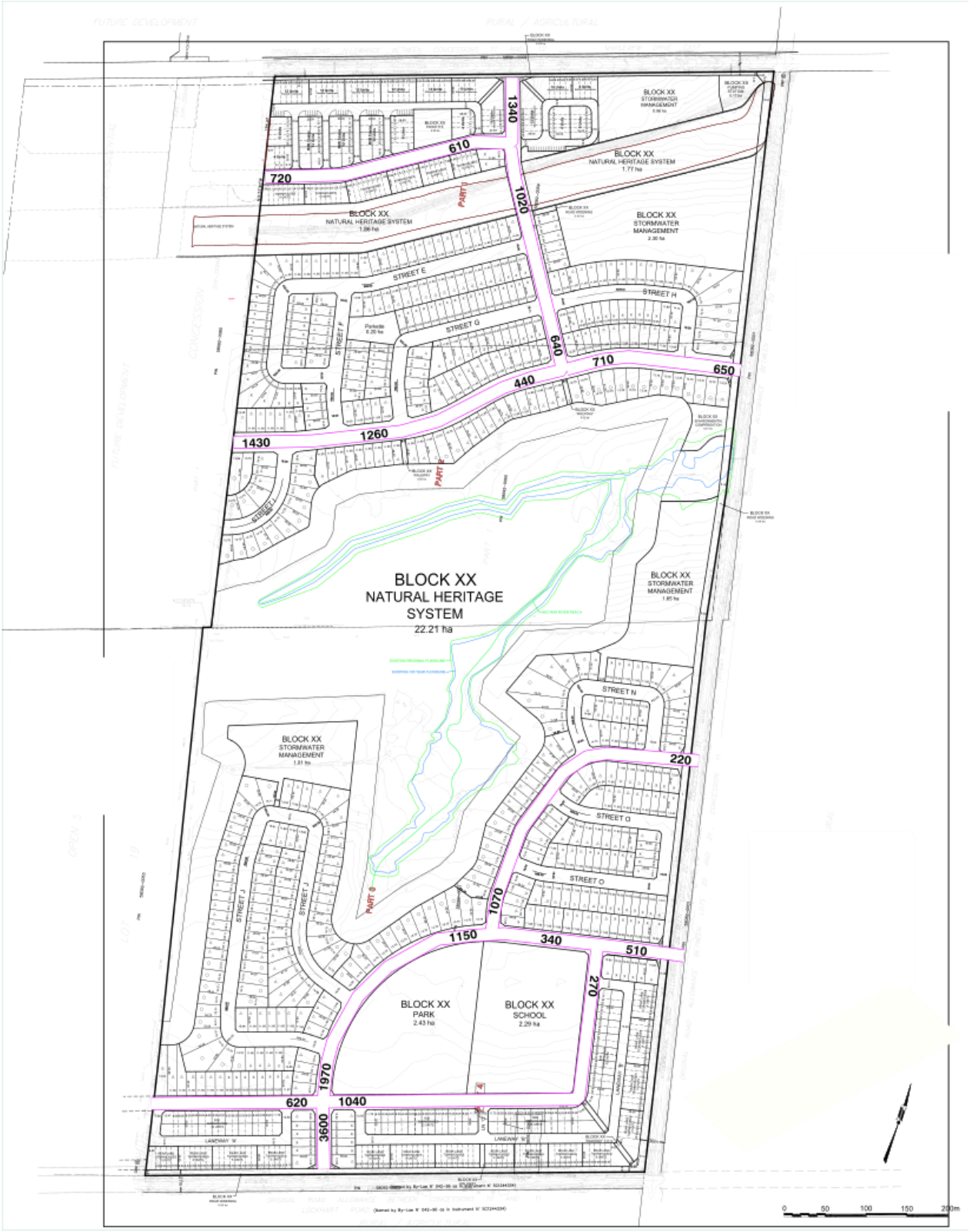


Figure 11: Internal 24-Hour Site Traffic Volumes



3.3 Background Traffic

City of Barrie staff provided 2031 and 2041 traffic volume projections from the City's long-range transportation model for use in identifying background traffic volumes on Mapleview Drive, 20th Sideroad and Lockhart Road. These volumes were applied to the through movements at the boundary road intersections.

The model also included a small amount of traffic on Street "A", representing traffic using Street "A" as a route between 20th Sideroad and the adjacent subdivisions to the west. The turning movement volumes at Street "A" and 20th Sideroad were estimated based on the upstream and downstream link volumes.

Figure 12 and **Figure 13** illustrate the projected future background volumes at the 2031 and 2041 horizons, respectively.

Figure 12: 2031 Future Background Traffic Volumes

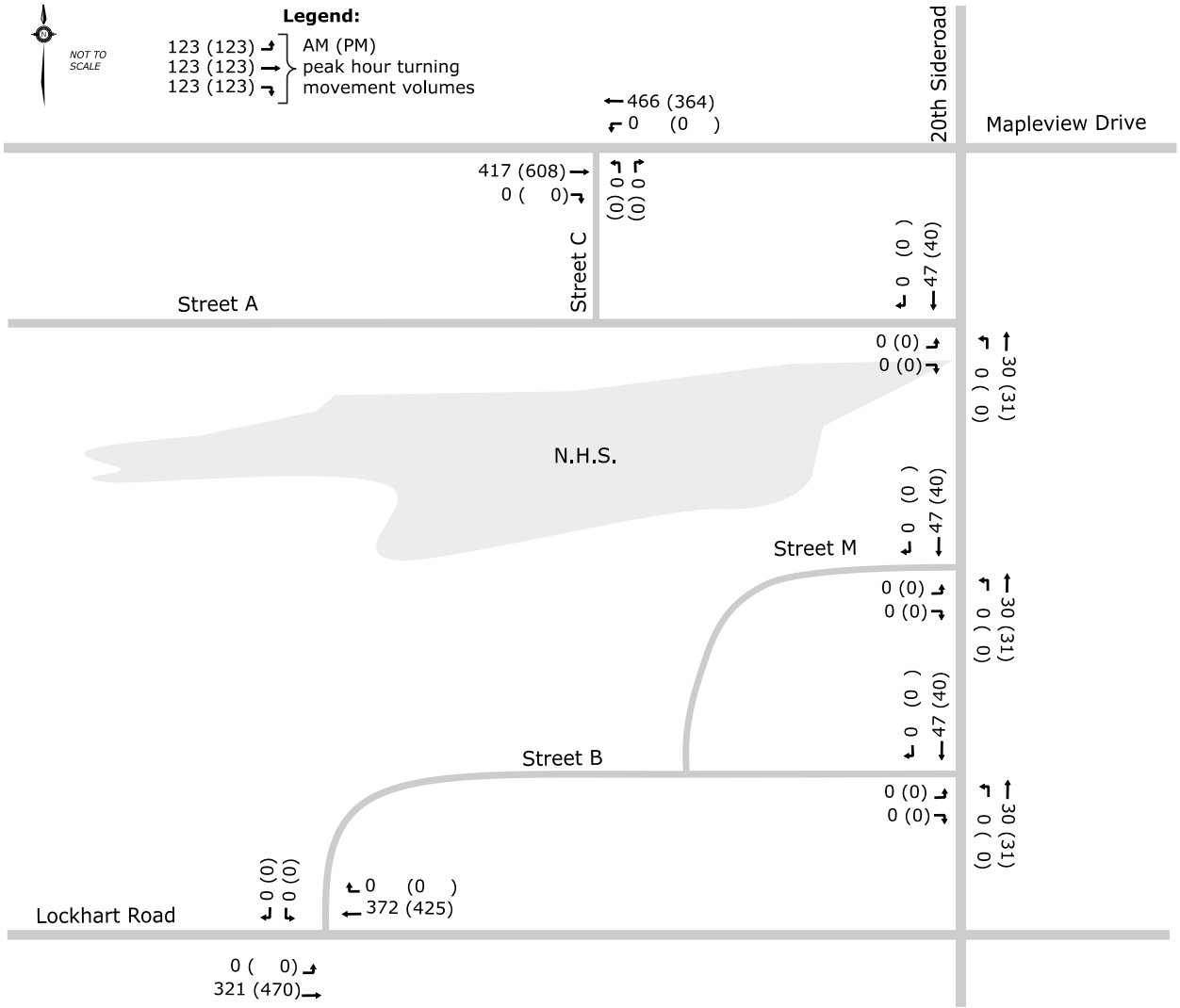
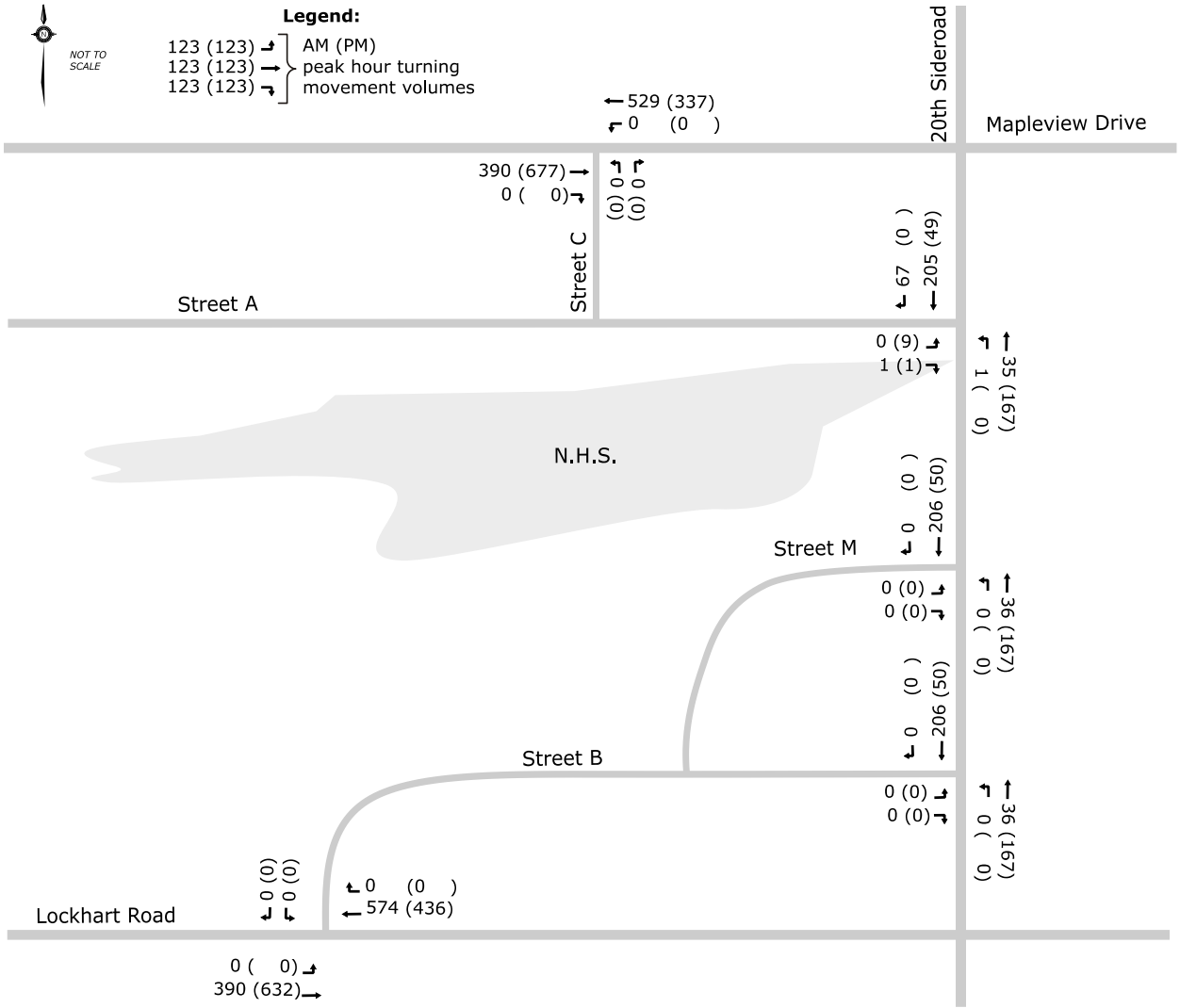


Figure 13: 2041 Future Background Traffic Volumes



3.4 Total Future Traffic Volumes

Total future traffic volumes at the site access intersections were calculated by adding the site traffic volumes to the future background traffic volumes. **Figure 14** and **Figure 15** illustrate the projected total future volumes at the 2031 and 2041 horizons, respectively.

Figure 14: 2031 Total Future Traffic Volumes

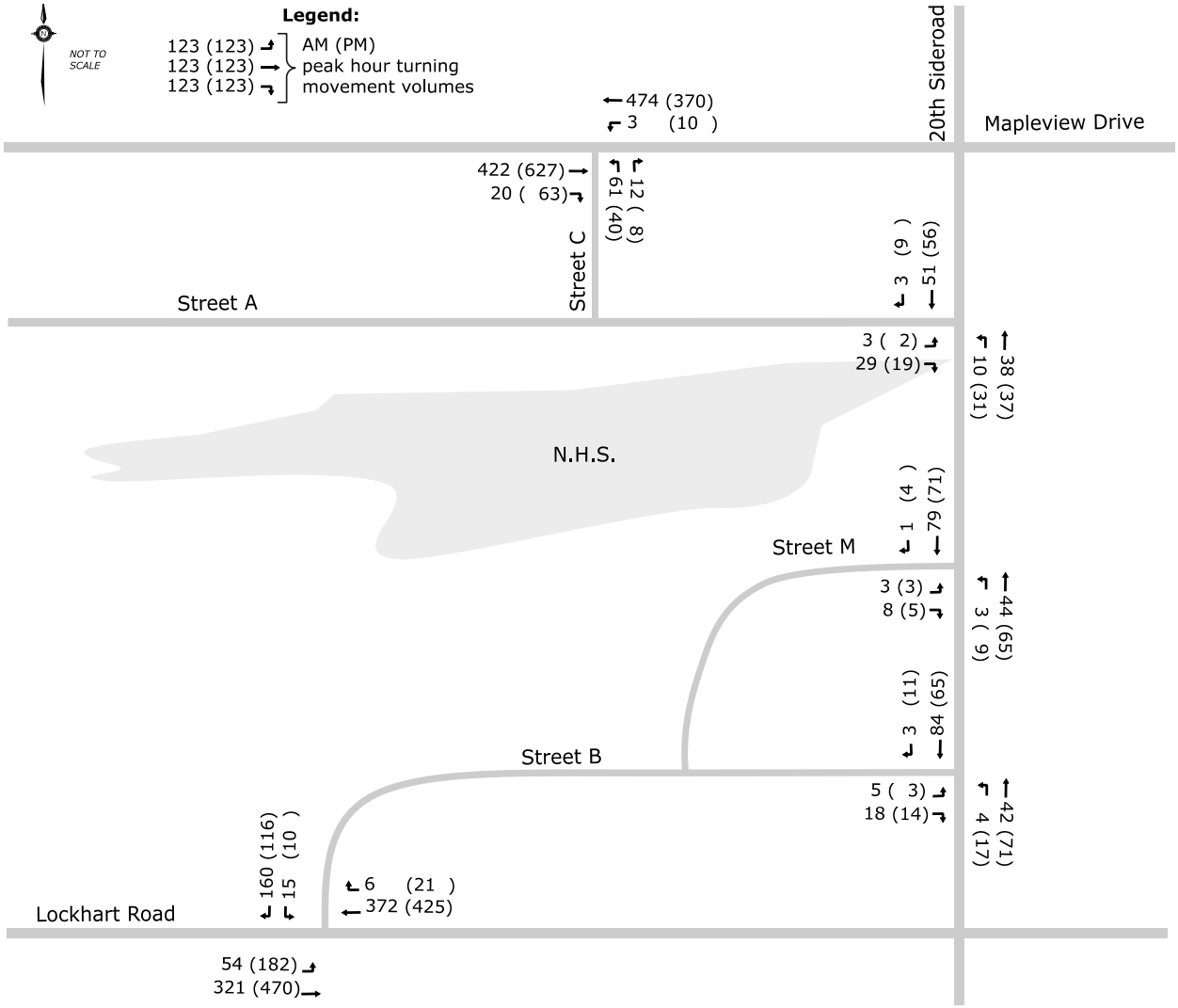
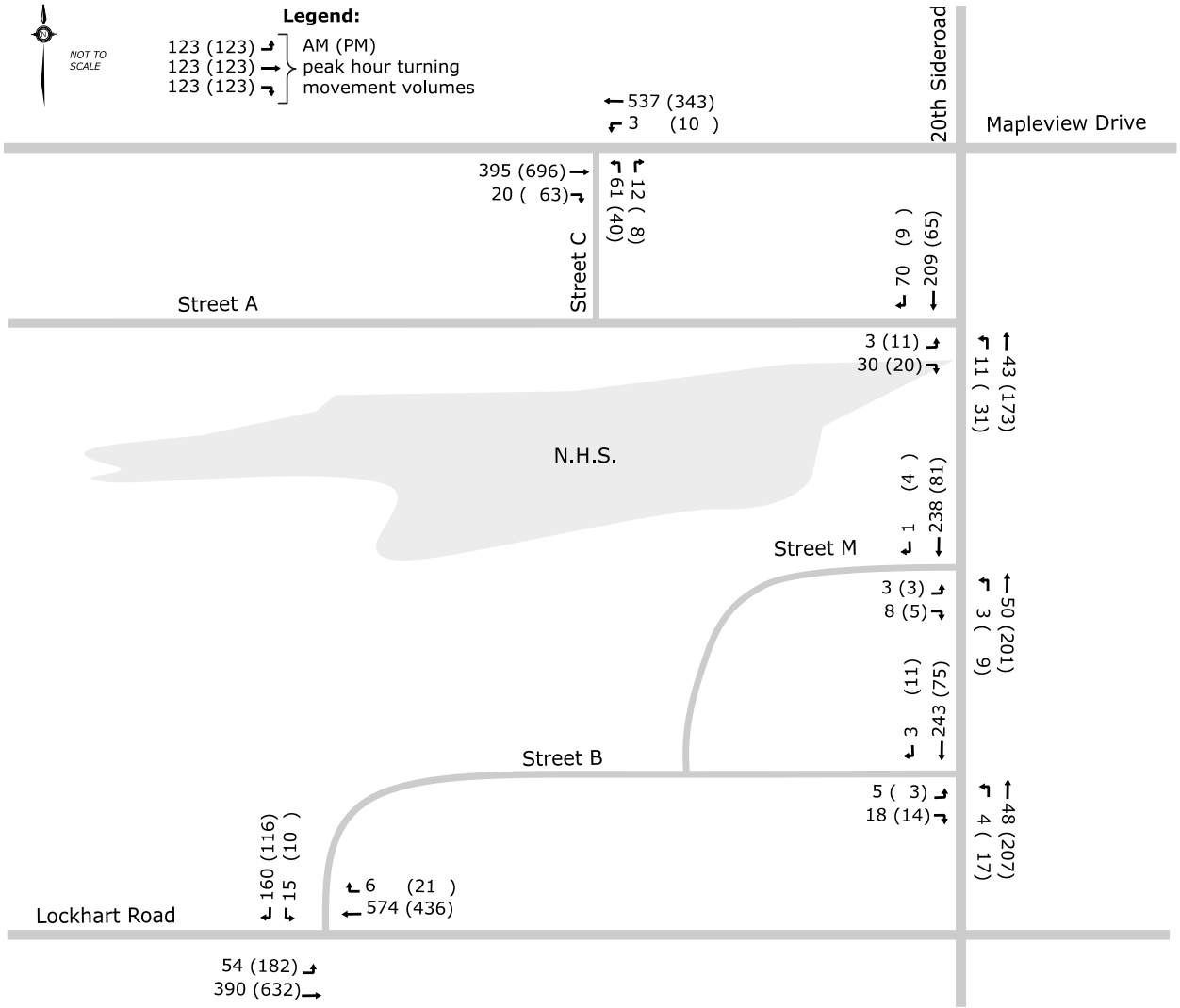


Figure 15: 2041 Total Future Traffic Volumes



3.5 Effect of School Traffic

The draft plan of subdivision includes a block for a potential elementary school in the southern portion of the subdivision. The foregoing analyses focused primarily on the effect of residential trips, details about the school are not known at this time. It is expected that a separate traffic study would be undertaken for the school site specifically once more details are known. For the purpose of this study, sensitivity testing was undertaken to estimate the potential impact of the school based on several high-level assumptions.

For analysis purposes, the school was assumed to support up to 700 students with 40 staff members, for a total of 740 person trips to the school. Vehicular access was assumed to be from Street “B”, on the north side of the school block.

School traffic trip generation was adapted from previous analyses undertaken for a comparable school in another municipality. The trip generation for that site was based on the following assumptions and calculations:

- General assumptions:
  - On any given day, 5% of students will be absent (i.e., 665 students will be on site) and all 40 staff members will be present.
  - All staff members will drive to work; the modal split for student trips will be as shown in ***Table 3***.

Table 3: School Modal Split Assumptions

Travel mode	Student trips	Staff trips
Auto driver	0%	100%
Auto passenger	15%	0%
School bus	54%	0%
Walking	24%	0%
Cycling	5%	0%
Other	2%	0%

- AM peak hour student trips:
  - Canada census data indicated 44% of households have one child, while 56% of households have two or more children. An auto occupancy rate of 1.3 students per automobile was applied, resulting in 77 vehicles carrying 100 students.
  - It was assumed that the school will be serviced by six school buses. Assuming the bus mode share rate is 54%, the school is expected to generate 359 student trips by bus, for an average of 60 students per bus. A typical long school bus can carry up to 72 elementary students, assuming three students per seat.
- AM peak hour staff trips:
  - During the AM peak period, the 40 elementary school staff are anticipated to generate one vehicle trip per employee. Of the proposed 40 staff members, it was assumed that 30 will arrive during the peak hour and the other 10 will arrive before or after the peak hour.
- PM peak hour student trips:
  - It is assumed that the school will offer after-school programs, and that approximately 14% of the 665 students (93 students) would be enrolled within the after-school program. The remaining 572 students would leave the school after the bell.
  - At the end of school bell it can be expected that 66 automobiles will pick up 86 students (assuming 1.3 students per vehicle assuming a similar automobile rate of 15%).
  - There will be 50 students that take the school bus in the morning but attend an after-school program and need to be picked up in the afternoon (i.e., 14% of the 54% of students that ride the school bus in the morning).

- PM peak hour staff trips:
  - Similar to the AM peak period, it was assumed that 30 staff members will leave during the school peak hour and the remaining 10 staff members would leave during the street peak hour.

The total daily trips were calculated by adding the trips generated during the AM peak hour, the PM school peak hour, and the PM street peak hour.

Table 4 outlines the trip generation calculations and assumptions.

Table 4: School Trip Generation

	AM peak hour			PM peak hour of school			PM peak commuting hour			Daily total		
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total
Staff parking (vehicles)	30	0	30	0	30	30	0	10	10	40	40	80
School bus trips (students)	359	0	359	0	309	309	0	0	0	359	359	718
School bus trips (buses)	6	6	12	6	6	12	0	0	0	12	12	24
Student drop-off / pick-up trips (15% of students)	100	0	100	0	86	86	0	56	56	142	142	284
Student drop-off / pick-up trips (vehicles)	77	77	154	66	66	132	43	43	86	186	186	372
Walking (assume 24% of students)	160	0	160	0	137	137	0	22	22	160	160	320
Cycling (assume 5% of students)	33	0	33	0	29	29	0	5	5	34	34	68
Total person trips	682	0	682	0	591	591	0	93	93	684	684	1368
Total Autos	**107**	**77**	**184**	**66**	**96**	**162**	**43**	**53**	**96**	**226**	**226**	**452**
Total Buses	**6**	**6**	**12**	**6**	**6**	**12**	**0**	**0**	**0**	**12**	**12**	**24**
Total	**113**	**83**	**196**	**72**	**102**	**174**	**43**	**53**	**96**	**238**	**238**	**476**

The trip distribution was based on the following assumptions:

- The majority of staff trips will originate from the west;
- The majority of student pick-up and drop-off trips would be from the north (including the area of the proposed subdivision north of the natural heritage lands), with the remainder being from the west;
- Counter-peak pick-up/drop-off trips will be more heavily oriented to the west (e.g., parents heading to work after dropping off their child).

Based on the above assumptions, ***Table 5*** presents the assumed trip distribution for school trips.

Table 5: School Trip Distribution

To/from:	AM peak hour		PM peak hour		24-hour	
	In	Out	In	Out	In	Out
North	65%	35%	35%	65%	50%	50%
West	35%	65%	65%	35%	50%	50%

The trip assignment for the school was assumed to be comparable to the assignment for the residential trips in the blocks immediately surrounding the school.

Figure 16 and **Figure 17** presents the 2031 and 2041 total future traffic volumes respectively at the boundary road intersections after accounting for traffic generated by the school. **Figure 18**, **Figure 19** and **Figure 20** present the 2041 anticipated AM peak hour, PM peak hour and 24-hour volumes, respectively, on the internal streets after accounting for school trips. The PM peak hour volumes reflect the commuter peak hour, not the school peak hour which may occur during the early afternoon.

Figure 16: 2031 Total Future Traffic Volumes (With School Trips)

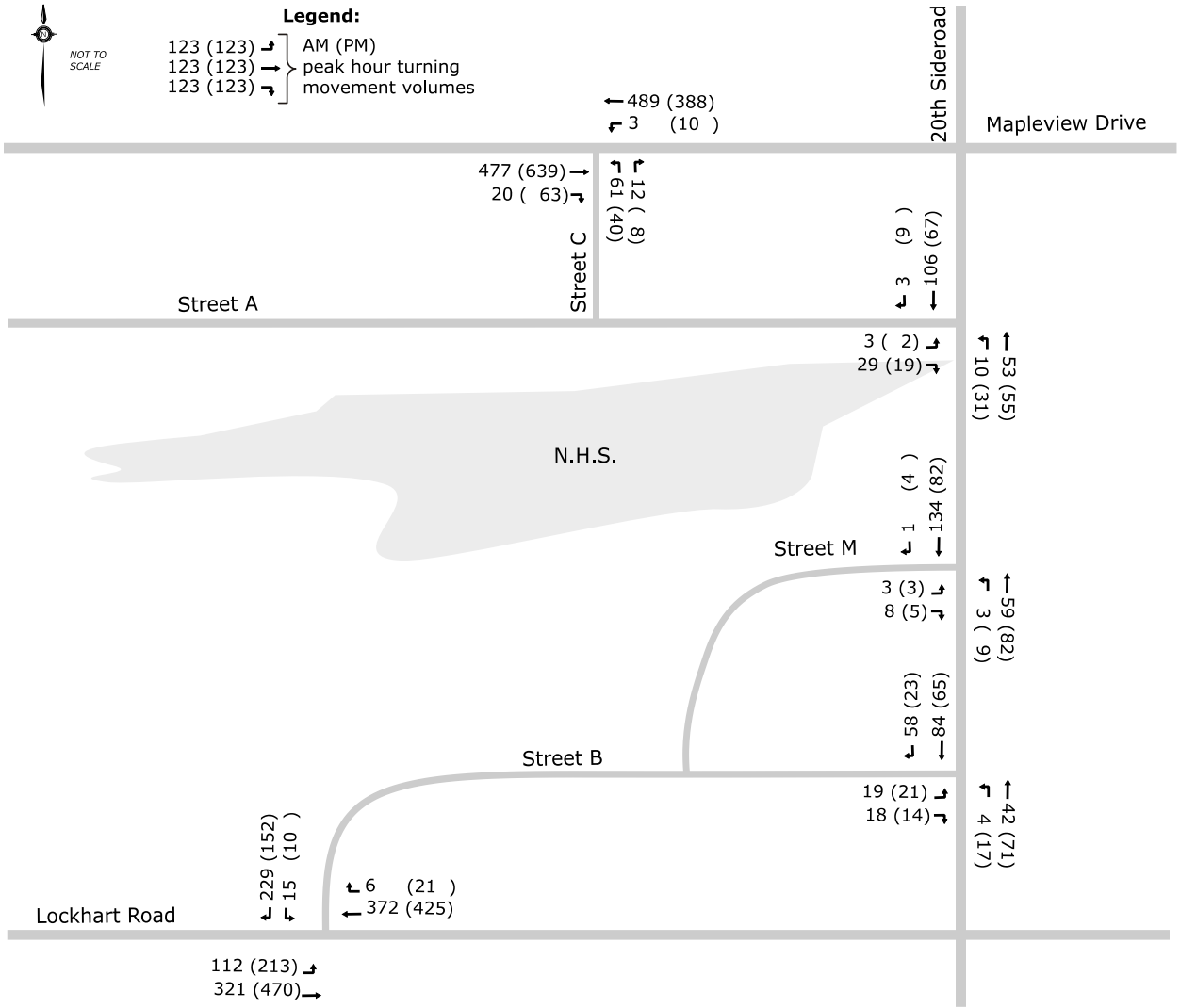


Figure 17: 2041 Total Future Traffic Volumes (With School Trips)

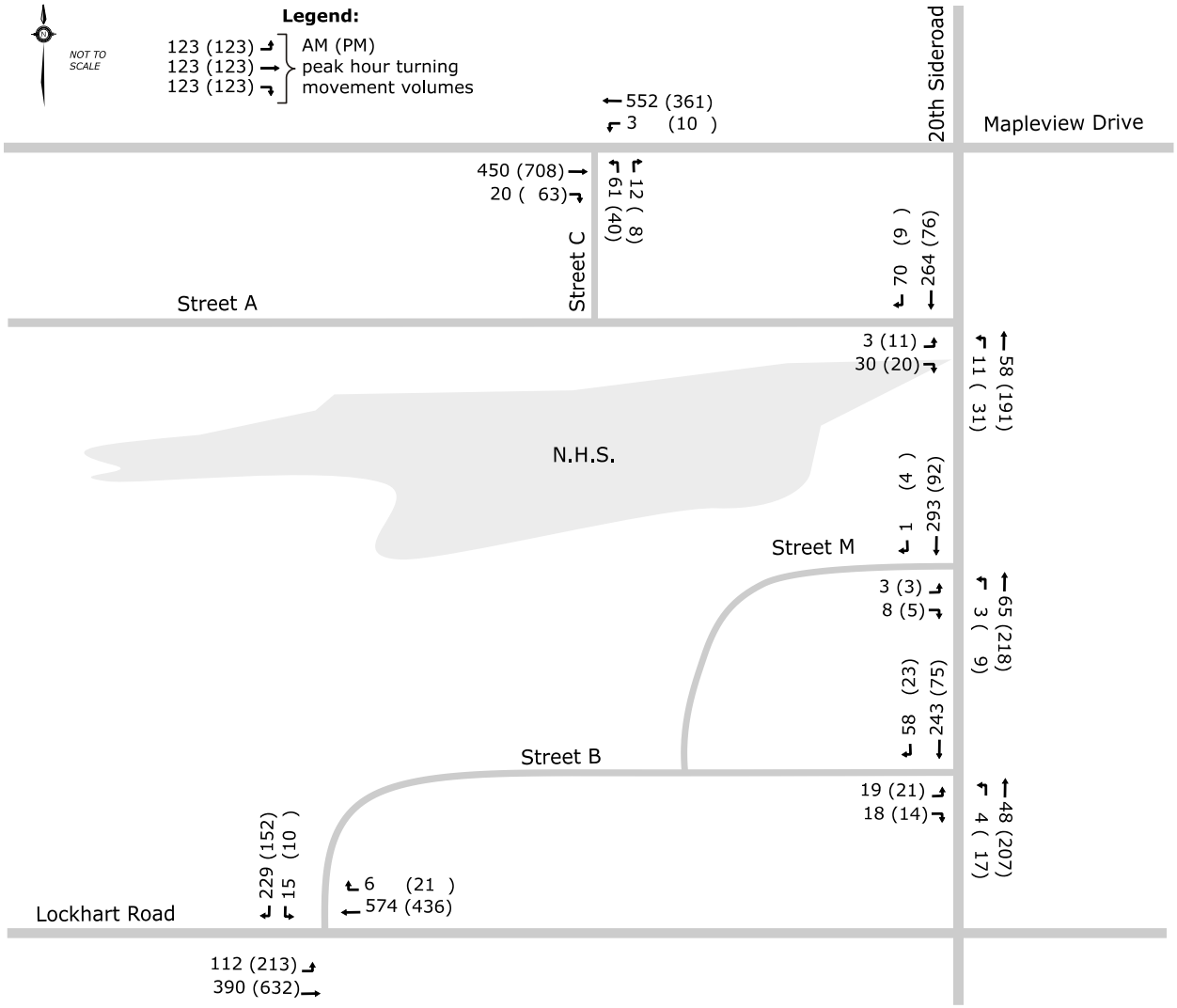


Figure 18: Internal 2041 AM Peak Hour Total Traffic Volumes (With School Trips)

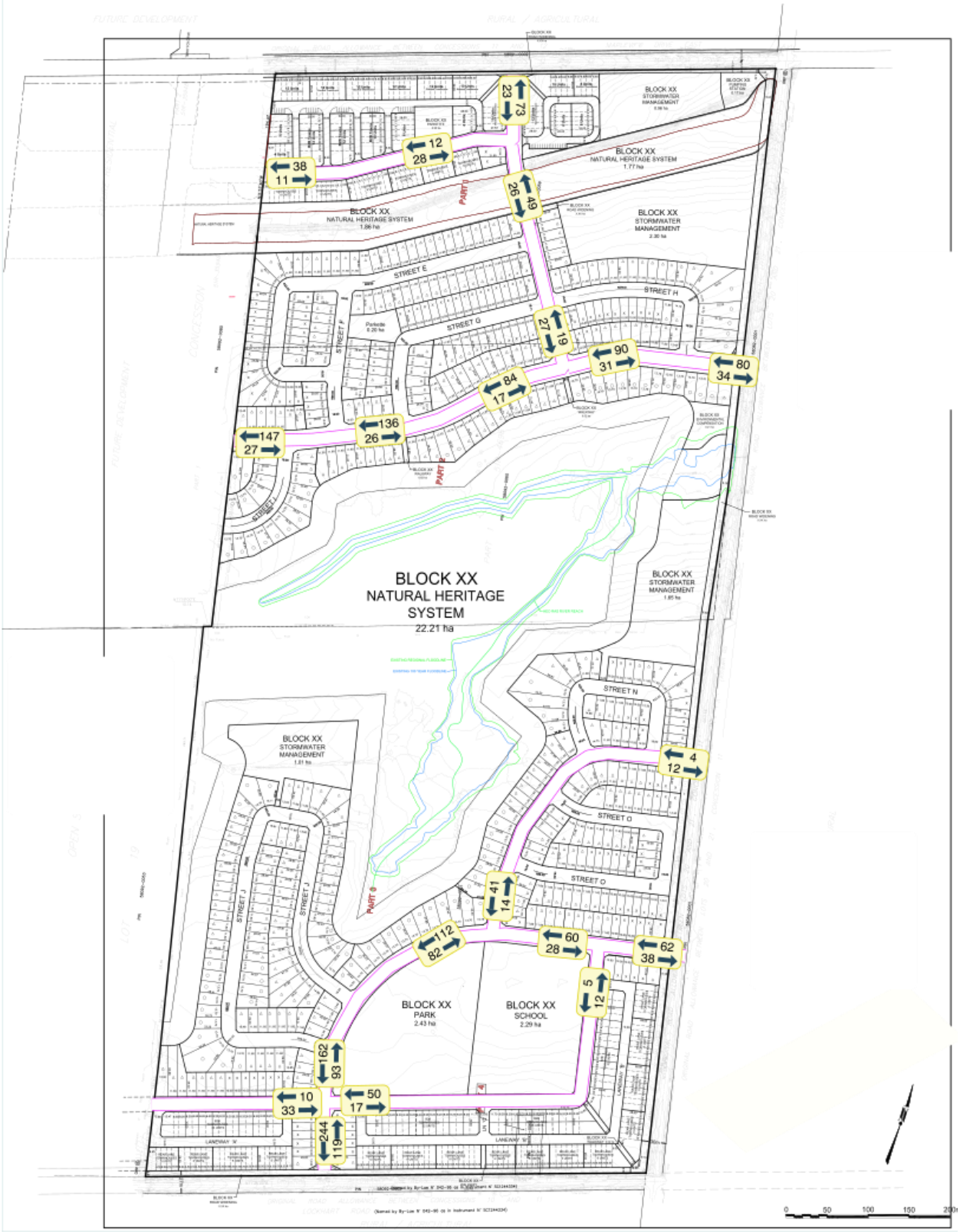


Figure 19: Internal 2041 PM Peak Hour Total Traffic Volumes (With School Trips)

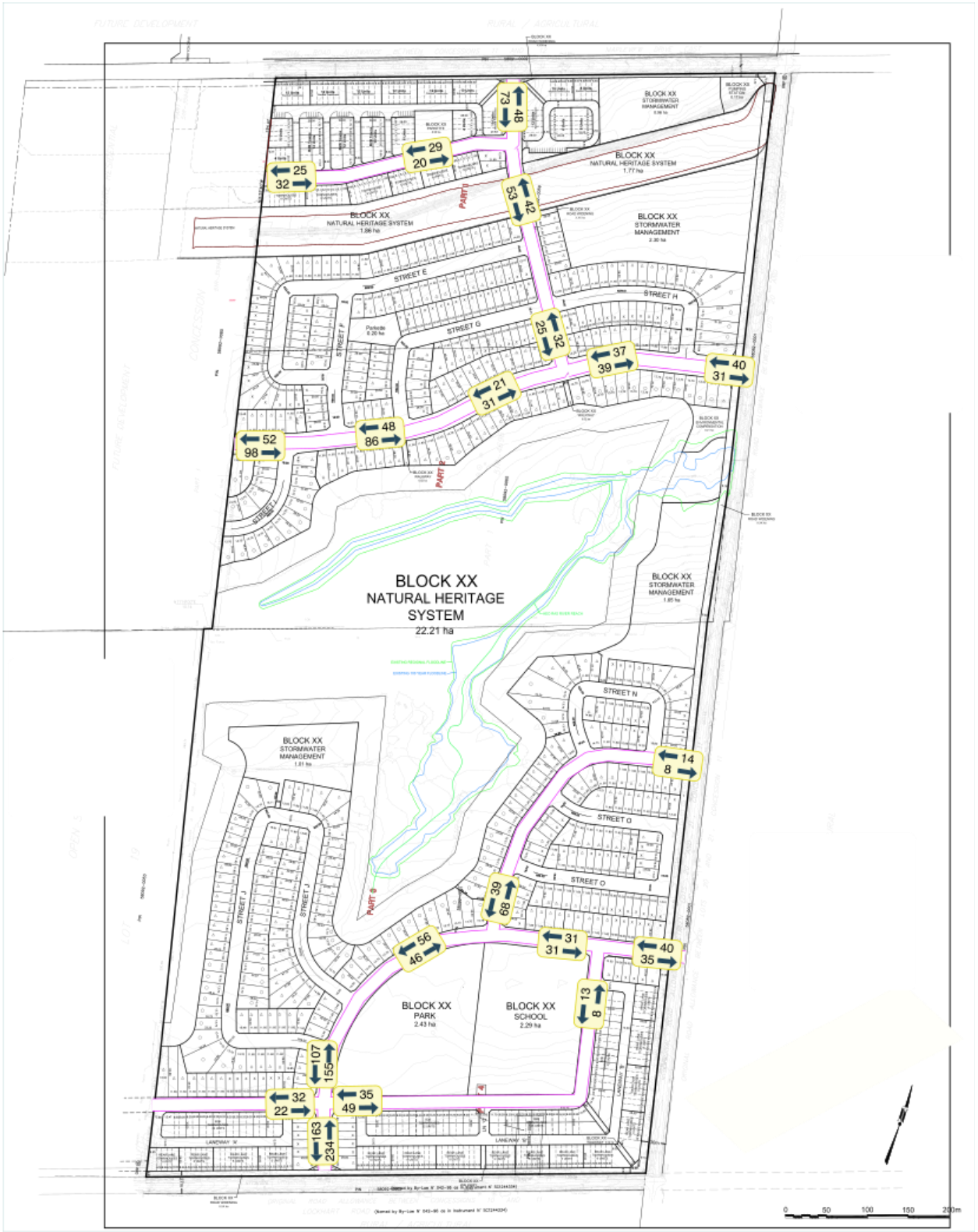
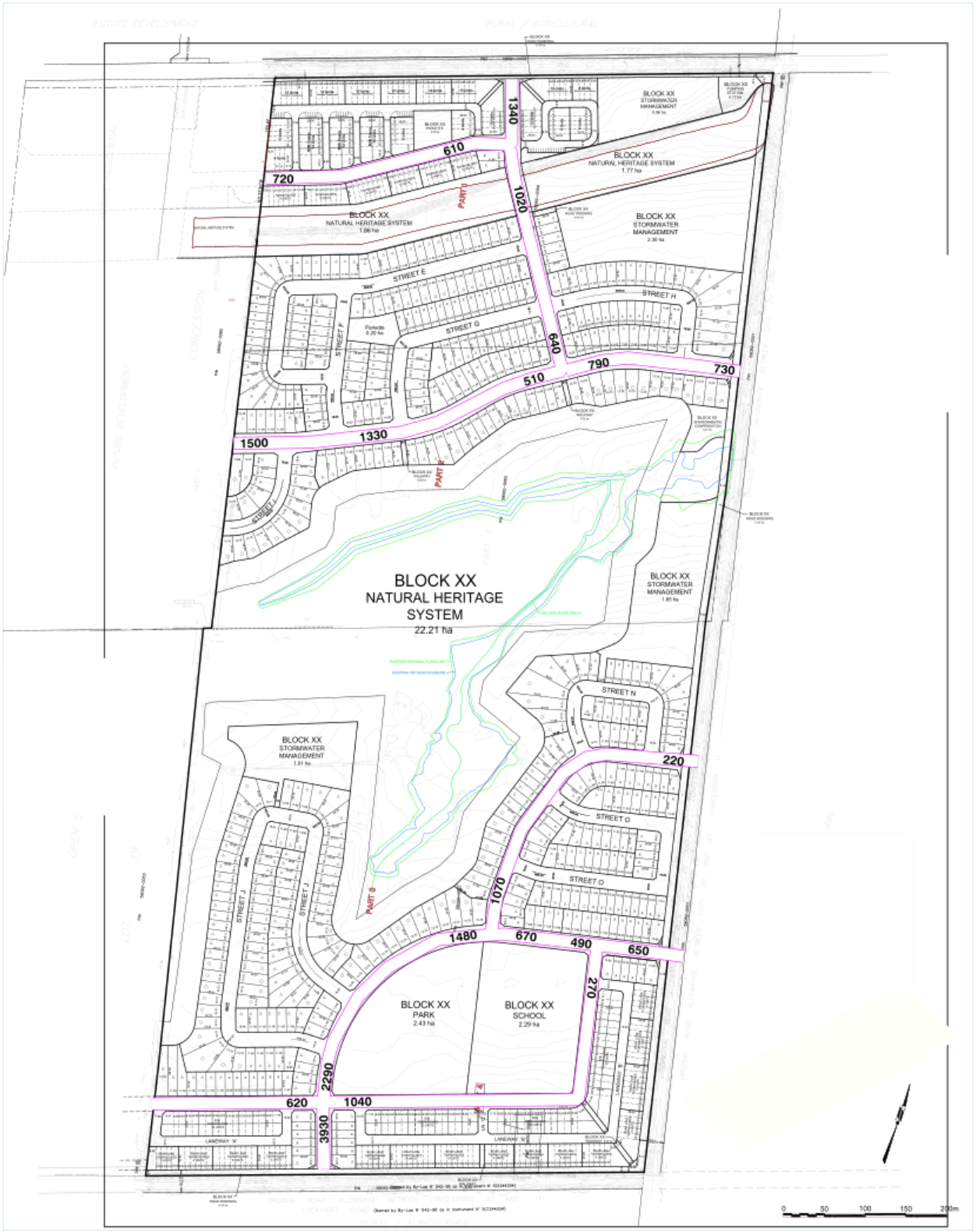


Figure 20: Internal 2041 24-Hour Total Traffic Volumes (With School Trips)



4.0 Site Access Considerations

For each of the four site accesses to the boundary road network, the following was reviewed:

- Sightlines were reviewed by way of on-site observations;
- Left turn lane warrant analyses were undertaken to determine the need for auxiliary lanes on the main street;
- Traffic signal warrant analyses were undertaken; and
- Intersection capacity and level of service analyses were undertaken.

4.1 Sightline Review

Driver sightlines were reviewed at the five external intersections to the arterial road network. The evaluation included a desktop review and in person observations, which occurred on January 11, 2023. Motorists exiting the subdivision onto the arterial road network must have sufficient sightline distance to identify a safe gap to enter into traffic.

At the proposed intersection of 20th Sideroad and Street "A", the original sight distance review was based on a previous proposed alignment of Street "A" that met 20th Sideroad at a point approximately 354 metres south of Mapleview Drive. The Street "A" intersection was subsequently relocated 15 metres southerly from its originally proposed location to increase sight distance to the north.

4.1.1 Sight Distance Requirements

The sightline evaluation was conducted following the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roadways. Chapter 9.9.2.2 of the TAC guidelines details the procedure for evaluating departure sight triangles.

Vehicles exiting the subdivision will either turn left or right from the subdivision. ***Table 6*** presents the turning sight distance requirements associated with left turns and right turns from stopped position.

Table 6: Sight Distance Requirements for Left and Right Turns from Stop

Posted speed limit *(km/h)*	Design speed *(km/h)*	Turning sight distance requirement *(m)*		
		Left turn from stop; sight distance to left*	Left turn from stop; sight distance to right*	Right turn from stop; sight distance to left**
50	60	130	130	110
60	70	150	150	130
80	100	210	210	185

Source: TAC Geometric Design Guide for Canadian Roads, June 2017, Chapter 9 ("Intersections"). See:
**Table 9.9.4: Design Intersection Sight Distance — Case 81, Left Turn From Stop.*
*** Table 9.9.6: Design Intersection Sight Distance — Case B2, Right Turn from Stop, and Case B3, Crossing Maneuver*

4.1.2 Departure Sightlines to Left

The sightlines to the left are associated both with left and right turns from the side street. Drivers turning to the left need to determine a large enough gap to cross the stream of traffic approaching from the left. Drivers turning to the right need to determine a gap large enough to enter the stream of traffic approaching from the left and accelerate without unduly impeding traffic on the main street.

Table 7 lists the required sight distance to the left to accommodate left and right turns from a stop condition at each of the arterial road intersections and provides commentary regarding the location of the proposed intersection.

Table 7: Departure Sightlines to Left

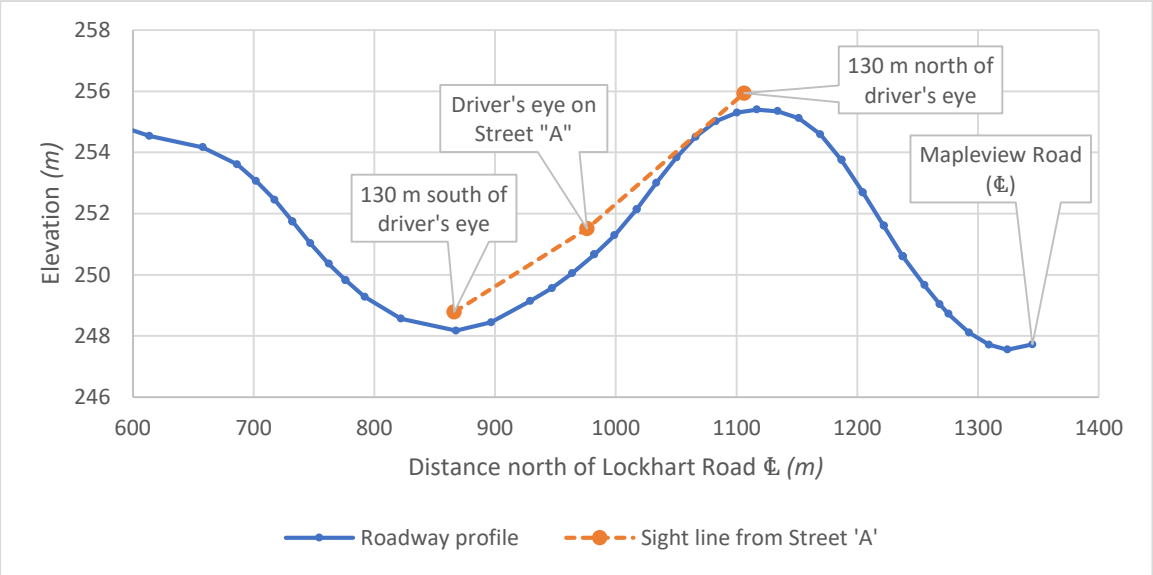
Intersection	Posted Speed Limit / Design Speed *(km/h)*	Departure Sight Distance Requirement	Comment
Mapleview Drive and Street "C"	60 / 70	150 m for left turns 130 m for right turns	Intersection location provides adequate sight distance to the left
20th Sideroad and Street "A"	80 / 100	210 m for left turns 185 m for right turns	Turning sight distance deficiencies were observed at the proposed Street "A" for a motorist sitting on Street "A" looking north on 20th Sideroad. The measured turning sight distance from the current intersection location is approximately 130 metres, which is well below the recommended distance for the existing posted speed limit.
20th Sideroad and Street "M"	80 /100	210 m for left turns 185 m for right turns	Intersection location provides adequate sight distance to the left
20th Sideroad and Street "B"	80 /100	210 m for left turns 185 m for right turns	Intersection location provides adequate sight distance to the left
Lockhart Road and Street "B"	80 /100	210 m for left turns 185 m for right turns	Intersection location provides adequate sight distance to the left

Figure 21 illustrates the sightline to the left from Street "A" at 20th Sideroad, based on the intersection's originally proposed location. The view of oncoming vehicles is obscured by the vertical curve to the north of Street "A". The limited sight distance has been partially mitigated by relocating Street "A" approximately 15 metres farther south so that southbound vehicles can be seen for a longer distance after crossing the crest of the vertical curve. To further mitigate the reduced sight distance, the posted speed limit on 20th Sideroad should be reduced to 50 km/h from Mapleview Drive to just south of Street "A". With the speed limit reduced to 50 km/h, the revised (i.e., currently proposed) intersection location meets TAC's departure sightline distance requirements for both left and right turns from Street "A". ***Figure 22*** illustrates the vertical sightlines along 20th Sideroad from the perspective of a motorist stopped at the current proposed Street "A" location, based on a profile developed from the surveyed contour lines and elevations specified in the TAC guidelines (1.05 m for the driver's eye height; 0.6 m for the height of the headlights of an approaching vehicle).

Figure 21: 20th Sideroad Looking North from Street "A"

Note: Image taken from originally proposed location of Street "A"

Figure 22: 20th Sideroad Profile Showing Sightlines from Street "A"



4.1.3 Departure Sightlines to Right

The sightlines to the right are associated only with left turns from the side street. Drivers turning to the left need to determine a gap large enough to enter the stream of traffic approaching from the right and accelerate without unduly impeding traffic on the main street.

Table 8 lists the required sight distance to the right to accommodate left turns from a stop condition at each of the arterial road intersections and provides commentary regarding the location of the proposed intersection. Each of the intersections provides adequate sight distance to the right.

Table 8: Departure Sight Distance to Right

Intersection	Posted Speed Limit / Design Speed *(km/h)*	Departure Sight Distance Requirement	Comment
Mapleview Drive and Street "C"	60 / 70	130 m for left turns	Intersection location provides adequate sight distance to the right
20th Sideroad and Street "A"	80 / 100	185 m for left turns	Intersection location provides adequate sight distance to the right
20th Sideroad and Street "M"	80 /100	185 m for left turns	Intersection location provides adequate sight distance to the right
20th Sideroad and Street "B"	80 /100	185 m for left turns	Intersection location provides adequate sight distance to the right
Lockhart Road and Street "B"	80 /100	185 m for left turns	Intersection location provides adequate sight distance to the right

4.2 Left Turn Lane Warrant Analyses

Left turn lane warrant analyses were undertaken to assess whether left turn lanes should be provided on the existing arterial roads at the proposed site access points. The assessment was undertaken using the MTO left turn lane warrant methodology. **Table 9** presents the parameters applied in the analyses; the left-turn warrant nomographs are presented in **Appendix E**.

At 20th Sideroad and Street "A", the left turn lane warrants were based on the existing 80 km/h posted speed limit (100 km/h design speed). As noted in ***Section 4.1.2***, it is recommended that the speed limit on 20th Sideroad be reduced to 50 km/h in the vicinity of this intersection and the section to the north. Assessing the left turn lane requirement based on the higher existing speed limit will result in a conservative assessment (i.e., if a left turn lane is not warranted for an 80 km/h speed limit, it would also not be warranted for a 50 km/h speed limit).

The following intersections warrant left turn lanes:

- On Mapleview Drive, a westbound left turn lane with 15 metres of storage will be warranted at Street "C".
- On Lockhart Road, an eastbound left turn lane with 65 metres of storage will be warranted at Street "B".
- On 20th Sideroad, northbound left turn lanes will not be warranted at Street "A", Street "M" or at Street "B".

Table 9: Left Turn Lane Warrant Analysis Results

Peak Hour	Scenario	Design speed *(km/h)*	V_A *(vph)*	V_O *(vph)*	V_{LT} *(vph)*	% left turns in V_A	Left turn lane warranted?	Storage length *(m)*
Mapleview Drive at Street "C" — westbound left turn								
AM	2031	80	478	442	5	1%	Yes	15
	2041	80	541	415	3	1%	Yes	15
	2041 with school	80	555	470	6	1%	Yes	15
PM	2031	80	380	690	11	3%	Yes	15
	2041	80	353	759	11	3%	Yes	15
	2041 with school	80	371	771	11	3%	Yes	15
20th Sideroad at Street "A" — northbound left turn								
AM	2031	100	48	54	8	20%	No	-
	2041	100	54	279	10	20%	No	-
	2041 with school	100	68	334	10	15%	No	-
PM	2031	100	68	65	31	45%	No	-
	2041	100	204	74	31	15%	No	-
	2041 with school	100	221	85	31	14%	No	-
20th Sideroad at Street "M" – northbound left turn								
AM	2031	100	47	80	3	7%	No	-
	2041	100	53	239	3	6%	No	-
	2041 with school	100	68	294	3	5%	No	
PM	2031	100	74	74	9	12%	No	-
	2041	100	210	85	9	5%	No	-
	2041 with school	100	227	96	9	4%	No	-
20th Sideroad at Street "B" – northbound left turn								
AM	2031	100	47	87	4	9%	No	-
	2041	100	53	246	4	8%	No	-
	2041 with school	100	53	301	4	8%	No	
PM	2031	100	88	76	17	19%	No	-
	2041	100	224	86	17	8%	No	-
	2041 with school	100	224	97	17	8%	No	-
Lockhart Road at Street "B" – eastbound left turn								
AM	2031	80	375	379	54	15%	Yes	15
	2041	80	444	581	54	12%	Yes	25

Peak Hour	Scenario	Design speed (km/h)	V_A (vph)	V_O (vph)	V_{LT} (vph)	% left turns in V_A	Left turn lane warranted?	Storage length (m)
PM	2041 with school	80	502	581	112	22%	Yes	40
	2031	80	652	446	182	28%	Yes	50
	2041	80	814	457	182	22%	Yes	50
	2041 with school	80	845	457	213	25%	Yes	65

4.3 Right Turn Lane Requirements

The TAC Geometric Design Guide indicates that a right-turn lane should be considered at unsignalized or signalized intersections as follows:

Unsignalized Intersections	When the volume of decelerating or accelerating vehicles compared with the through traffic volume causes undue hazard.
Signalized Intersections	Right-turn lane without separate signal indication when the volume of right-turning traffic is 10-20% of the total approaching volume

At the intersection of 20th Sideroad and Street "A", a southbound right turn lane was considered due to the reduced sightlines associated with the vertical curve. The 2041 AM peak hour projected traffic volumes indicates 70 right turning vehicles, however the majority of these vehicles were forecast from the transportation model and were passing through to lands to the west. The lands to the west are primarily residential in nature and are unlikely to generate high inbound volumes during the AM peak hour. As such, a southbound right turn lane on 20th Sideroad at Street "A" is deemed not required.

It is recommended that an eastbound right turn lane be provided on Mapleview Drive at Street "C" due to the projected high eastbound through lane volumes and potential conflicts with right turning traffic.

The implementation of a right turn lane is not required at the following intersections:

- 20th Side Road at Street "M";
- 20th Side Road at Street "B"; and,
- Lockhart Road at Street "B".

4.4 Traffic Signal Warrant Analyses

The projected total future traffic volumes were reviewed to determine whether they would justify the installation of traffic signals. Analyses were undertaken using the traffic signal warrant methodology outlined in the *Ontario Traffic Manual* (OTM), Book 12 ("Traffic Signals"). The five site access intersections currently do not exist, and as such the analyses were based on Justification 7 ("Projected

Volumes"), with either the volume or delay component of the warrant required to be met to 150%. "Average hour" volumes were used in the analyses, defined in OTM Book 12 as the sum of the AM and PM peak hour volumes, divided by four.

The signal warrant thresholds, the applicable volumes and the justification results are presented in the following tables:

-
- **Table** 10 presents the results at Mapleview Drive and Street "C";
- **Table 11** presents the results at 20th Sideroad and Street "A";
- **Table 12** presents the results at 20th Sideroad and Street "M";
- **Table 13** presents the results at 20th Sideroad and Street "B"; and
- **Table 14** presents the results at Lockhart Road and Street "B".

Table 10: Signal Warrant Analyses — Mapleview Drive at Street "C"

	2041 total future (residential only)					2041 total future (with school)				
	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% compliance	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% Compliance
Justification 1: Intersection Volume										
1a: Total traffic	720	1028	1160	547	76%	720	1098	1189	572	79%
1b: Minor street	255	73	48	30	12%	255	73	48	30	12%
Overall:					12%					12%
Signal warranted?					No					No
Justification 2: Delay to Cross Traffic										
2a: Major street	720	956	1112	517	72%	720	1026	1141	542	75%
2b: Crossing traffic	75	61	40	25	34%	75	61	40	25	34%
Overall:					34%					34%
Signal warranted?					No					No

Table 11: Signal Warrant Analyses — 20th Sideroad at Street "A"

	2041 total future (residential only)					2041 total future (with school)				
	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% compliance	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% Compliance
Justification 1: Intersection Volume										
1a: Total traffic	720	367	310	169	23%	720	436	338	194	27%
1b: Minor street	255	34	31	16	6%	255	34	31	16	6%
Overall:					6%					6%
Signal warranted?					No					No
Justification 2: Delay to Cross Traffic										
2a: Major street	720	333	278	153	21%	720	403	307	177	25%
2b: Crossing traffic	75	3	11	4	5%	75	3	11	4	5%
Overall:					5%					5%
Signal warranted?					No					No

Table 12: Signal Warrant Analyses — 20th Sideroad at Street "M"

	2041 total future (residential only)					2041 total future (with school)				
	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% compliance	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% Compliance
Justification 1: Intersection Volume										
1a: Total traffic	720	304	304	152	21%	720	374	332	176	25%
1b: Minor street	255	12	8	5	2%	255	12	8	5	2%
Overall:					2%					2%
Signal warranted?					No					No
Justification 2: Delay to Cross Traffic										
2a: Major street	720	293	295	147	20%	720	362	324	171	24%
2b: Crossing traffic	75	3	3	2	2%	75	3	3	2	2%
Overall:					2%					2%
Signal warranted?					No					No

Table 13: Signal Warrant Analyses — 20th Sideroad at Street "B"

	2041 total future (residential only)					2041 total future (with school)				
	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% compliance	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% Compliance
Justification 1: Intersection Volume										
1a: Total traffic	720	322	328	162	23%	720	391	356	187	26%
1b: Minor street	255	23	18	10	4%	75	38	35	18	7%
Overall:					4%					7%
Signal warranted?					No					No
Justification 2: Delay to Cross Traffic										
2a: Major street	720	299	310	152	21%	720	292	281	143	20%
2b: Crossing traffic	75	5	3	2	3%	720	354	321	169	23%
Overall:					3%	75	19	21	10	13%
Signal warranted?					No					13%

Table 14: Signal Warrant Analyses — Lockhart Road at Street "B"

	2041 total future (residential only)					2041 total future (with school)				
	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% compliance	Minimum required	AM peak hour	PM peak hour	Avg. hourly volume	% Compliance
Justification 1: Intersection Volume										
1a: Total traffic	720	1200	1397	649	90%	720	1327	1465	698	97%
1b: Minor street	255	175	127	76	30%	255	244	163	102	40%
Overall:					30%					40%
Signal warranted?					No					No
Justification 2: Delay to Cross Traffic										
2a: Major street	720	1025	1270	574	80%	720	1083	1302	596	83%
2b: Crossing traffic	75	15	10	6	9%	75	15	10	6	9%
Overall:					9%					9%
Signal warranted?					No					No

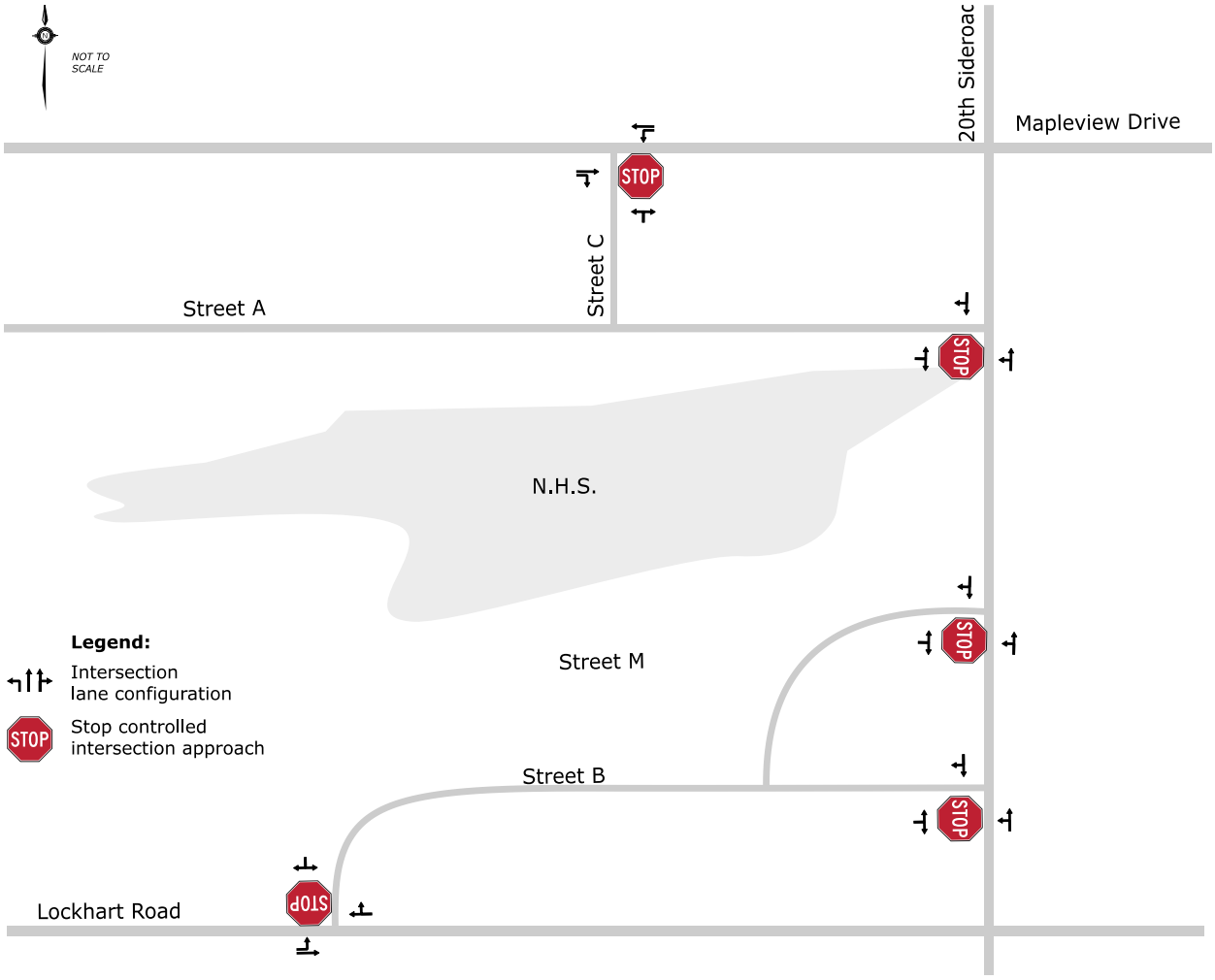
The signal warrant analyses indicate that the projected volumes would not warrant traffic signals at any of the five site access intersections.

4.5 Intersection Operational Analyses

Intersection operational analyses were completed for the study area intersections using Trafficware's Synchro software (version 11).

None of the site access intersections were found to warrant traffic signals (see ***Section 4.4)***, and as such the intersections were all analyzed assuming two-way stop control (stop sign controlled on the side street approach). Left turn lanes were assumed on the main street where warranted (see ***Section 0***). Single-lane approaches were assumed on the side street approaches.
Figure 23 illustrates the presumed lane configuration and traffic regulation.

Figure 23: Assumed Lane Geometry and Traffic Control



At each intersection, the v/c ratio, delay, level of service and 95th percentile queue were noted for the stop-controlled movements, and any critical movements were identified. Level of service definitions are provided in **Appendix F**. Synchro analysis worksheets reports are provided in **Appendix G**. At unsignalized intersections, the City of Barrie defines an individual movement or lane group as being critical when it reaches LOS F.

Table 15 presents the results of the intersection operational analyses.

Table 15: Projected Future Intersection Operations

	Movement	AM peak hour				PM peak hour			
		v/c	LOS	Delay *(s/veh)*	95th %ile queue *(m)*	v/c	LOS	Delay *(s/veh)*	95th %ile queue *(m)*
Mapleview Drive at Street "C"	**2031 total future**								
	NB approach	0.26	C	21.0	8.2	0.21	C	23.0	6.1
	2041 total future (residential trips only)								
	NB approach	0.27	C	22.0	8.6	0.22	C	24.7	6.6
	2041 total future (with school trips)								
	NB approach	0.30	C	24.6	9.9	0.23	D	25.7	6.9
20th Sideroad at Street "A"	**2031 total future**								
	EB approach	0.04	A	8.7	0.9	0.02	A	8.8	0.6
	2041 total future (residential trips only)								
	EB approach	0.05	A	10.0	1.2	0.04	A	9.5	1.0
	2041 total future (with school trips)								
	EB approach	0.05	B	10.4	1.3	0.04	A	9.6	1.1
20th Sideroad at Street "M"	**2031 total future**								
	EB approach	0.01	A	8.9	0.3	0.01	A	9.0	0.2
	2041 total future (residential trips only)								
	EB approach	0.02	A	9.9	0.4	0.01	A	9.4	0.2
	2041 total future (with school trips)								
	EB approach	0.02	A	10.3	0.4	0.01	A	9.5	0.2
20th Sideroad at Street "B"	**2031 total future**								
	EB approach	0.03	A	8.9	0.7	0.02	A	8.9	0.5
	2041 total future (residential trips only)								
	EB approach	0.03	A	10.0	0.8	0.02	A	9.1	0.5
	2041 total future (with school trips)								
	EB approach	0.06	B	10.6	1.5	0.05	B	10.2	1.3

	Movement	AM peak hour				PM peak hour			
		v/c	LOS	Delay *(s/veh)*	95th %ile queue *(m)*	v/c	LOS	Delay *(s/veh)*	95th %ile queue *(m)*
Lockhart Road at Street "B"	**2031 total future**								
	SB approach	0.32	B	14.0	11.1	0.30	C	16.1	9.9
	2041 total future (residential trips only)								
	SB approach	0.44	C	19.7	17.6	0.33	C	17.7	11.2
	2041 total future (with school trips)								
	SB approach	0.62	D	26.0	32.4	0.41	C	19.1	15.7

The analyses indicate that the side street approaches to Mapleview Drive and to Lockhart Road are anticipated to operate at acceptable levels of service (LOS D or better), and the side street approaches to 20th Sideroad are anticipated to operate at good levels of service (LOS B or better). All stop-controlled movements are anticipated to operate well within capacity. The southbound queues on Street "B" at Lockhart Road are anticipated to reach approximately five vehicles in length; all other queues are anticipated to reach one to two vehicles in length. The results of the capacity analysis indicate that a side street single lane approach provides adequate traffic operations and there is no need from a capacity perspective to provide separate left and right turn lanes on the side street approaches.

5.0 Internal Road Network Considerations

The internal road network was reviewed to identify the following:

- Roadway classification;
- Typical roadway cross-sections (based on City policies and standards); and
- Potential need and/or opportunities for traffic calming measures.

The City has indicated that they will determine intersection control within the subdivision. The location of sidewalks is to be provided by the Landscape Architect. As such, these factors have not been reviewed as part of this study.

5.1 Road Classification

The City of Barrie's Transportation Design Manual lists typical characteristics of residential collector and residential local roadways, providing guidance on where the roadways general function, traffic volumes and access characteristics suggest that a collector road classification would be appropriate. These characteristics are listed in **Table 16**.

Table 16: Residential Roadway Characteristics by Functional Classification

Characteristic	Residential Collector	Residential Local
General function	Carries moderate traffic volumes between arterial and local roads	Carries low traffic volumes, providing access to abutting lands
Volume of traffic, typical both directions, in vehicles per day (vpd)	Less than 8,000 vpd	Less than 1,000 vpd
Intersection and access	Intersection with arterial, collector and local roads. Access may be restricted to right-in/ right-out only	Intersection with collector and local roads (arterial roads discouraged). No access restrictions

Source: Adapted from City of Barrie Transportation Design Manual, Table 1: Characteristics of Typical Roadway Cross Sections

The City's Official Plan Mobility Network Map 4B identifies a single collector road within the subdivision. Street "A" is illustrated schematically as beginning in the east at 20th Sideroad, just north of the natural heritage block, and extending westerly through the subdivisions, west of the subject lands. The proposed draft plan of subdivision indicates a 24-metre right-of-way for Street "A", and 18-metre rights-of-way for most local streets, consistent with the road network designated in the Official Plan. There are also laneways to multi-family blocks providing 8.5 metre rights-of-way. Streets B and C are proposed as minor collector roadways with a reduced 20-metre right-of-way.

On the basis of projected roadway volumes alone (see **Figure 20**), the following additional streets are anticipated to exceed the 1,000 vehicle per day upper guideline for local streets:

- Street "A" (OP designated residential collector roadway) — west of Street "G";
- Street "C" — north of Street "E" (approximately 200 metres); and
- Street "B" — between Lockhart Road and Street "M" (approximately 400 metres).

A collector road network on the basis of projected daily volumes only, as described above, would be discontinuous. When considering the other characteristics (roadway function; intersection and access characteristics), as well as general connectivity considerations, it would be appropriate for Streets "C" and "B" to be designated as collector roads in their entirety, and for the remaining streets to be designated as local roads or laneways as per the draft plan.

5.2 Internal Roadway Cross-Sections

General roadway cross-sections within the study area are identified in the following sources:

- The Hewitt's Secondary Plan[1] provides general guidelines for street characteristics within the secondary plan area; and
- The City's Transportation Design Manual provides detailed cross-sections for new residential local and collector roads across Barrie.

5.2.1 Hewitt's Secondary Plan

The following policies apply from the Hewitt's Secondary Plan:

- Sidewalks shall generally be provided on both sides of all streets with the exception of the following where sidewalks shall only be required on one side of the street:
  - Residential streets with less than ten dwelling units or culs-de-sac;
  - Window streets; and
  - A street flanking the Natural Heritage System or a public park.
- The City may also give consideration to permitting one sidewalk on some additional Local Streets where the City is satisfied through the submission of a pedestrian circulation plan that only one sidewalk is necessary and provided that the street is not a transit route, does not provide direct access to a school, shopping area, park or Village Square, and the street has a maximum right-of way width of 18 metres. The geographic extent of the pedestrian circulation plan shall be sufficient to demonstrate how the above conditions are met, as well as the relationship of the area to the transit system, community facilities and shopping areas.
- Provision for cyclists to travel either on the street or on pathways separated from the street system, which may or may not include a designated lane, shall be recognized in the design of all

[1] The Hewitt's Secondary Plan is no longer formally in effect after having been rolled into the City's new Official Plan. However, the policies and principles have been referenced in this report because they were in effect at the time the draft plan of subdivision was originally developed.

arterial and collector streets. A system of pathways will be developed primarily in the Natural Heritage System based on the conceptual system on Schedule 9D1. The pathway system shall be subject to further study to the satisfaction of the City, in consultation with the applicable conservation authority and the landowners.

- City streets shall be planned and developed as multi-modal transportation corridors that are designed within an urban cross section to safely accommodate pedestrian, bicycle, transit and vehicular movement for people of all ages and abilities, as well as complying with the City's streetscaping design policies in Section 9.4.4.4. Such facilities shall generally be designed to conform to the following standards and the other applicable policies of this Secondary Plan. Transportation facilities shall also be consistent with the recommendations of the City of Barrie Multi-Modal Active Transportation Master Plan (Transportation Master Plan).

Table 17: Hewitt's Secondary Plan Roadway Characteristics

Roadway Classification	*No. of Travel Lanes*	*Right-of-Way Width*	*Access*	*Parking*
Minor Collectors	2 maximum	24 metres maximum	Direct access from individual properties except adjacent to intersections or in areas such as adjacent to schools requiring access control	On street parking permitted
Local Streets	2 maximum	20 metres maximum	Direct access from individual properties	On street parking permitted
Window Road	2 maximum	16 metres maximum	Direct access from individual properties	On-street parking permitted
Lane/Service Road	2 maximum	7.5 metres maximum with a 0.75 setback for residential properties and 12 metres with a 1 m setback for commercial properties	Direct access for individual properties	No on-street parking

5.2.2 City of Barrie Transportation Design Manual

The City Transportation Design Manual standards are indicated in provided in **Table 18**. The Standard Road Drawings are provided in **Appendix D** for the local roadways and 24-metre residential Minor Collector Road.

Table 18: City of Barrie Widths of Typical Roadway Cross Sections

Road Type	ROW Width (m)	Pavement Width (m)	Sidewalk Width (m)	Number of Lanes	Standard Drawing
Local Roads					
18.0m Local Road Allowance Residential	18.0	8.0	1.5	2	BSD-301
20.0m Local Road Allowance Industrial	20.0	9.4	1.5	2	BSD-302
Collector Roads					
24.0m Minor Collector Road Allowance Residential	24.0	12.5	2.0	2	BSD-303
25.0m Minor Collector Road Allowance Industrial	25.0	13.25	2.0	3	BSD-304
27.0m Major Collector Road Allowance	27.0	16.75	2.0	3	BSD-305

Source: Table 2 of the City of Barrie Transportation Design Manual

A key difference between the two guidelines/standards is the pavement allocation for collector roads. The Hewitt's Secondary Plan identifies that on-street parking will generally be permitted on minor collector roads. The standard drawing indicates two vehicular lanes and two bicycle lanes in lieu of on-street parking.

Through discussions with City Transportation staff, the City has agreed that a 20 metre minor collector road allowance may be acceptable. The City is currently reviewing the 20 metre residential collector right-of-way. A 20 metre road allowance is proposed for Streets B and C.

5.3 Traffic Calming Measures

The City endeavours to build livable neighbourhoods and streets. To achieve this, the City looks to implement their standard cross sections while supplementing traffic calming measures to ensure traffic speeds remain low.

The following are traffic calming measures that are typically endorsed by the City that have been considered for implementation within the subdivision:

- Textured crosswalks;
- Raised intersections;

- Curb extensions;
- Curb radius reductions;
- Raised median islands;
- Traffic circles; and
- Speed cushions.

Speed cushions are characterized in the City's traffic calming policy as temporary measures that would be installed on the road surface in the spring and then removed prior to the winter, although they can also be permanently installed (constructed out of asphalt, similar to speed humps). The remaining measures are characterized as permanent measures.

In retrofit scenarios, the City identifies the following guidelines for warranting traffic calming measures:

- The 85th percentile speed is greater than 10 km/h over the posted speed limit of the roadway;
- The vehicle volume is greater than 900 vehicles per day;
- The vehicle volume must be less than 5,000 vehicles per day within a 5 year horizon period; and
- The roadway is not a transit route.

For new secondary plans, the policy provides the following additional guidance:

- Roadways accessing new plans of subdivision from an arterial or major collector roadway may be required to enter a gateway traffic calming feature before connecting to internal residential roadways. The gateway feature may consist of roundabouts, large raised median islands or other form of traffic calming.
- All internal roadways should be designed in such a manner as to deter vehicles from a direct access through a residential neighbourhood. A non-linear street grid in residential neighbourhoods is encouraged to reduce through traffic and vehicle speeding.
- All internal roadways will use a combination of physical measures to deter cut through vehicles, vehicle speeding, and identify areas where pedestrians are anticipated to cross the roadway.

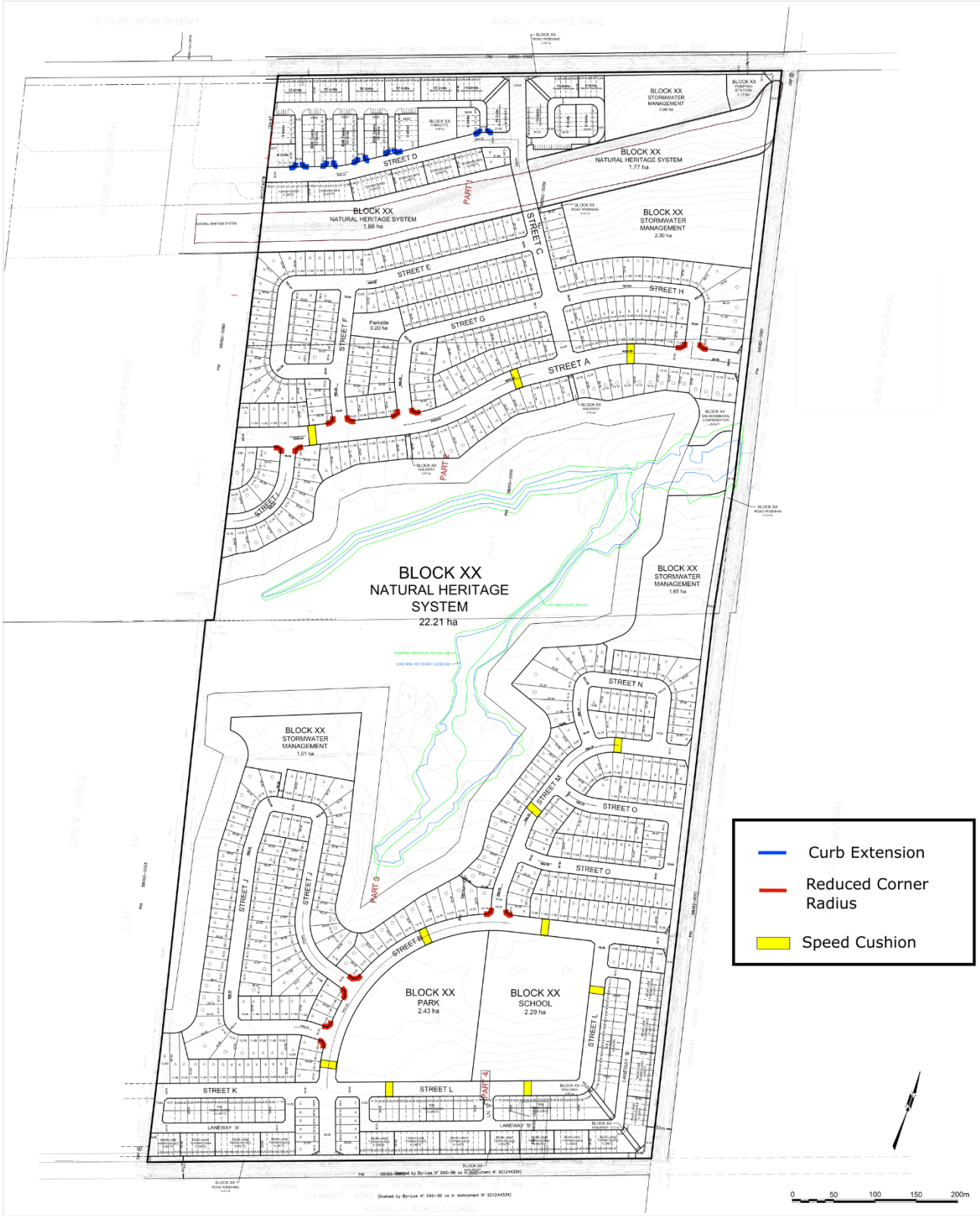
It is recommended that a mixture of speed cushions, curb extensions and corner radius reductions be implemented to calm traffic within the subdivision. **Figure 24** illustrates the proposed traffic calming plan.

Speed cushions should be implemented permanently and constructed out of asphalt on collector roadways (Streets "A", "B" and "C") as well as local Streets "L", "M" and "N".

Curb extensions should be implemented on the north side of Street "D". There are no driveways on the north side and therefore the curb extensions would reduce the roadway width while clearly defining on-street parking areas. The south side of Street "D" provides many driveway accesses with little opportunity for on-street parking and is therefore not suitable for curb extensions.

Corner radius reductions should be applied to all collector/local intersections on Street “A” and “B”, assuming Street “B” is classified as a residential collector and is to be provided with bike lanes. The wider curb-to-curb with of the collector roadway provides additional room for vehicles to manoeuvre, reducing the need for larger corner radii.

Figure 24: Proposed Traffic Calming Plan



6.0 Summary

This TIS has been prepared in support of DIV Development (Barrie) Limited application for a draft plan of subdivision. The subject lands are located along the west side of 20th Sideroad between Mapleview Drive and Lockhart Road, and are currently undeveloped. The application seeks to permit a residential subdivision containing approximately 560 single-detached dwellings and 440 townhouse dwellings within the subject lands, as well as ancillary blocks for parkland, natural heritage lands and an elementary school.

The proposed draft plan of subdivision includes a total of five access points to the arterial road network, including an access to Mapleview Drive, three accesses from 20th Sideroad, and one access to Lockhart Road. The Street M connection to 20th Sideroad has been added to provide a secondary access to the dwelling units north of Street B. Natural heritage lands bisect the plan into northern and southern development areas which are not directly connected by an internal road network, however pedestrian connections are to be provided. The northern and southern portions of the development are both provided with a single access to 20th Sideroad.

The following summarizes the recommended arterial road intersection treatments:

Mapleview Drive and Street "C"

- Traffic control signals are not required, provide Stop sign control on Street "C";
- Provide an eastbound right turn lane;
- Provide a westbound left turn lane with 15 metres of storage; and,
- Provide a single lane approach on Street "C".

20th Sideroad and Street "A"

- Traffic control signals are not required, provide Stop sign control on Street "A";
- Provide a single approach lane in each direction; and
- Request the Town of Innisfil to reduce the posted speed limit on 20th Sideroad to 50 km/h (currently at 80 km/h) from Mapleview Drive to just south of Street "A" due to sightline restrictions caused by the existing vertical road profile.

20th Sideroad and Street "M"

- Traffic control signals are not required, provide Stop sign control on Street "M"; and,
- Provide a single approach lane in each direction.

20th Sideroad and Street "B"

- Traffic control signals are not required, provide Stop sign control on Street "B"; and,
- Provide a single approach lane in each direction.

Lockhart Road and Street "B"

- Traffic control signals are not required, provide Stop sign control on Street "B"; and,
- Provide an eastbound left turn lane with 65 metres of storage;
- Provide a single southbound and westbound approach lane;
- Design a 70-meter parallel lane, with the taper length adhering to the criteria specified in *Table 9.17.1 of the TAC Geometric Design Guide for Canadian Roads*.

Internal Road Network

The proposed plan includes an internal road network that consists of residential collectors (Street "A", "B" and "C"), local and laneway streets.

Street "A" is designated as a Collector roadway, which requires a 24 metre road allowance and has been included in the draft plan.

Street "C" is indicated as a 20 metre wide Collector roadway which runs north/south between Mapleview Drive and Street "A". The forecast traffic volume slightly exceeds the local roadway designation.

Street "B" is indicated as a 20 metre wide Collector roadway which runs generally east/west between Lockhart Road and 20th Sideroad.

Traffic calming measures are recommended to keep traffic speeds within a desirable range. It is recommended that permanent speed cushions, reduced corner radii, and curb extensions be implemented as indicated on ***Figure 24***.

Appendix A

Proposed Draft Plan of Subdivision

DRAFT PLAN OF SUBDIVISION

Part of Lot 20
Concession 11
City of Barrie
Former Town of Innisfil, now
County of Simcoe

Prepared For:

DIV Development (Barrie) Ltd.

KEY PLAN

SUBJECT PROPERTY

SCHEDULE OF LAND USE

LOT/BLOCK	LAND USE		UNITS	AREA (ha)
	13.7m Single Detached		84	
	11.6m Single Detached		319	
	10.0m Single Detached		157	
	6.1m Street Townhouses		41	
	6.5m Rear Lane Townhouses		98	
	6.5m B2B Townhouses		126	
	Medium Density	Condo Townhouses	31	
		Condo Stacked Townhouses	110	
		Condo B2B Townhouses	34	
	Elementary School			
	Park			
	Parkettes			
	Walkways			
	Stormwater Management			
	Natural Heritage System			
	Pumping Station			
	Environmental Compensation			
	Servicing Block			
	Roads			
Totals			1000	

OWNER'S AUTHORIZATION

I hereby authorize Malone Given Parsons Ltd. to prepare and submit this Draft Plan of Subdivision to the City of Barrie.

DIV Developments (Barrie) Ltd. — Date

SURVEYOR'S CERTIFICATE

I hereby certify that the boundaries of the lands to be subdivided as shown on this Plan and their relationship to the adjacent lands are accurately and correctly shown.

Dan Dzaldov
DZALDOV SCHAEFFER PURCELL LTD. — Date

ADDITIONAL INFORMATION

AS REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT, CHAPTER P.13(R.S.O. 1990).

(a),(e),(f),(g),(j),(l) - As shown of the Draft Plan.
(b),(c) - As shown on the Draft and Key Plan.
(d) - Land to be used in accordance with the Schedule of Land Use.
(i) - Soil is silt and clay loam.
(h),(k) - Full municipal services to be provided.

Date	Revision	

MGP File No.: 12-2089
Date: July 25, 2023

Malone Given Parsons
140 Renfrew Drive, Suite 201 | Markham, ON | L3R 6B3
905 513 0170 | mgp.ca

Appendix B

Level of Service Definitions

Highway Capacity Manual 2010

Signalized intersection level of service (LOS) is defined in terms of a weighted average control delay for the entire intersection. Control delay quantifies the increase in travel time that a vehicle experiences due to the traffic signal control as well as provides a surrogate measure for driver discomfort and fuel consumption. Signalized intersection LOS is stated in terms of average control delay per vehicle (in seconds) during a specified time period (e.g., weekday PM peak hour). Control delay is a complex measure based on many variables, including signal phasing and coordination (i.e., progression of movements through the intersection and along the corridor), signal cycle length, and traffic volumes with respect to intersection capacity and resulting queues. Table 1 summarizes the LOS criteria for signalized intersections, as described in the *Highway Capacity Manual 2010* (Transportation Research Board, 2010).

Table 1. Level of Service Criteria for Signalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)	General Description
A	≤10	Free Flow
B	>10 – 20	Stable Flow (slight delays)
C	>20 – 35	Stable flow (acceptable delays)
D	>35 – 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 – 80	Unstable flow (intolerable delay)
F[1]	>80	Forced flow (congested and queues fail to clear)

Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.

1. If the volume-to-capacity (v/c) ratio for a lane group exceeds 1.0 LOS F is assigned to the individual lane group. LOS for overall approach or intersection is determined solely by the control delay.

Unsignalized intersection LOS criteria can be further reduced into three intersection types: all-way stop, two-way stop, and roundabout control. All-way stop and roundabout control intersection LOS is expressed in terms of the weighted average control delay of the overall intersection or by approach. Two-way stop-controlled intersection LOS is defined in terms of the average control delay for each minor-street movement (or shared movement) as well as major-street left-turns. This approach is because major-street through vehicles are assumed to experience zero delay, a weighted average of all movements results in very low overall average delay, and this calculated low delay could mask deficiencies of minor movements. Table 2 shows LOS criteria for unsignalized intersections.

Table 2. Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)
A	0 – 10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F[1]	>50

Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.

1. If the volume-to-capacity (v/c) ratio exceeds 1.0, LOS F is assigned an individual lane group for all unsignalized intersections, or minor street approach at two-way stop-controlled intersections. Overall intersection LOS is determined solely by control delay.

LEVEL OF SERVICE ANALYSIS AT UNSIGNALIZED INTERSECTIONS[1]

The term "level of service" implies a qualitative measure of traffic flow at an intersection. It is dependent upon the vehicle delay and vehicle queue lengths at approaches. The level of service at unsignalized intersections is often related to the delay accumulated by flows on the minor streets, caused by all other conflicting movements. The following table describes the characteristics of each level.

LOS	Delay (seconds)	Features
A	0 – 10	Little or no traffic delay occurs. Approaches appear open, turning movements are easily made, and drivers have freedom of operation.
B	> 10 – 15	Short traffic delays occur. Many drivers begin to feel somewhat restricted in terms of freedom of operation.
C	> 15 – 25	Average traffic delays occur. Operations are generally stable, but drivers emerging from the minor street may experience difficulty in completing their movement. This may occasionally impact on the stability of flow on the major street.
D	> 25 – 35	Long traffic delays occur. Motorists emerging from the minor street experience significant restriction and frustration. Drivers on the major street will experience congestion and delay as drivers emerging from the minor street interfere with the major through movements.
E	> 35 – 50	Very long traffic delays occur. Operations approach the capacity of the intersection.
F	> 50	Saturation occurs, with vehicle demand exceeding the available capacity. Very long traffic delays occur.

[1] Highway Capacity Manual – Special Report No. 209, Transportation Research Board, 1985

Appendix C

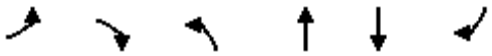
Synchro Analysis Worksheets

DILLON CONSULTING

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	422	20	3	474	61	12
Future Volume (Veh/h)	422	20	3	474	61	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	459	22	3	515	66	13
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				357		
pX, platoon unblocked						
vC, conflicting volume			481		980	459
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			481		980	459
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		76	98
cM capacity (veh/h)			1082		276	602

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	459	22	3	515	79
Volume Left	0	0	3	0	66
Volume Right	0	22	0	0	13
cSH	1700	1700	1082	1700	303
Volume to Capacity	0.27	0.01	0.00	0.30	0.26
Queue Length 95th (m)	0.0	0.0	0.1	0.0	8.2
Control Delay (s)	0.0	0.0	8.3	0.0	21.0
Lane LOS			A		C
Approach Delay (s)	0.0		0.0		21.0
Approach LOS					C

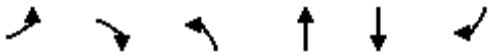
Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.7%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	29	10	38	51	3
Future Volume (Veh/h)	3	29	10	38	51	3
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	32	11	41	55	3
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	120	56	58			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	120	56	58			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	97	99			
cM capacity (veh/h)	870	1010	1546			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	35	52	58
Volume Left	3	11	0
Volume Right	32	0	3
cSH	996	1546	1700
Volume to Capacity	0.04	0.01	0.03
Queue Length 95th (m)	0.9	0.2	0.0
Control Delay (s)	8.7	1.6	0.0
Lane LOS	A	A	
Approach Delay (s)	8.7	1.6	0.0
Approach LOS	A		

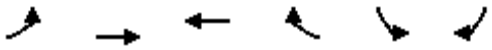
Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	19.2%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	18	4	42	84	3
Future Volume (Veh/h)	5	18	4	42	84	3
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	20	4	46	91	3
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	146	92	94			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	146	92	94			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	98	100			
cM capacity (veh/h)	844	965	1500			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	25	50	94
Volume Left	5	4	0
Volume Right	20	0	3
cSH	938	1500	1700
Volume to Capacity	0.03	0.00	0.06
Queue Length 95th (m)	0.7	0.1	0.0
Control Delay (s)	8.9	0.6	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	0.6	0.0
Approach LOS	A		

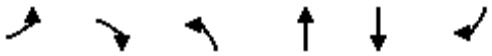
Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	15.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	54	321	372	6	15	160
Future Volume (Veh/h)	54	321	372	6	15	160
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	59	349	404	7	16	174
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	411				874	408
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	411				874	408
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				95	73
cM capacity (veh/h)	1148				304	644

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	59	349	411	190
Volume Left	59	0	0	16
Volume Right	0	0	7	174
cSH	1148	1700	1700	588
Volume to Capacity	0.05	0.21	0.24	0.32
Queue Length 95th (m)	1.3	0.0	0.0	11.1
Control Delay (s)	8.3	0.0	0.0	14.0
Lane LOS	A			B
Approach Delay (s)	1.2		0.0	14.0
Approach LOS				B

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	44.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	8	3	44	79	1
Future Volume (Veh/h)	3	8	3	44	79	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	9	3	48	86	1
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	140	86	87			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	140	86	87			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	100			
cM capacity (veh/h)	851	972	1509			

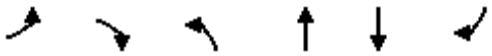
Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	12	51	87
Volume Left	3	3	0
Volume Right	9	0	1
cSH	939	1509	1700
Volume to Capacity	0.01	0.00	0.05
Queue Length 95th (m)	0.3	0.0	0.0
Control Delay (s)	8.9	0.4	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	0.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	14.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	627	63	10	370	40	8
Future Volume (Veh/h)	627	63	10	370	40	8
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	682	68	11	402	43	9
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				357		
pX, platoon unblocked						
vC, conflicting volume			750		1106	682
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			750		1106	682
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		81	98
cM capacity (veh/h)			859		230	450

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	682	68	11	402	52
Volume Left	0	0	11	0	43
Volume Right	0	68	0	0	9
cSH	1700	1700	859	1700	251
Volume to Capacity	0.40	0.04	0.01	0.24	0.21
Queue Length 95th (m)	0.0	0.0	0.3	0.0	6.1
Control Delay (s)	0.0	0.0	9.2	0.0	23.0
Lane LOS			A		C
Approach Delay (s)	0.0		0.2		23.0
Approach LOS					C

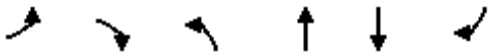
Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	2	19	31	37	56	9
Future Volume (Veh/h)	2	19	31	37	56	9
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	21	34	40	61	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	174	66	71			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	174	66	71			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	98			
cM capacity (veh/h)	798	998	1529			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	23	74	71
Volume Left	2	34	0
Volume Right	21	0	10
cSH	977	1529	1700
Volume to Capacity	0.02	0.02	0.04
Queue Length 95th (m)	0.6	0.5	0.0
Control Delay (s)	8.8	3.5	0.0
Lane LOS	A	A	
Approach Delay (s)	8.8	3.5	0.0
Approach LOS	A		

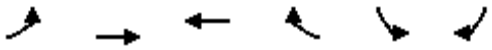
Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	20.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	14	17	71	65	11
Future Volume (Veh/h)	3	14	17	71	65	11
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	15	18	77	71	12
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	190	77	83			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	190	77	83			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	99			
cM capacity (veh/h)	790	984	1514			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	18	95	83
Volume Left	3	18	0
Volume Right	15	0	12
cSH	945	1514	1700
Volume to Capacity	0.02	0.01	0.05
Queue Length 95th (m)	0.5	0.3	0.0
Control Delay (s)	8.9	1.5	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	1.5	0.0
Approach LOS	A		

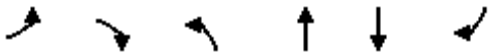
Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	21.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	182	470	425	21	10	116
Future Volume (Veh/h)	182	470	425	21	10	116
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	198	511	462	23	11	126
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	485				1380	474
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	485				1380	474
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	82				92	79
cM capacity (veh/h)	1078				130	591

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	198	511	485	137
Volume Left	198	0	0	11
Volume Right	0	0	23	126
cSH	1078	1700	1700	460
Volume to Capacity	0.18	0.30	0.29	0.30
Queue Length 95th (m)	5.4	0.0	0.0	9.9
Control Delay (s)	9.1	0.0	0.0	16.1
Lane LOS	A			C
Approach Delay (s)	2.5		0.0	16.1
Approach LOS				C

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	5	9	65	71	4
Future Volume (Veh/h)	3	5	9	65	71	4
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	5	10	71	77	4
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	170	79	81			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	170	79	81			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	815	981	1517			

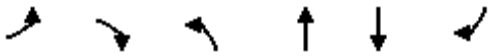
Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	8	81	81
Volume Left	3	10	0
Volume Right	5	0	4
cSH	912	1517	1700
Volume to Capacity	0.01	0.01	0.05
Queue Length 95th (m)	0.2	0.2	0.0
Control Delay (s)	9.0	1.0	0.0
Lane LOS	A	A	
Approach Delay (s)	9.0	1.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	20.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	395	20	3	537	61	12
Future Volume (Veh/h)	395	20	3	537	61	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	429	22	3	584	66	13
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				357		
pX, platoon unblocked						
vC, conflicting volume			451		1019	429
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			451		1019	429
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		75	98
cM capacity (veh/h)			1109		262	626

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	429	22	3	584	79
Volume Left	0	0	3	0	66
Volume Right	0	22	0	0	13
cSH	1700	1700	1109	1700	290
Volume to Capacity	0.25	0.01	0.00	0.34	0.27
Queue Length 95th (m)	0.0	0.0	0.1	0.0	8.6
Control Delay (s)	0.0	0.0	8.3	0.0	22.0
Lane LOS			A		C
Approach Delay (s)	0.0		0.0		22.0
Approach LOS					C

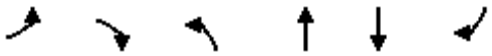
Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	39.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	30	11	43	209	70
Future Volume (Veh/h)	3	30	11	43	209	70
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	33	12	47	227	76
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	336	265	303			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	336	265	303			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	96	99			
cM capacity (veh/h)	653	774	1258			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	36	59	303
Volume Left	3	12	0
Volume Right	33	0	76
cSH	762	1258	1700
Volume to Capacity	0.05	0.01	0.18
Queue Length 95th (m)	1.2	0.2	0.0
Control Delay (s)	10.0	1.7	0.0
Lane LOS	A	A	
Approach Delay (s)	10.0	1.7	0.0
Approach LOS	A		

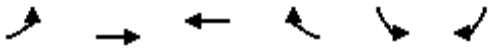
Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	25.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	18	4	48	243	3
Future Volume (Veh/h)	5	18	4	48	243	3
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	20	4	52	264	3
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	326	266	267			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	326	266	267			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	97	100			
cM capacity (veh/h)	667	773	1297			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	25	56	267
Volume Left	5	4	0
Volume Right	20	0	3
cSH	749	1297	1700
Volume to Capacity	0.03	0.00	0.16
Queue Length 95th (m)	0.8	0.1	0.0
Control Delay (s)	10.0	0.6	0.0
Lane LOS	A	A	
Approach Delay (s)	10.0	0.6	0.0
Approach LOS	A		

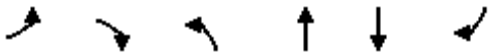
Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	54	390	574	6	15	160
Future Volume (Veh/h)	54	390	574	6	15	160
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	59	424	624	7	16	174
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	631				1170	628
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	631				1170	628
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	94				92	64
cM capacity (veh/h)	951				200	483

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	59	424	631	190
Volume Left	59	0	0	16
Volume Right	0	0	7	174
cSH	951	1700	1700	432
Volume to Capacity	0.06	0.25	0.37	0.44
Queue Length 95th (m)	1.6	0.0	0.0	17.6
Control Delay (s)	9.0	0.0	0.0	19.7
Lane LOS	A			C
Approach Delay (s)	1.1		0.0	19.7
Approach LOS				C

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	8	3	50	238	1
Future Volume (Veh/h)	3	8	3	50	238	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	9	3	54	259	1
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	320	260	260			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	320	260	260			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	100			
cM capacity (veh/h)	672	779	1304			

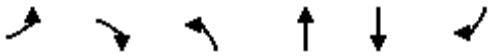
Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	12	57	260
Volume Left	3	3	0
Volume Right	9	0	1
cSH	749	1304	1700
Volume to Capacity	0.02	0.00	0.15
Queue Length 95th (m)	0.4	0.1	0.0
Control Delay (s)	9.9	0.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.9	0.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	22.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	696	63	10	343	40	8
Future Volume (Veh/h)	696	63	10	343	40	8
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	757	68	11	373	43	9
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				357		
pX, platoon unblocked						
vC, conflicting volume			825		1152	757
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			825		1152	757
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		80	98
cM capacity (veh/h)			805		216	408

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	757	68	11	373	52
Volume Left	0	0	11	0	43
Volume Right	0	68	0	0	9
cSH	1700	1700	805	1700	235
Volume to Capacity	0.45	0.04	0.01	0.22	0.22
Queue Length 95th (m)	0.0	0.0	0.3	0.0	6.6
Control Delay (s)	0.0	0.0	9.5	0.0	24.7
Lane LOS			A		C
Approach Delay (s)	0.0		0.3		24.7
Approach LOS					C

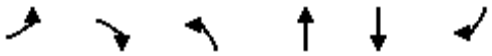
Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	11	20	31	173	65	9
Future Volume (Veh/h)	11	20	31	173	65	9
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	12	22	34	188	71	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	332	76	81			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332	76	81			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	98	98			
cM capacity (veh/h)	648	985	1517			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	34	222	81
Volume Left	12	34	0
Volume Right	22	0	10
cSH	832	1517	1700
Volume to Capacity	0.04	0.02	0.05
Queue Length 95th (m)	1.0	0.6	0.0
Control Delay (s)	9.5	1.3	0.0
Lane LOS	A	A	
Approach Delay (s)	9.5	1.3	0.0
Approach LOS	A		

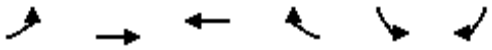
Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	27.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	14	17	207	75	11
Future Volume (Veh/h)	3	14	17	207	75	11
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	15	18	225	82	12
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	349	88	94			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	349	88	94			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	99			
cM capacity (veh/h)	640	970	1500			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	18	243	94
Volume Left	3	18	0
Volume Right	15	0	12
cSH	894	1500	1700
Volume to Capacity	0.02	0.01	0.06
Queue Length 95th (m)	0.5	0.3	0.0
Control Delay (s)	9.1	0.6	0.0
Lane LOS	A	A	
Approach Delay (s)	9.1	0.6	0.0
Approach LOS	A		

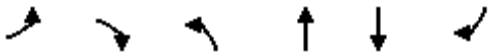
Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	28.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	182	632	436	21	10	116
Future Volume (Veh/h)	182	632	436	21	10	116
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	198	687	474	23	11	126
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	497				1568	486
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497				1568	486
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	81				89	78
cM capacity (veh/h)	1067				99	582

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	198	687	497	137
Volume Left	198	0	0	11
Volume Right	0	0	23	126
cSH	1067	1700	1700	419
Volume to Capacity	0.19	0.40	0.29	0.33
Queue Length 95th (m)	5.4	0.0	0.0	11.2
Control Delay (s)	9.1	0.0	0.0	17.7
Lane LOS	A			C
Approach Delay (s)	2.0		0.0	17.7
Approach LOS				C

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	52.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	5	9	201	81	4
Future Volume (Veh/h)	3	5	9	201	81	4
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	5	10	218	88	4
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	328	90	92			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	328	90	92			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	662	968	1503			

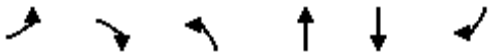
Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	8	228	92
Volume Left	3	10	0
Volume Right	5	0	4
cSH	825	1503	1700
Volume to Capacity	0.01	0.01	0.05
Queue Length 95th (m)	0.2	0.2	0.0
Control Delay (s)	9.4	0.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.4	0.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	27.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	450	20	3	552	61	12
Future Volume (Veh/h)	450	20	3	552	61	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	489	22	3	600	66	13
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				357		
pX, platoon unblocked						
vC, conflicting volume			511		1095	489
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			511		1095	489
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		72	98
cM capacity (veh/h)			1054		236	579

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	489	22	3	600	79
Volume Left	0	0	3	0	66
Volume Right	0	22	0	0	13
cSH	1700	1700	1054	1700	261
Volume to Capacity	0.29	0.01	0.00	0.35	0.30
Queue Length 95th (m)	0.0	0.0	0.1	0.0	9.9
Control Delay (s)	0.0	0.0	8.4	0.0	24.6
Lane LOS			A		C
Approach Delay (s)	0.0		0.0		24.6
Approach LOS					C

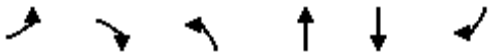
Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	39.8%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	30	11	58	264	70
Future Volume (Veh/h)	3	30	11	58	264	70
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	33	12	63	287	76
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	412	325	363			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	412	325	363			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	95	99			
cM capacity (veh/h)	590	716	1196			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	36	75	363
Volume Left	3	12	0
Volume Right	33	0	76
cSH	704	1196	1700
Volume to Capacity	0.05	0.01	0.21
Queue Length 95th (m)	1.3	0.2	0.0
Control Delay (s)	10.4	1.4	0.0
Lane LOS	B	A	
Approach Delay (s)	10.4	1.4	0.0
Approach LOS	B		

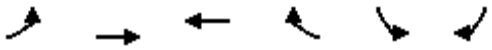
Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	28.1%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	19	18	4	48	243	58
Future Volume (Veh/h)	19	18	4	48	243	58
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	21	20	4	52	264	63
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	356	296	327			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	356	296	327			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	97	100			
cM capacity (veh/h)	640	744	1233			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	41	56	327
Volume Left	21	4	0
Volume Right	20	0	63
cSH	687	1233	1700
Volume to Capacity	0.06	0.00	0.19
Queue Length 95th (m)	1.5	0.1	0.0
Control Delay (s)	10.6	0.6	0.0
Lane LOS	B	A	
Approach Delay (s)	10.6	0.6	0.0
Approach LOS	B		

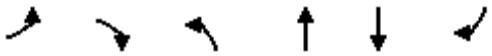
Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	112	390	574	6	15	229
Future Volume (Veh/h)	112	390	574	6	15	229
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	122	424	624	7	16	249
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	631				1296	628
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	631				1296	628
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	87				90	48
cM capacity (veh/h)	951				156	483

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	122	424	631	265
Volume Left	122	0	0	16
Volume Right	0	0	7	249
cSH	951	1700	1700	429
Volume to Capacity	0.13	0.25	0.37	0.62
Queue Length 95th (m)	3.5	0.0	0.0	32.4
Control Delay (s)	9.3	0.0	0.0	26.0
Lane LOS	A			D
Approach Delay (s)	2.1		0.0	26.0
Approach LOS				D

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	61.8%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	8	3	65	293	1
Future Volume (Veh/h)	3	8	3	65	293	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	9	3	71	318	1
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	396	318	319			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	396	318	319			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	100			
cM capacity (veh/h)	608	722	1241			

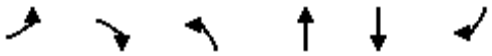
Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	12	74	319
Volume Left	3	3	0
Volume Right	9	0	1
cSH	690	1241	1700
Volume to Capacity	0.02	0.00	0.19
Queue Length 95th (m)	0.4	0.1	0.0
Control Delay (s)	10.3	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.3	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	25.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	708	63	10	361	40	8
Future Volume (Veh/h)	708	63	10	361	40	8
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	770	68	11	392	43	9
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				357		
pX, platoon unblocked						
vC, conflicting volume			838		1184	770
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			838		1184	770
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		79	98
cM capacity (veh/h)			796		206	401

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	770	68	11	392	52
Volume Left	0	0	11	0	43
Volume Right	0	68	0	0	9
cSH	1700	1700	796	1700	225
Volume to Capacity	0.45	0.04	0.01	0.23	0.23
Queue Length 95th (m)	0.0	0.0	0.3	0.0	6.9
Control Delay (s)	0.0	0.0	9.6	0.0	25.7
Lane LOS			A		D
Approach Delay (s)	0.0		0.3		25.7
Approach LOS					D

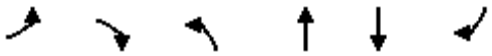
Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	47.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	11	20	31	191	76	9
Future Volume (Veh/h)	11	20	31	191	76	9
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	12	22	34	208	83	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	364	88	93			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	364	88	93			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	98	98			
cM capacity (veh/h)	621	970	1501			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	34	242	93
Volume Left	12	34	0
Volume Right	22	0	10
cSH	810	1501	1700
Volume to Capacity	0.04	0.02	0.05
Queue Length 95th (m)	1.1	0.6	0.0
Control Delay (s)	9.6	1.2	0.0
Lane LOS	A	A	
Approach Delay (s)	9.6	1.2	0.0
Approach LOS	A		

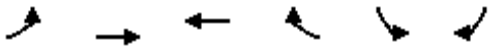
Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	21	14	17	207	75	23
Future Volume (Veh/h)	21	14	17	207	75	23
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	23	15	18	225	82	25
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					177	
pX, platoon unblocked						
vC, conflicting volume	356	94	107			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	356	94	107			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	98	99			
cM capacity (veh/h)	635	962	1484			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	38	243	107
Volume Left	23	18	0
Volume Right	15	0	25
cSH	733	1484	1700
Volume to Capacity	0.05	0.01	0.06
Queue Length 95th (m)	1.3	0.3	0.0
Control Delay (s)	10.2	0.6	0.0
Lane LOS	B	A	
Approach Delay (s)	10.2	0.6	0.0
Approach LOS	B		

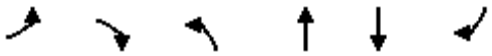
Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	28.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	213	632	436	21	10	152
Future Volume (Veh/h)	213	632	436	21	10	152
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	232	687	474	23	11	165
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	497				1636	486
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497				1636	486
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	78				87	72
cM capacity (veh/h)	1067				87	582

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	232	687	497	176
Volume Left	232	0	0	11
Volume Right	0	0	23	165
cSH	1067	1700	1700	429
Volume to Capacity	0.22	0.40	0.29	0.41
Queue Length 95th (m)	6.6	0.0	0.0	15.7
Control Delay (s)	9.3	0.0	0.0	19.1
Lane LOS	A			C
Approach Delay (s)	2.4		0.0	19.1
Approach LOS				C

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	56.0%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	5	9	218	92	4
Future Volume (Veh/h)	3	5	9	218	92	4
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	5	10	237	100	4
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	359	102	104			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	359	102	104			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	635	953	1488			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	8	247	104
Volume Left	3	10	0
Volume Right	5	0	4
cSH	803	1488	1700
Volume to Capacity	0.01	0.01	0.06
Queue Length 95th (m)	0.2	0.2	0.0
Control Delay (s)	9.5	0.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.5	0.4	0.0
Approach LOS	A		

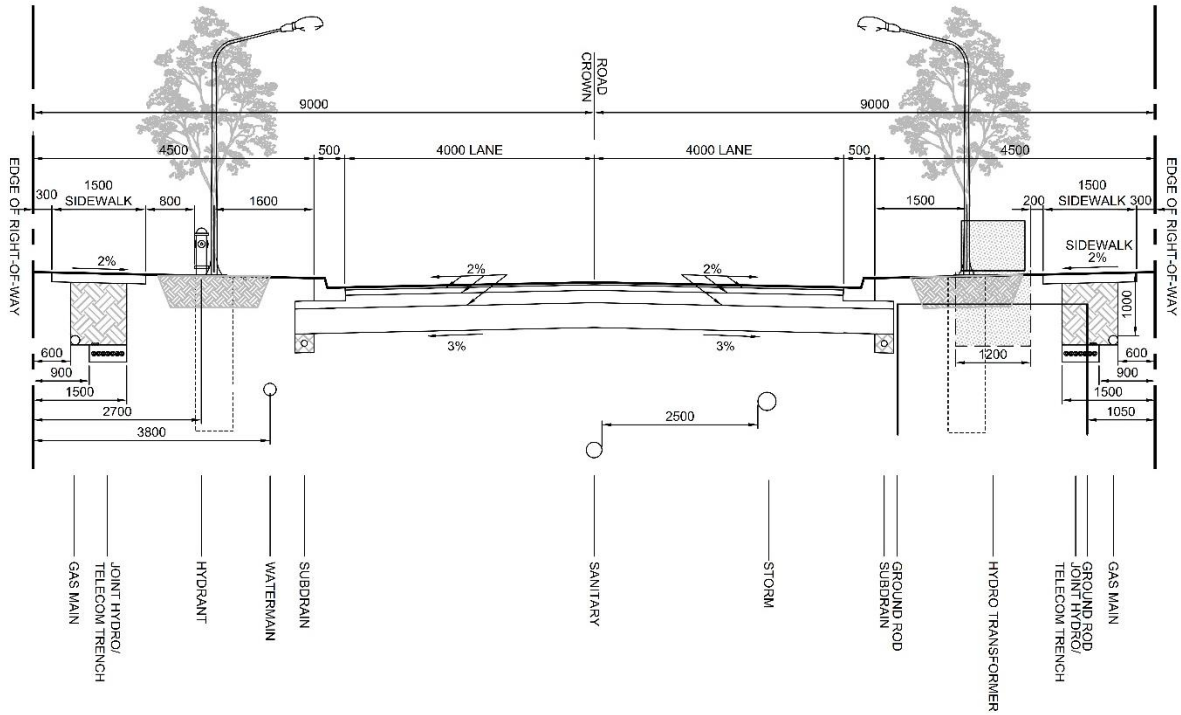
Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	28.6%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix D

City of Barrie Standard Roadway Cross-Sections

Table 1 – Characteristics of Typical Roadway Cross Sections

Characteristic	Arterial	Collector	Local
General Function	Carries moderate to high traffic volumes, providing through routes across and within City.	Carries moderate traffic volumes between arterial and local roads. May be designated Major or Minor, Residential or Industrial	Carries low traffic volumes, providing access to abutting lands. May be designated Residential or Industrial
Volume of Traffic, typical both directions, in vehicles per day (vpd)	Usually over 10,000 vpd.	Industrial areas: less than 12,000 vpd. Residential areas: less than 8,000 vpd.	Industrial areas: less than 3,000 vpd. Residential areas: less than 1,000 vpd.
Intersection and Access	Intersection with arterial and collector roads. Access may be restricted to right-in/ right-out only.	Intersection with arterial, collector and local roads. Access may be restricted to right-in/ right-out only.	Intersection with collector and local roads (arterial roads discouraged). No access restrictions.
Parking	Prohibited or peak hour restrictions.	Peak hour restrictions.	Per Zoning By-Law
Heavy Trucks	Standard highway tractor semi-trailer or larger vehicles where required.	Standard tractor semi-trailers.	Industrial: standard tractor semi-trailers. Residential: typically service and emergency vehicles only.
Transit Service and High Occupancy Vehicle (HOV) Lanes	Local and express buses. HOV lanes possible.	Local buses.	Transit buses generally not permitted.
Pedestrians	In accordance with Official Plan Amendment No. 38, and City of Barrie Infill Sidewalk Policy (*see section 2.3.5 of this document*)		
Cyclists and Other Non-Motorized Users	Bike lanes both sides, buffered on roads with 4 or more lanes.	Bike lanes (not buffered) one or both sides.	None.

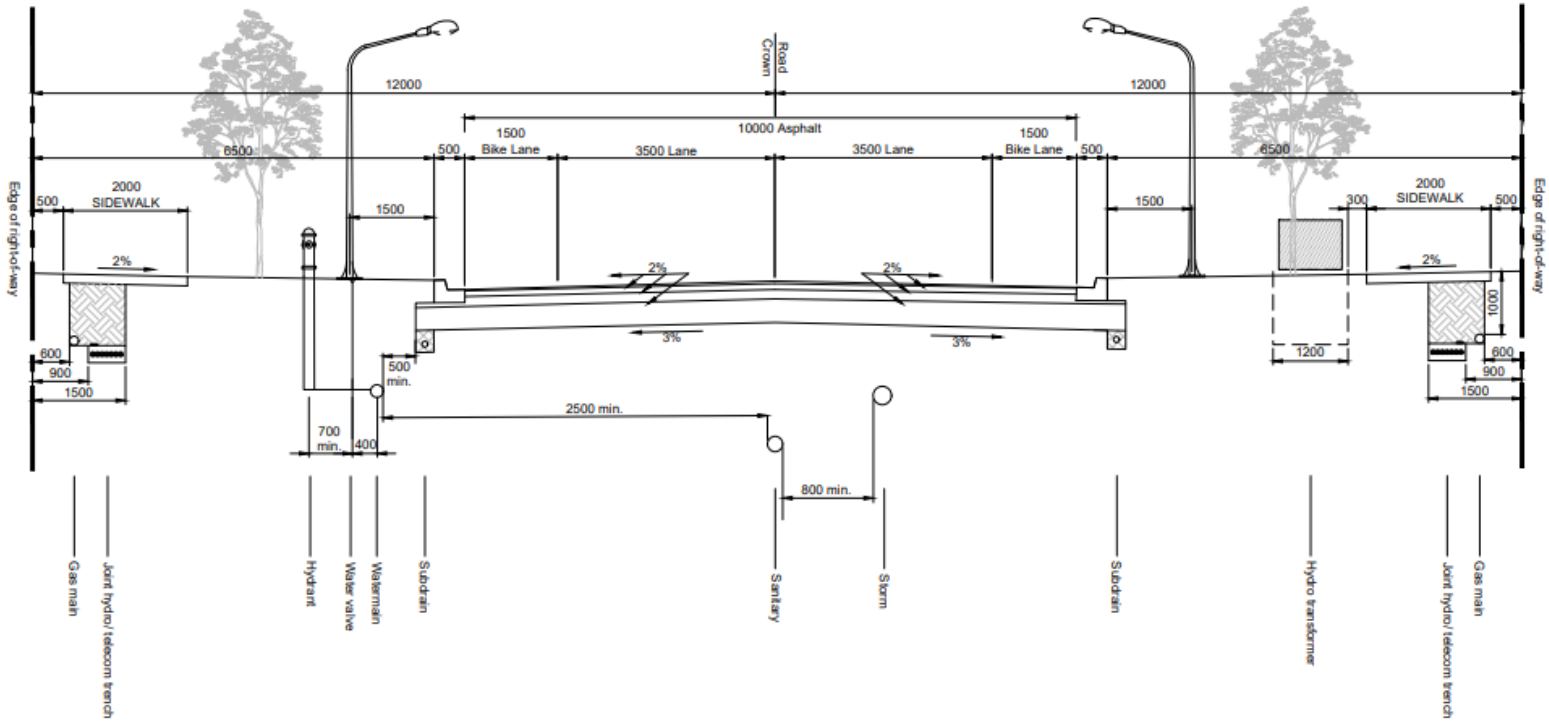


NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. WASTEWATER SYSTEMS, STORMWATER SYSTEMS, INCLUDING LOW IMPACT DEVELOPMENT FACILITIES, AND WATER DISTRIBUTION AND TRANSMISSION SYSTEMS TO BE DESIGNED IN ACCORDANCE WITH CITY OF BARRIE ENGINEERING GUIDELINES AND STANDARDS.
3. REFER TO THE CITY OF BARRIE ROADWAY ILLUMINATION POLICIES AND DESIGN GUIDELINES AND ASSOCIATED BSD'S FOR LIGHT STANDARD AND POLE BASE LOCATION AND DEPTH.
4. REFER TO TRANSPORTATION DESIGN MANUAL FOR PAVEMENT DESIGN METHODOLOGY.
5. TREES TO BE PLACED IN LOCATIONS APPROVED BY THE PARKS, PLANNING, AND DEVELOPMENT BRANCH. (SEE BSD-1315)

Barrie STANDARD DETAIL	18.0 m LOCAL ROAD ALLOWANCE - RESIDENTIAL 8.0 m ASPHALT	REV No. 1 / DATE: OCT 2017 / SCALE: N.T.S. / BSD-301	APPROVED DATE . . . . . DIRECTOR OF ENGINEERING

DILLON CONSULTING



Notes:

1. All dimensions are millimetres unless otherwise shown.
2. Wastewater systems, stormwater systems including low impact development facilities, and water distribution and transmission systems to be designed in accordance with City of Barrie engineering guidelines and standards.
3. Refer to the City of Barrie Roadway Illumination Policies and Design Guidelines and associated BSDs for light standard and pole base location and depth.
4. Refer to the Transportation Design Manual for pavement design methodology.
5. Widenings may be required at intersections to accommodate required turning lanes.
6. Trees to be placed in locations approved by Parks Planning and Development branch (see BSD-1315).

Barrie

24.0 m Minor Collector
Residential Road Allowance

REV No.	DATE: Aug. 2019
2	SCALE: N.T.S.

BSD-303

Appendix E

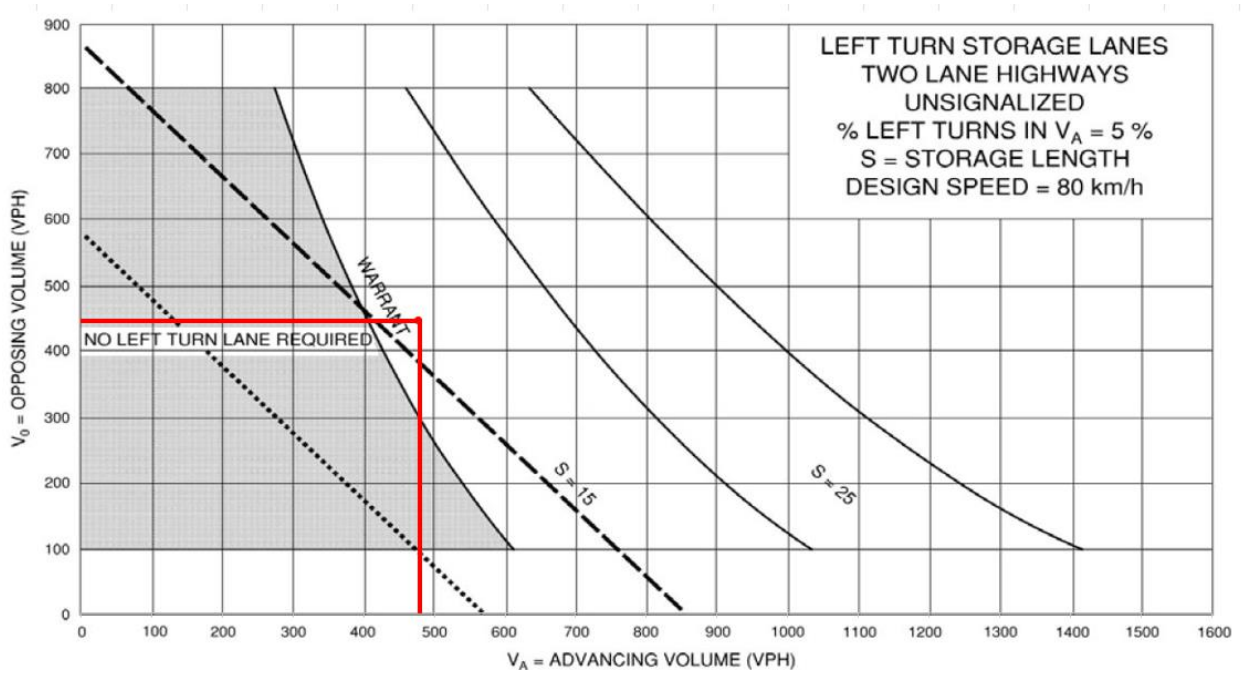
Left Turn Lane Warrant Nomographs

DILLON CONSULTING

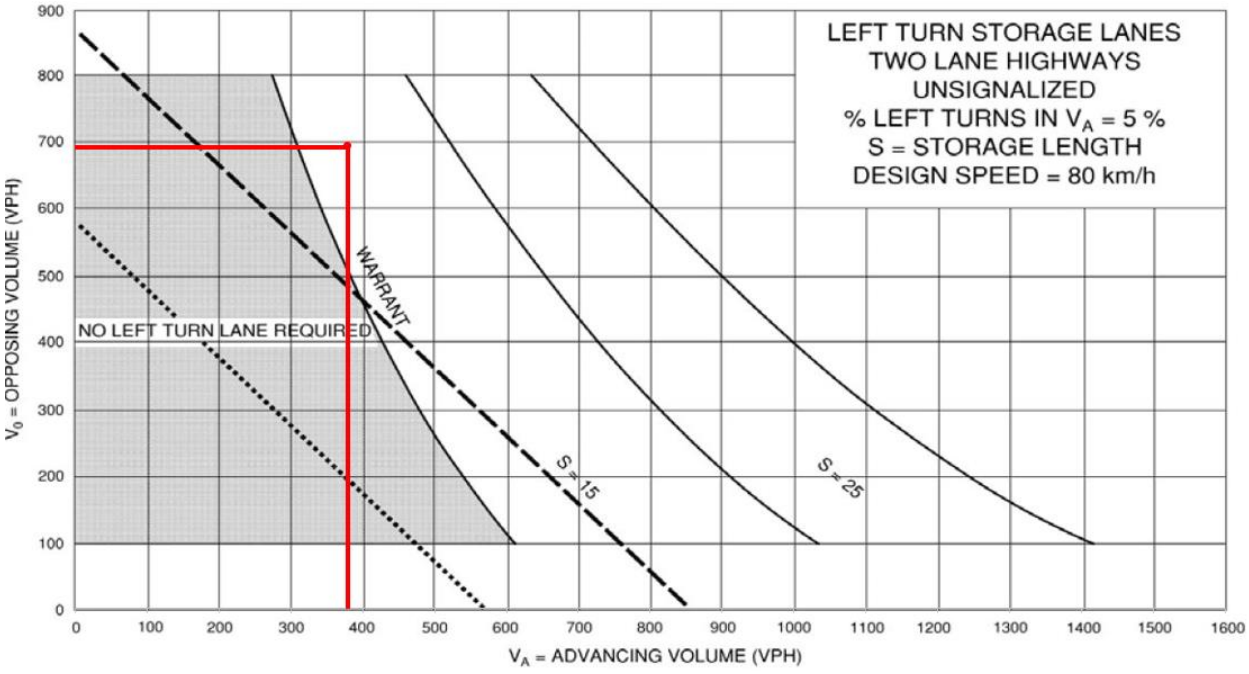
Westbound Left Turn Warrant at Mapleview Road and Street "C" intersection

2031 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



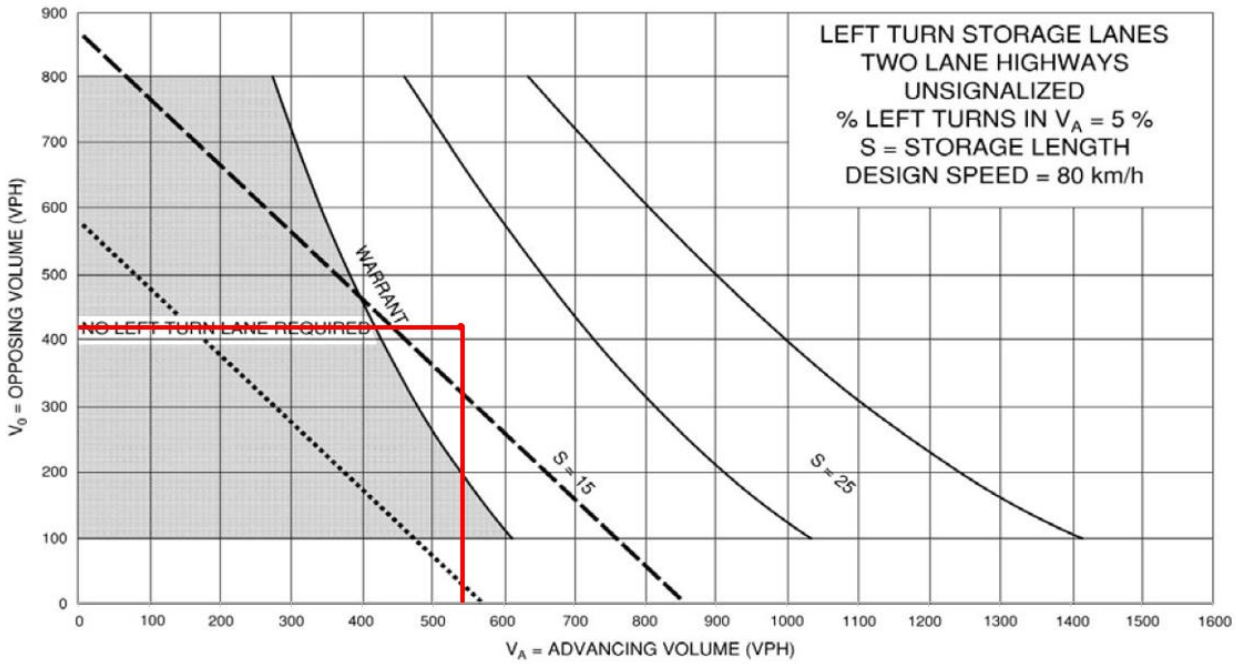
PM Peak Hour:



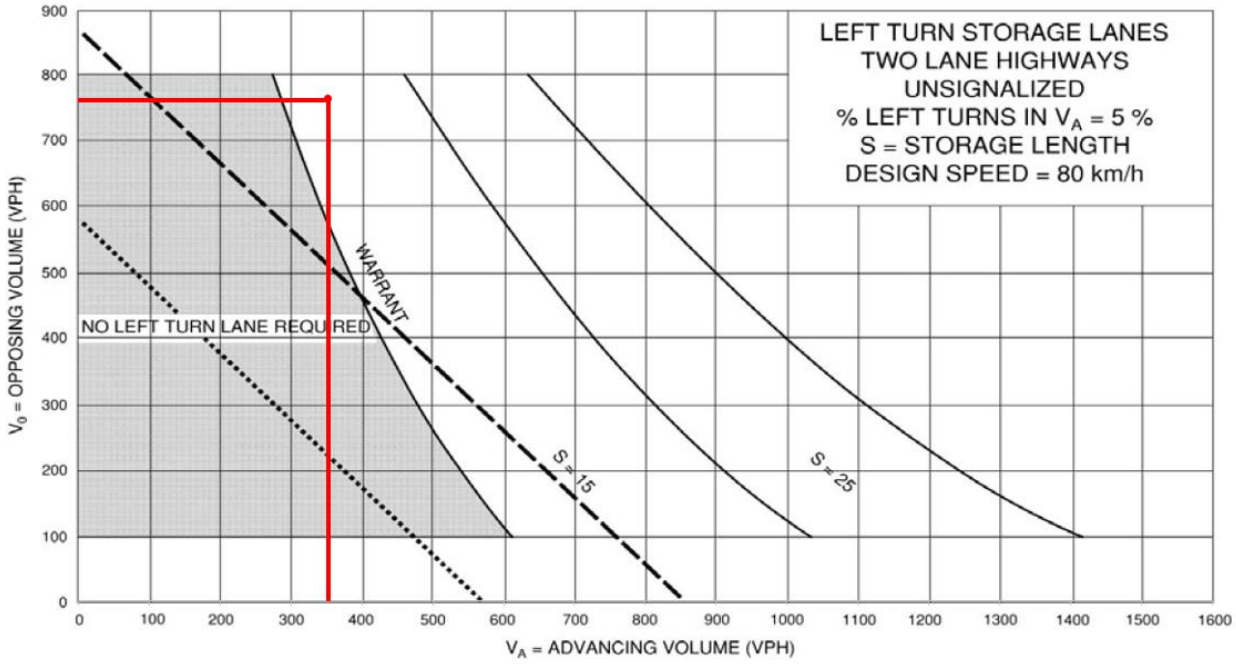
Westbound Left Turn Warrant at Mapleview Road and Street "C" intersection

2041 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



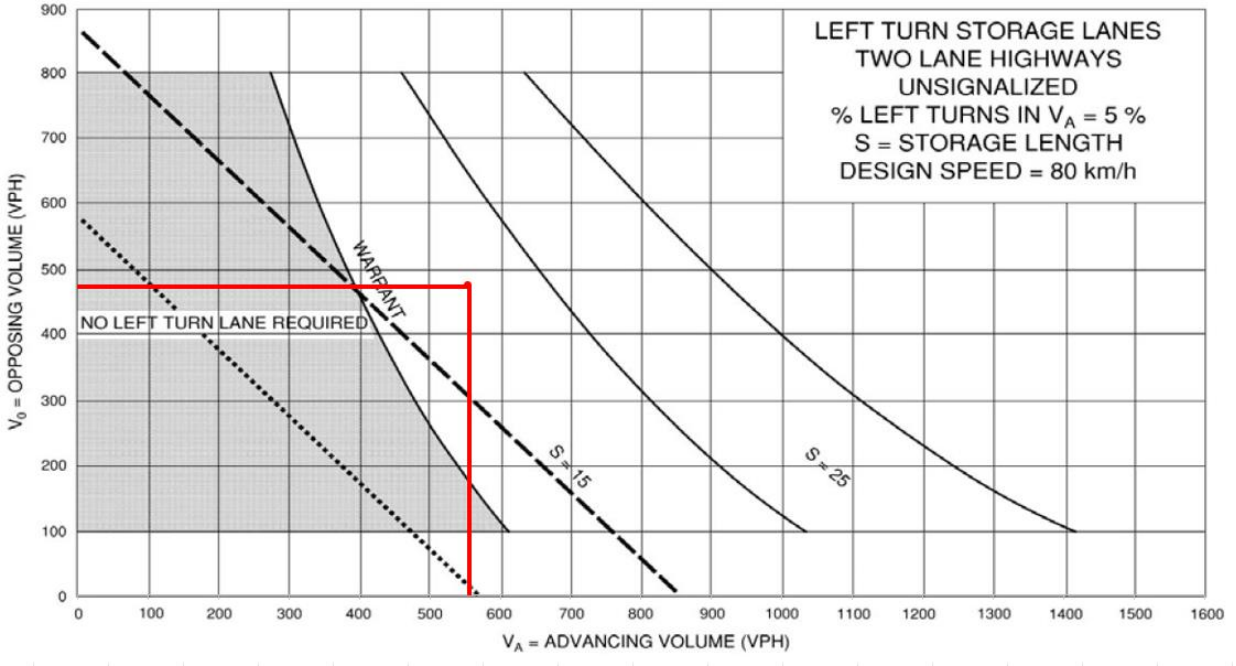
PM Peak Hour:



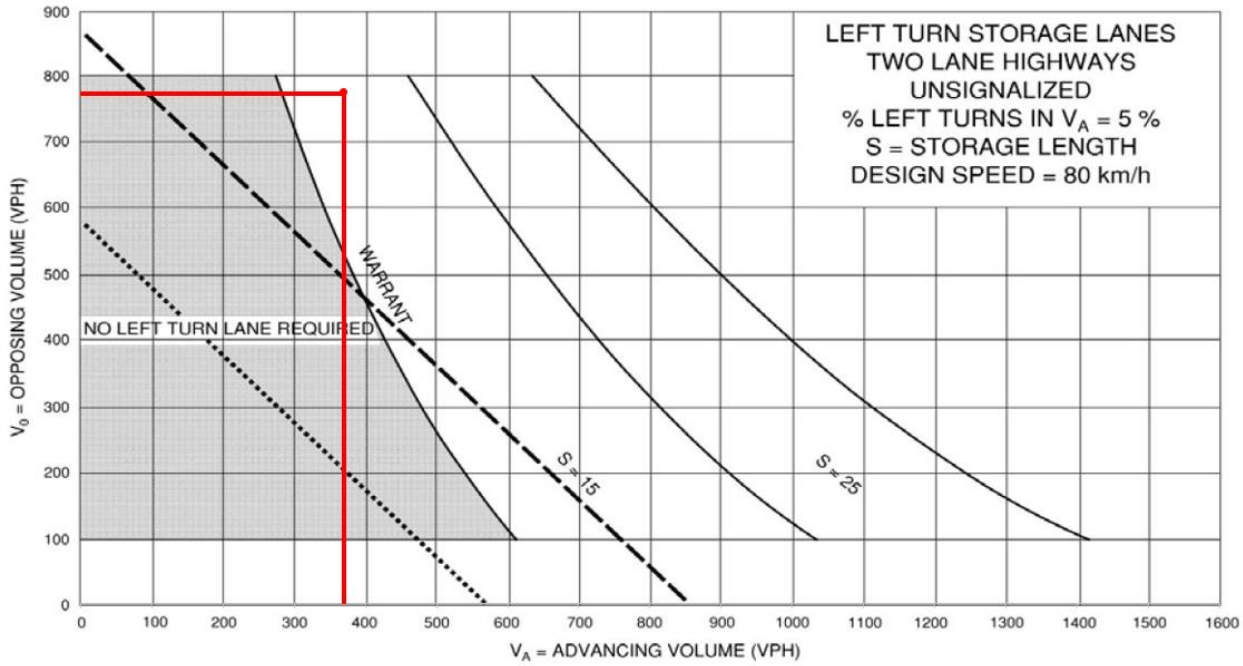
Westbound Left Turn Warrant at Mapleview Road and Street "C" intersection

2041 Total Future Traffic Volumes (With School Trips)

AM Peak Hour:



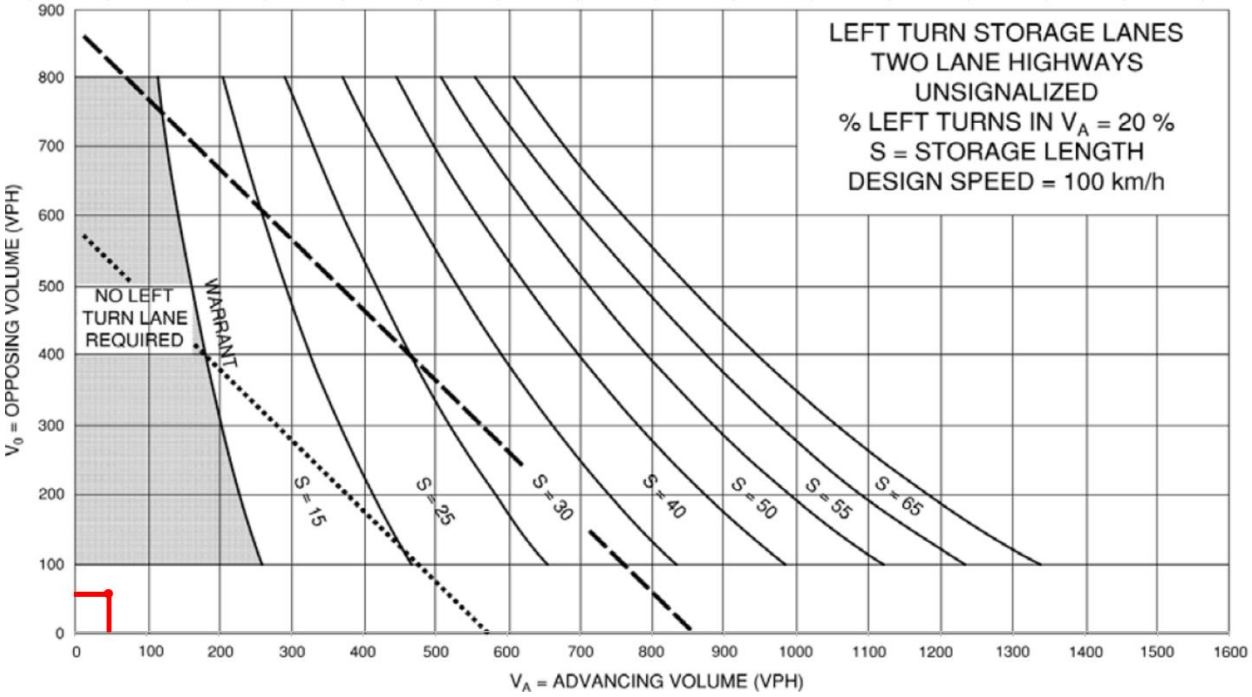
PM Peak Hour:



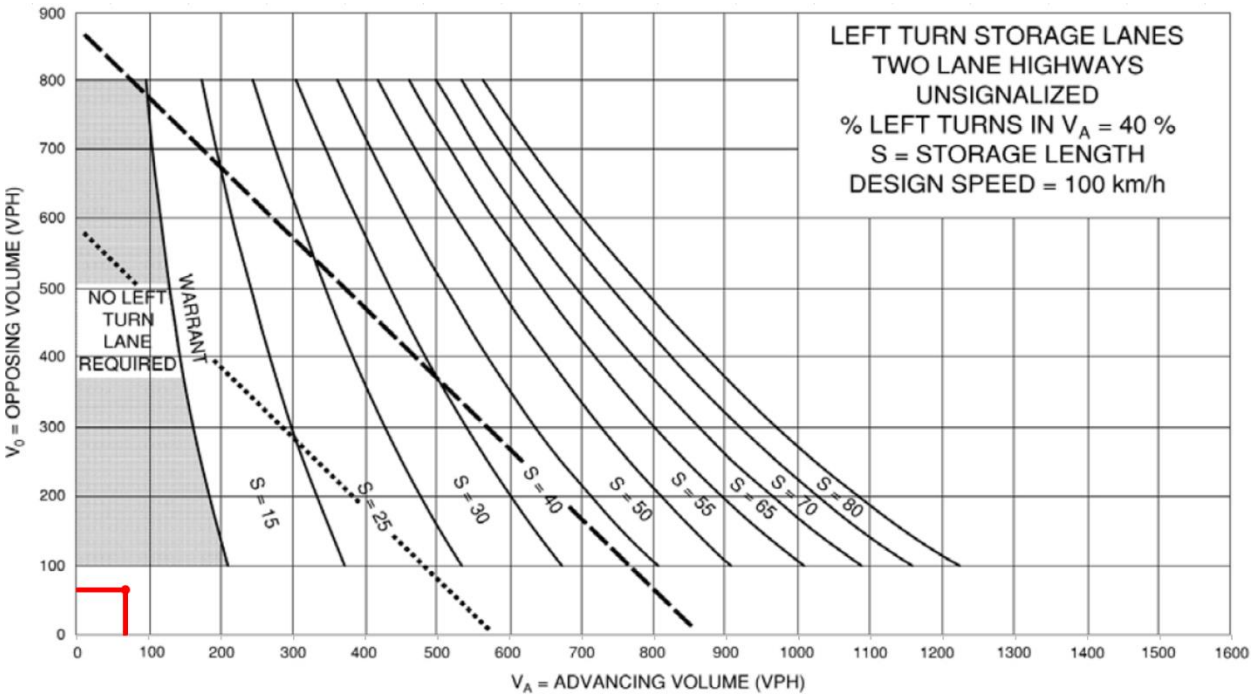
Northbound Left Turn Warrant at 20th Sideroad and Street "A" intersection

2031 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



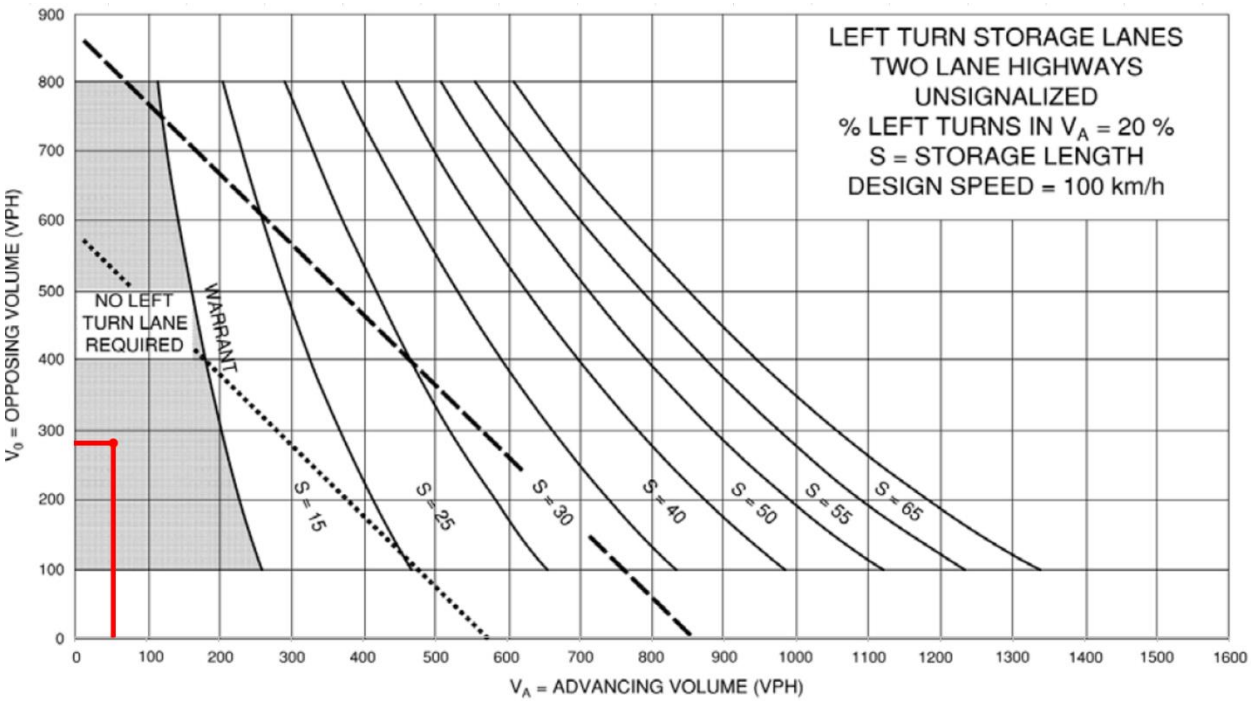
PM Peak Hour:



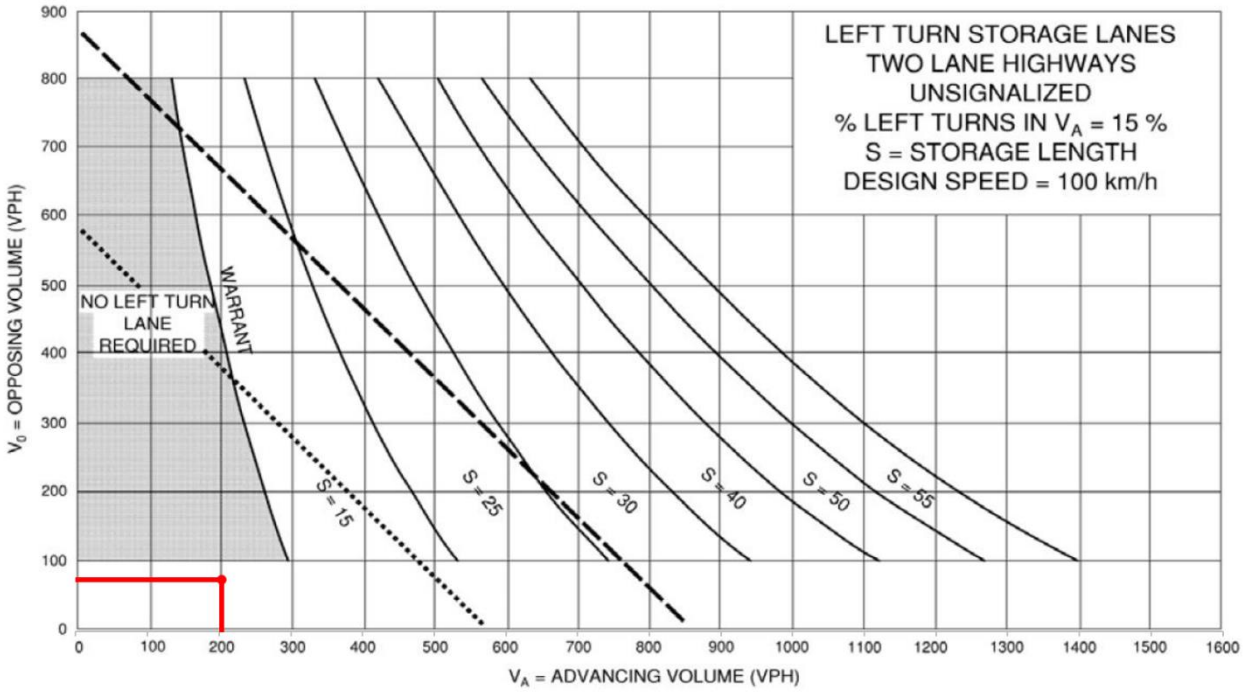
Northbound Left Turn Warrant at 20th Sideroad and Street "A" intersection

2041 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



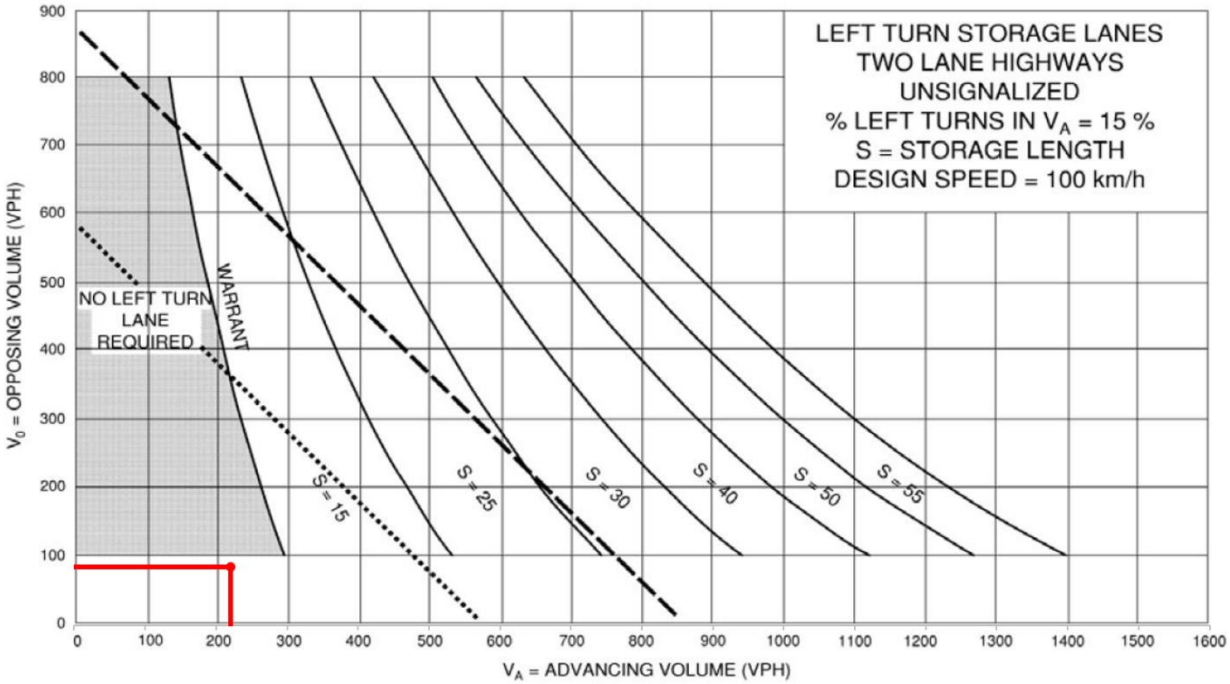
PM Peak Hour:



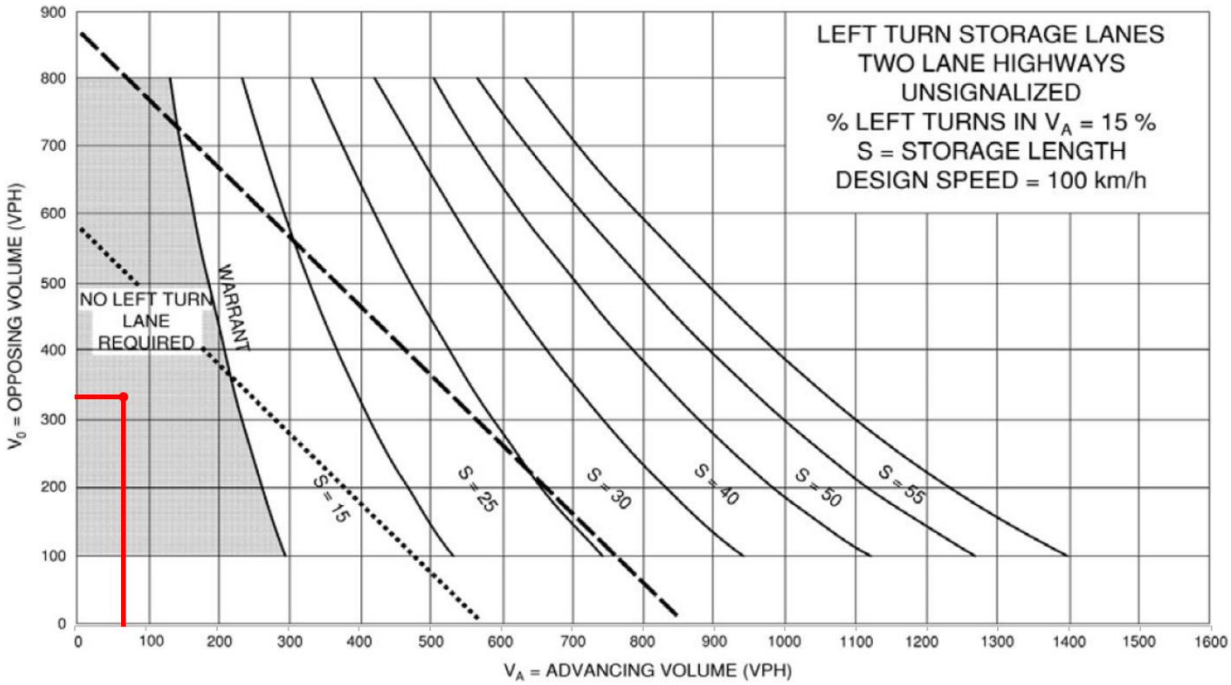
Northbound Left Turn Warrant at 20th Sideroad and Street "A" intersection

2041 Total Future Traffic Volumes (With School Trips)

AM Peak Hour:



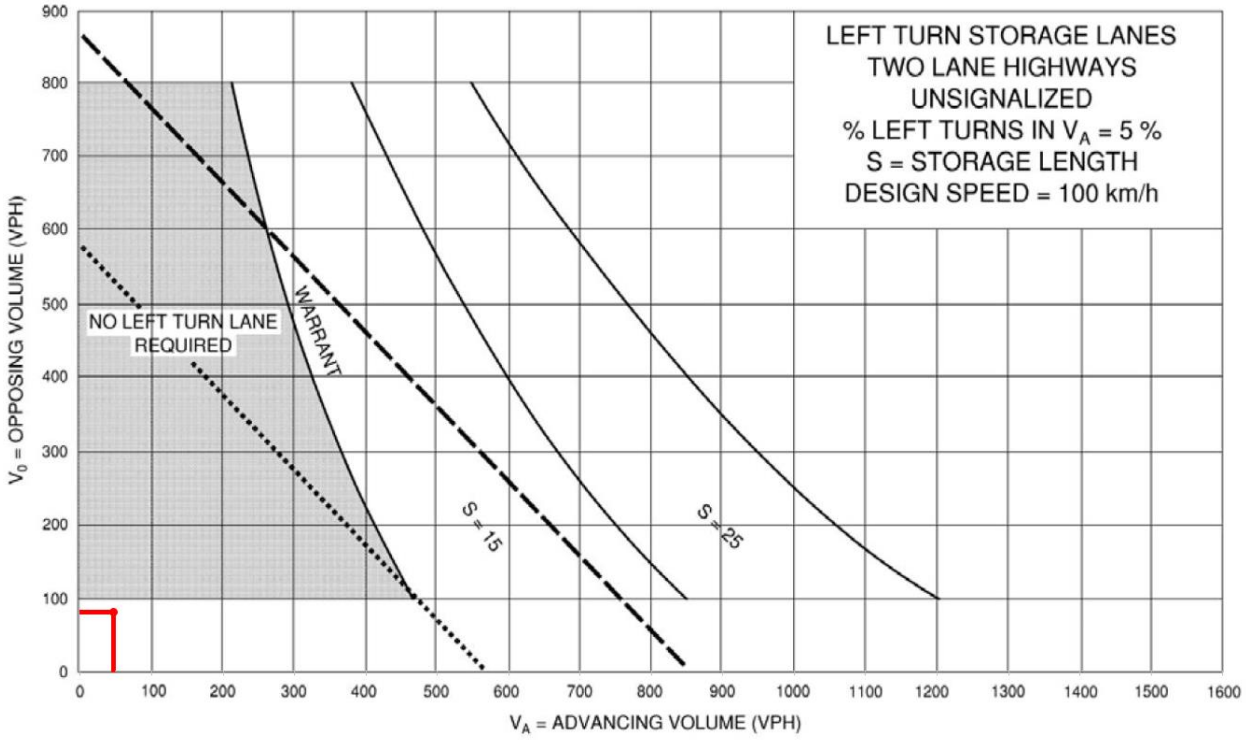
PM Peak Hour:



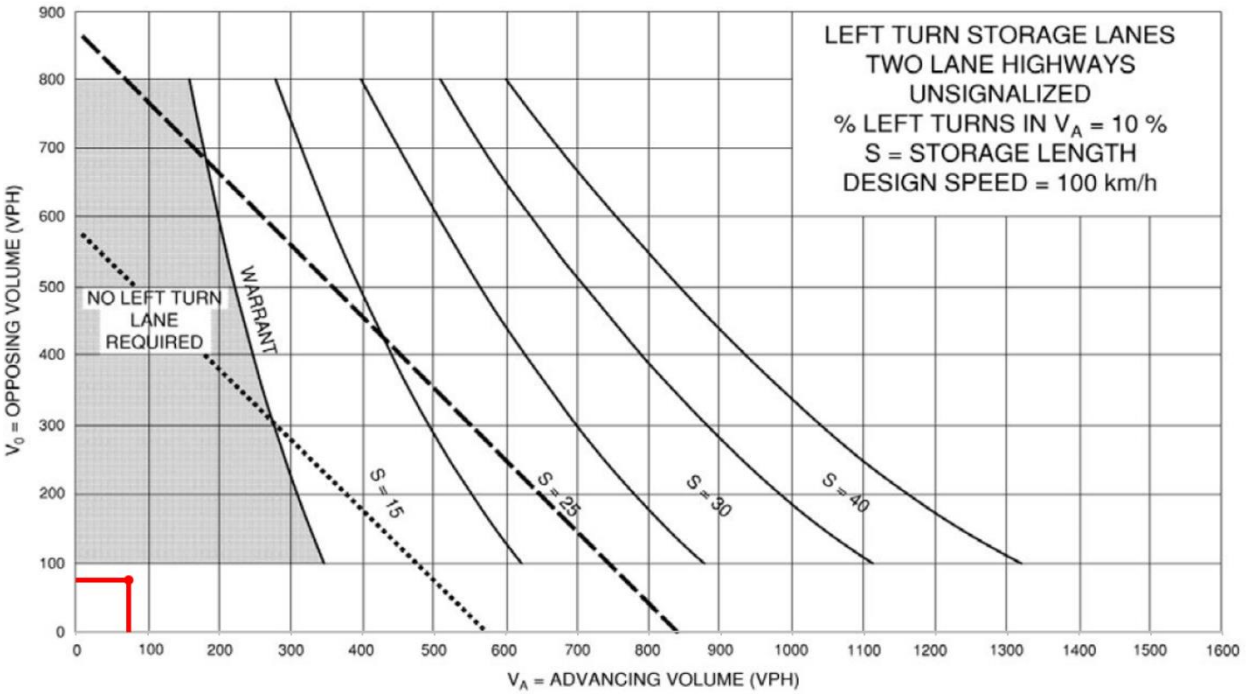
Northbound Left Turn Warrant at 20th Sideroad and Street "M" intersection

2031 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



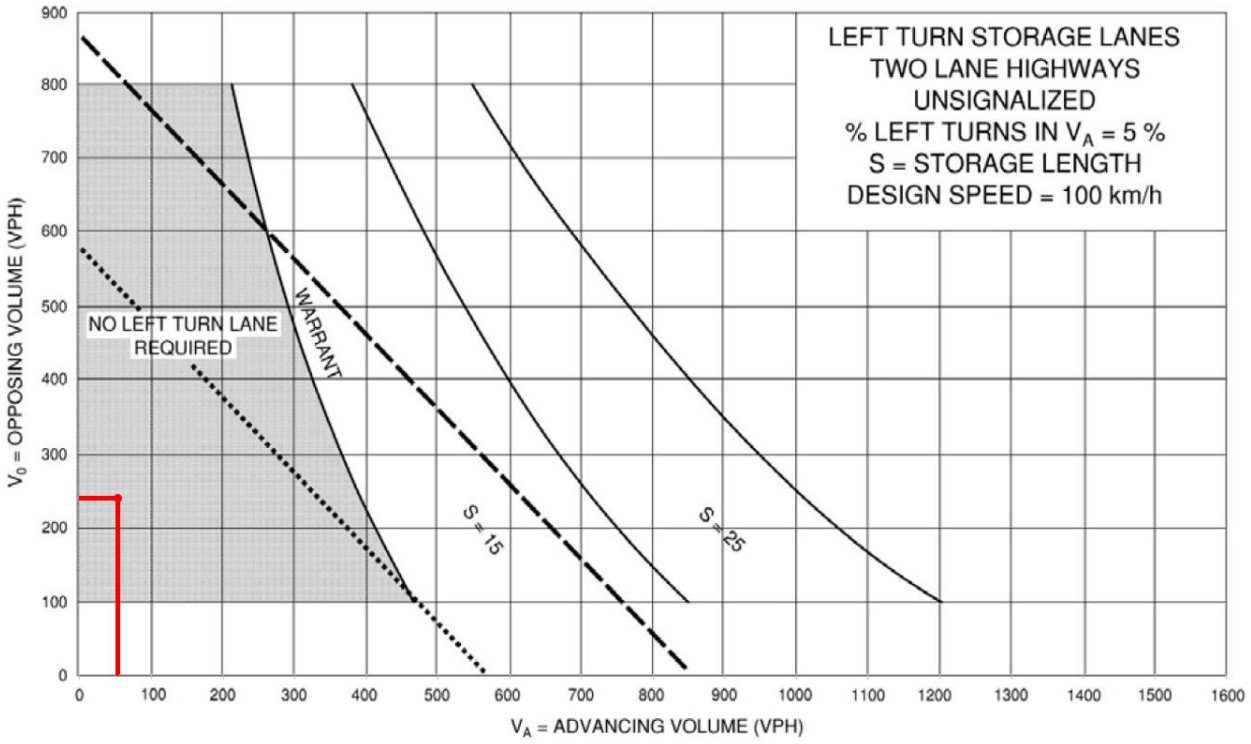
PM Peak Hour:



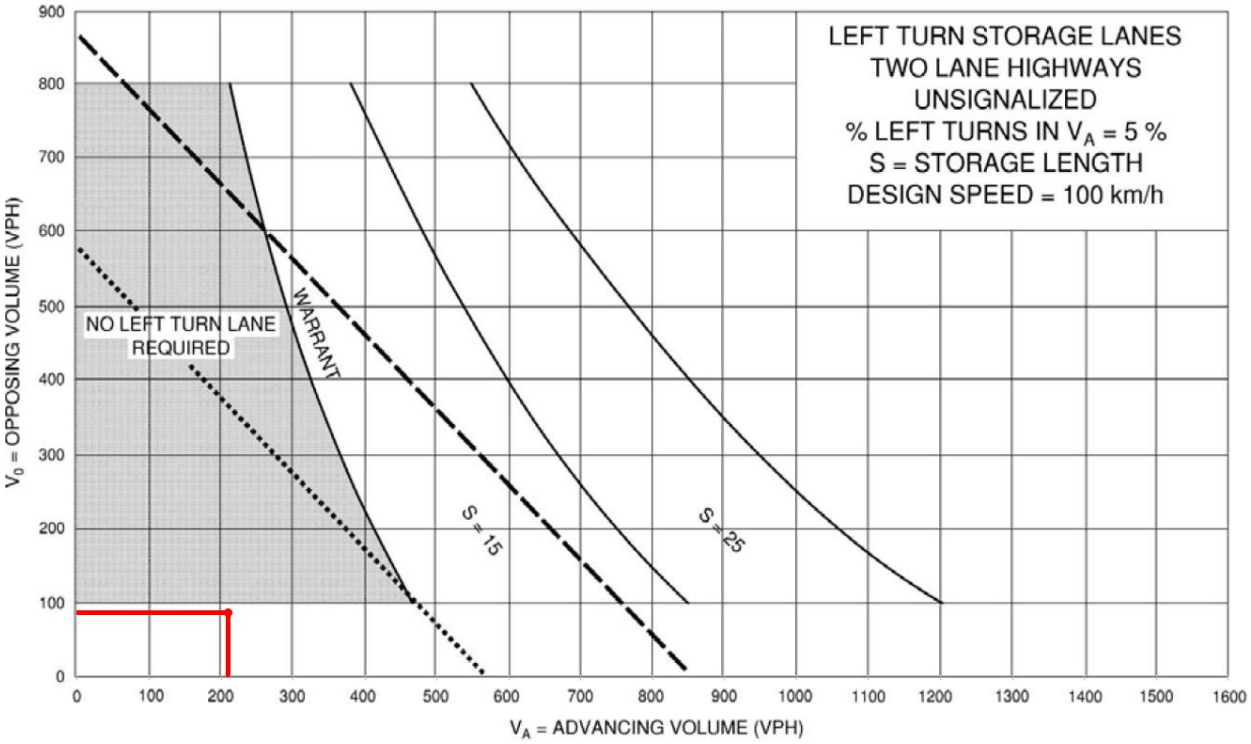
Northbound Left Turn Warrant at 20th Sideroad and Street "M" intersection

2041 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



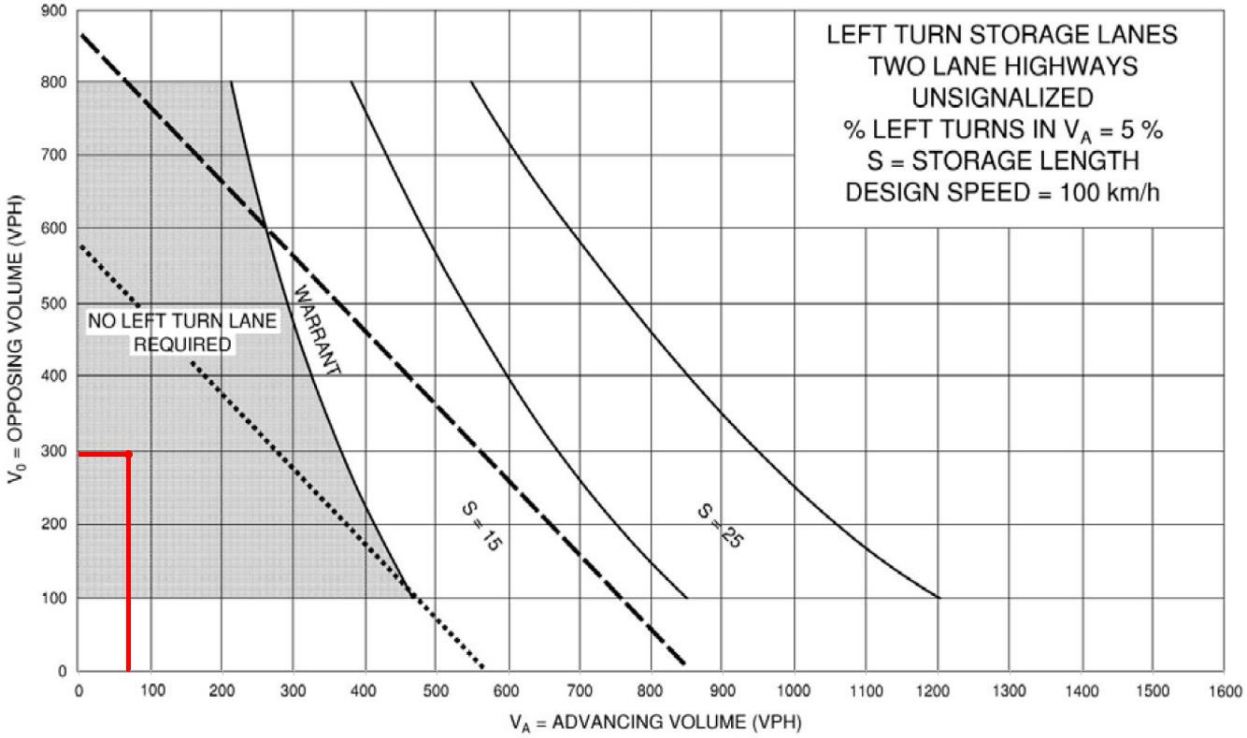
PM Peak Hour:



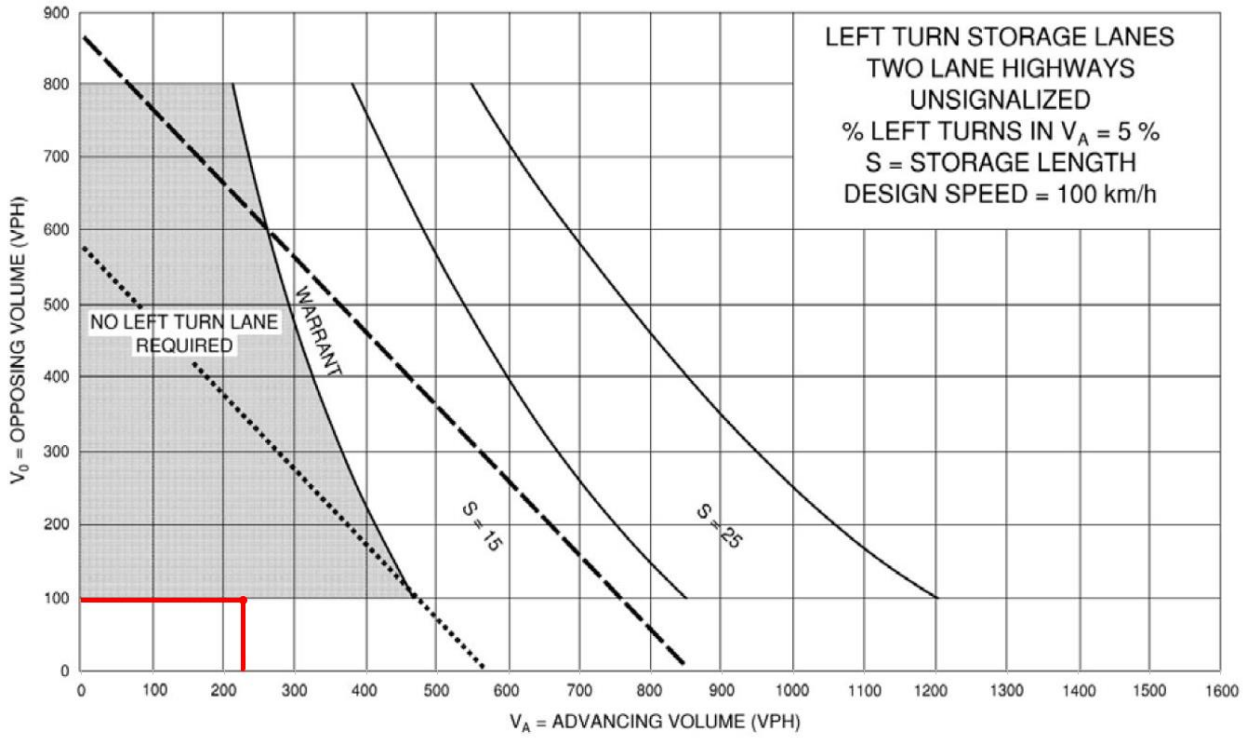
Northbound Left Turn Warrant at 20th Sideroad and Street "M" intersection

2041 Total Future Traffic Volumes (With School Trips)

AM Peak Hour:



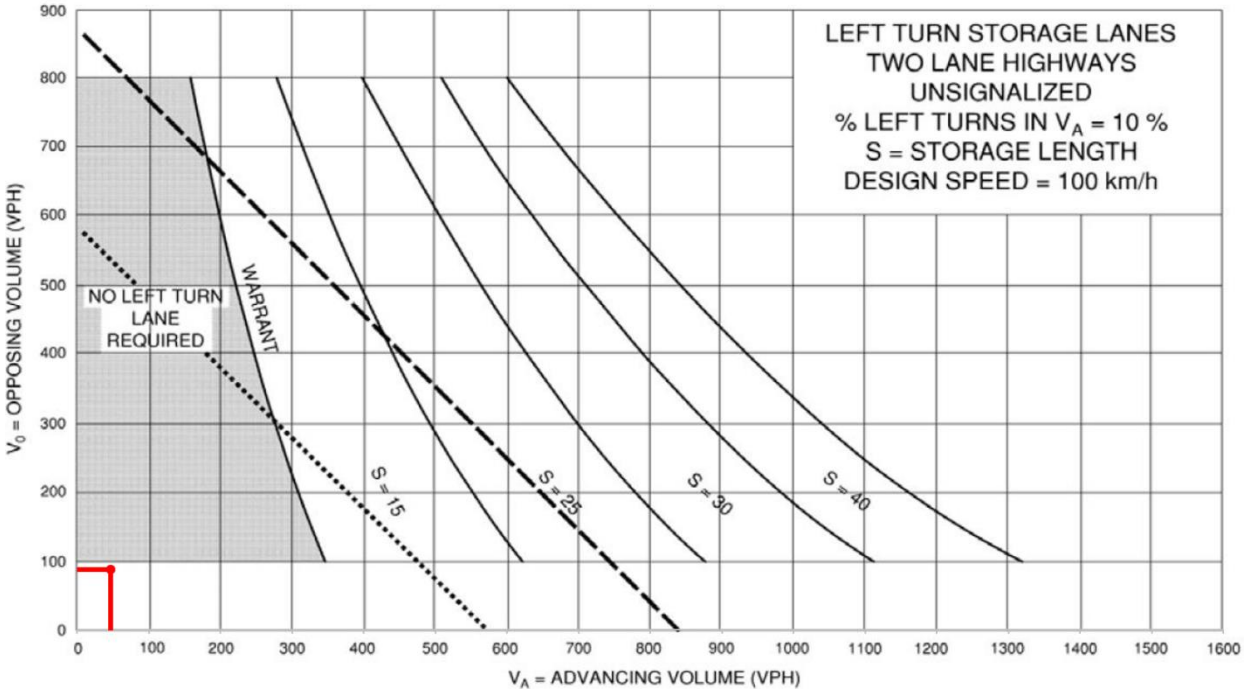
PM Peak Hour:



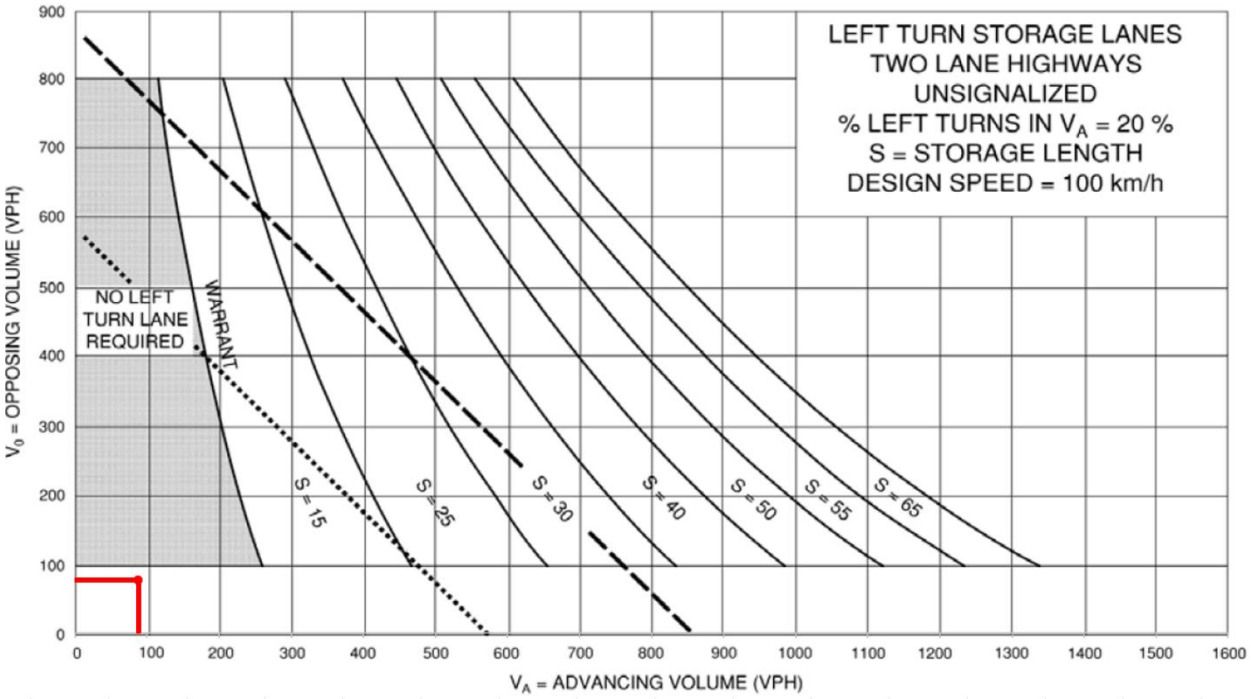
Northbound Left Turn Warrant at 20th Sideroad and Street "B" intersection

2031 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



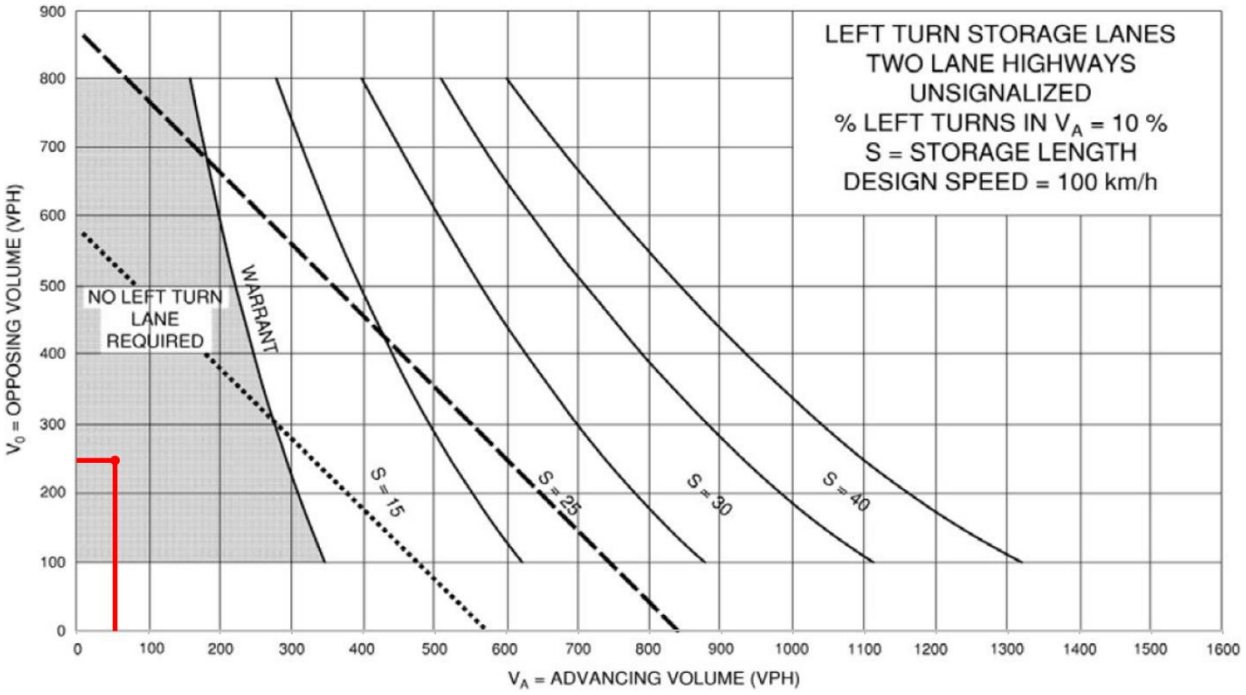
PM Peak Hour:



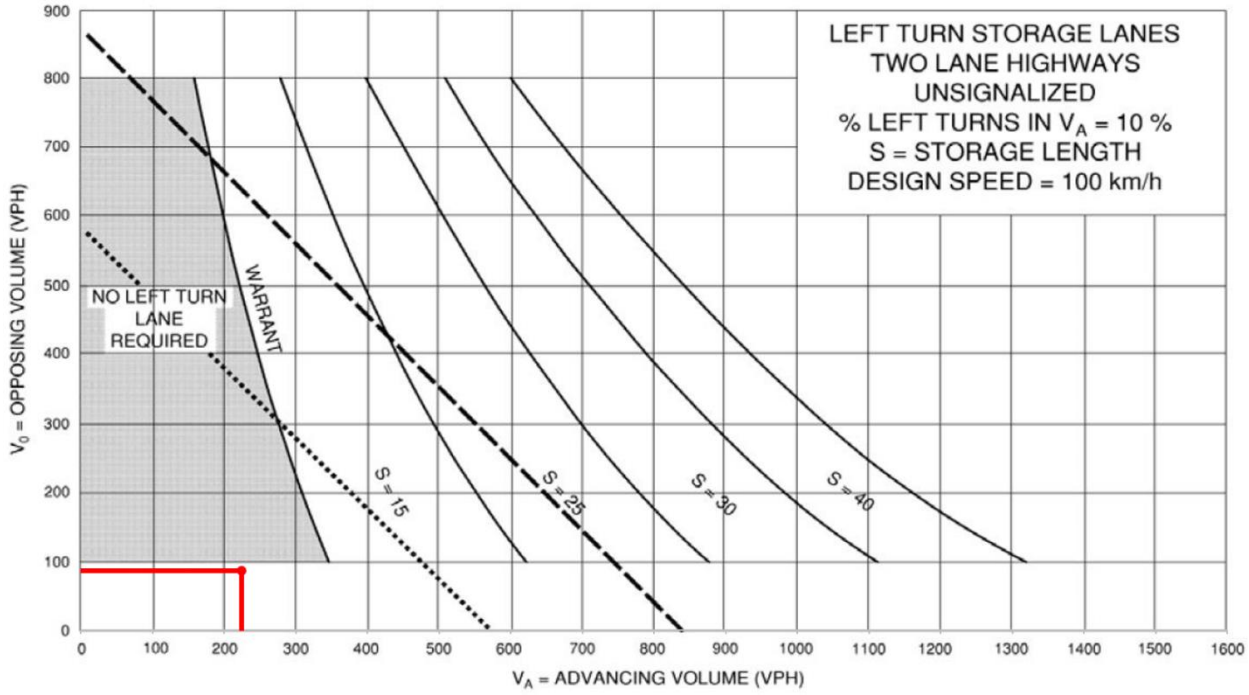
Northbound Left Turn Warrant at 20th Sideroad and Street "B" intersection

2041 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



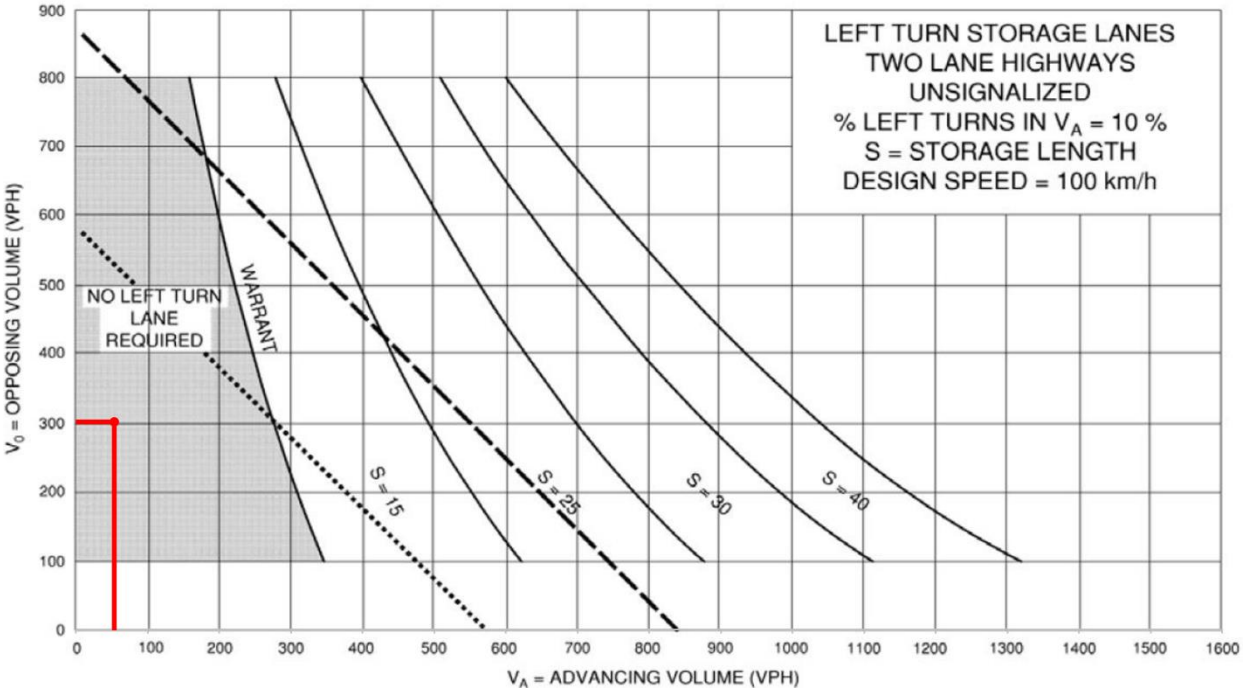
PM Peak Hour:



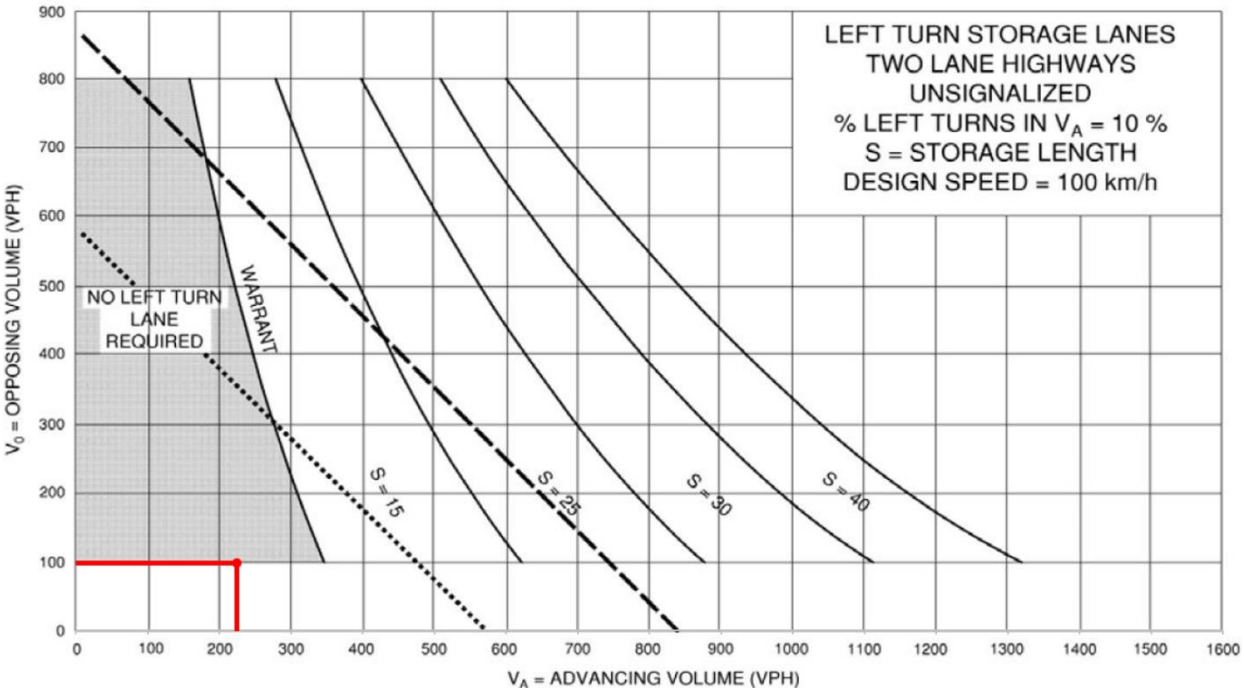
Northbound Left Turn Warrant at 20th Sideroad and Street "B" intersection

2041 Total Future Traffic Volumes (With School Trips)

AM Peak Hour:



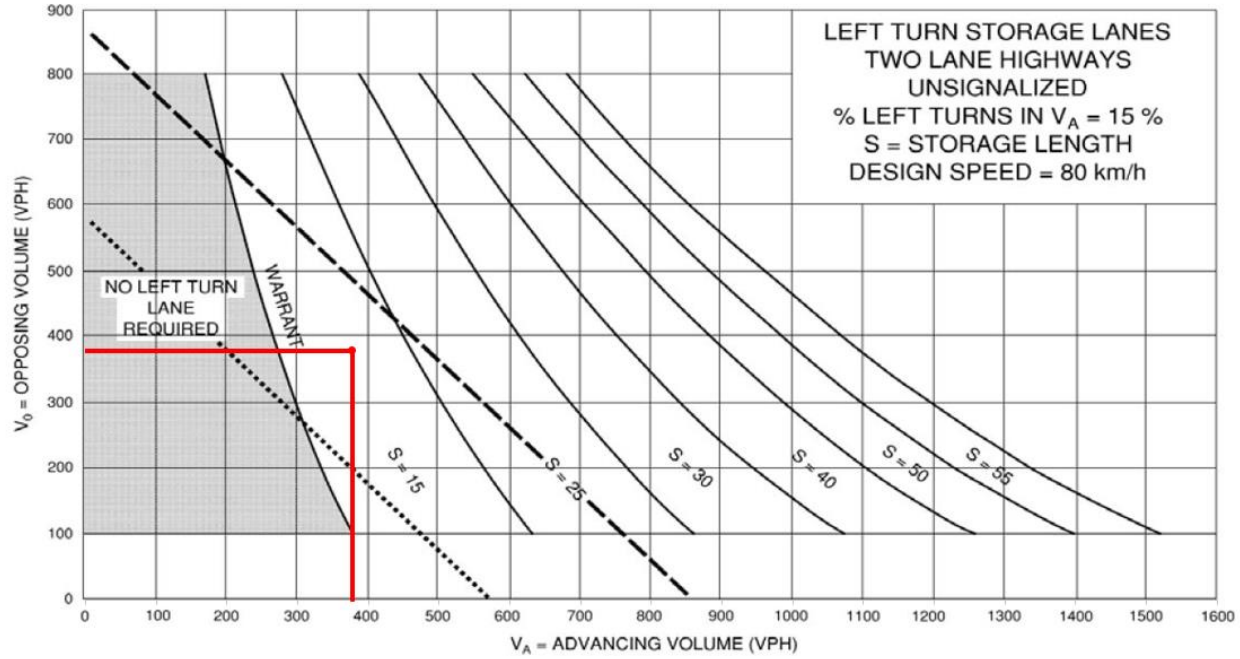
PM Peak Hour:



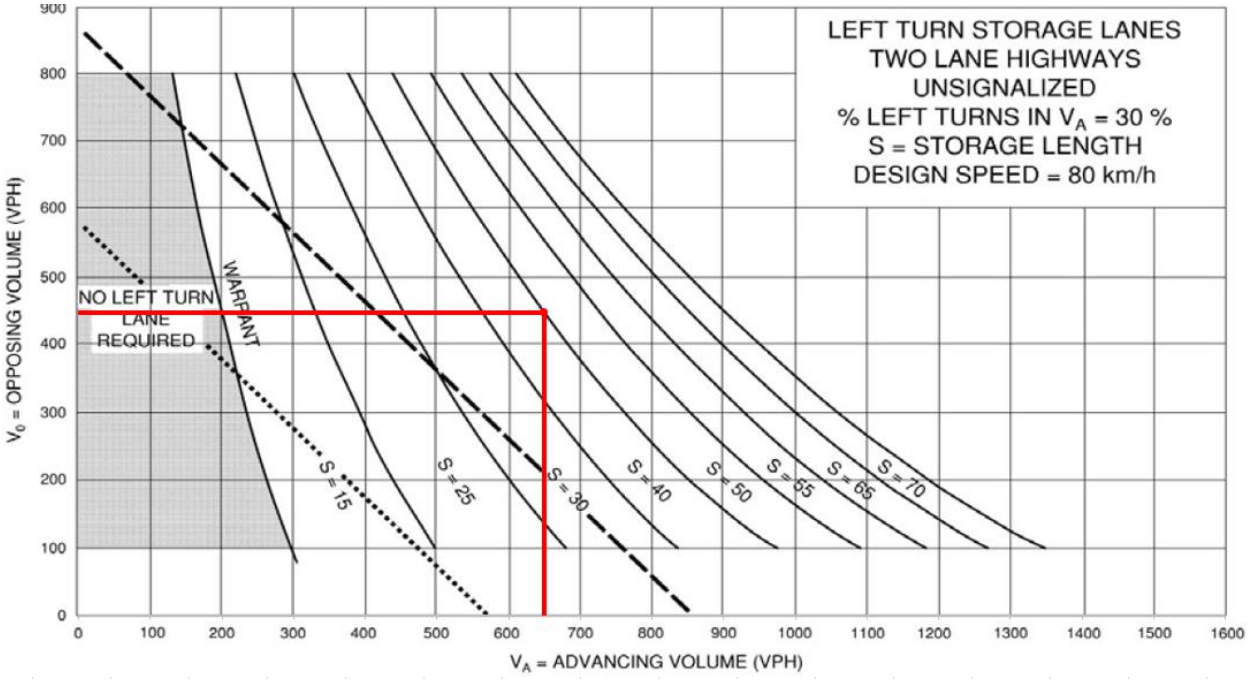
Eastbound Left Turn Warrant at Lockhart Road and Street “B” intersection

2031 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



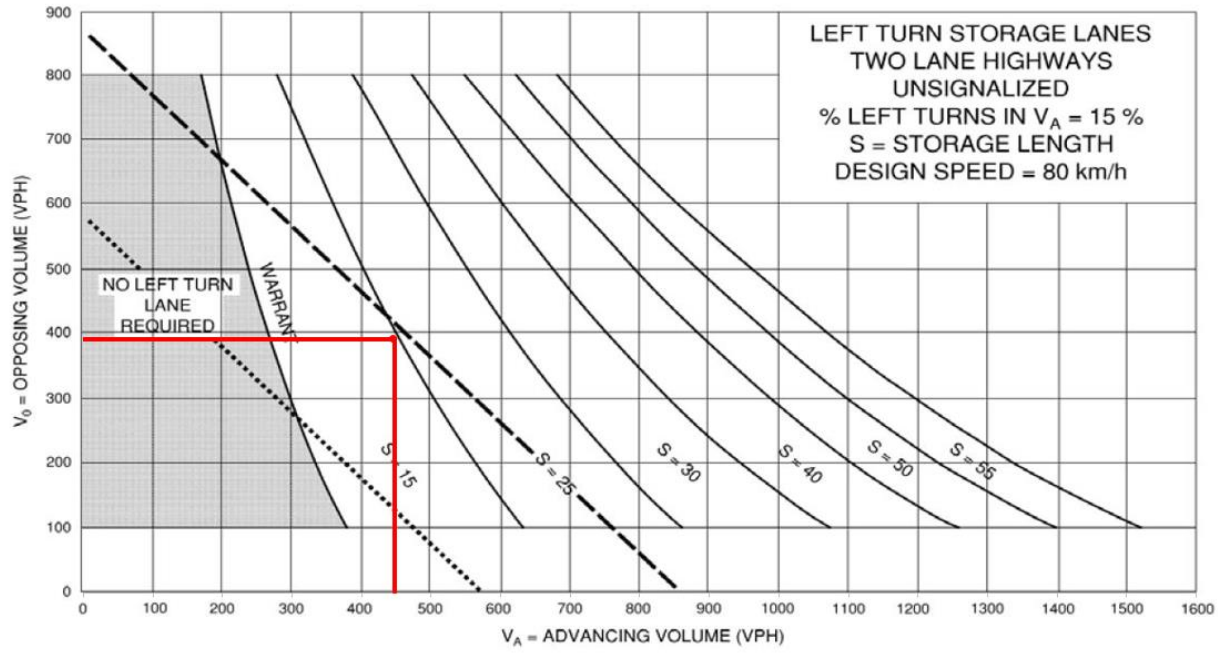
PM Peak Hour:



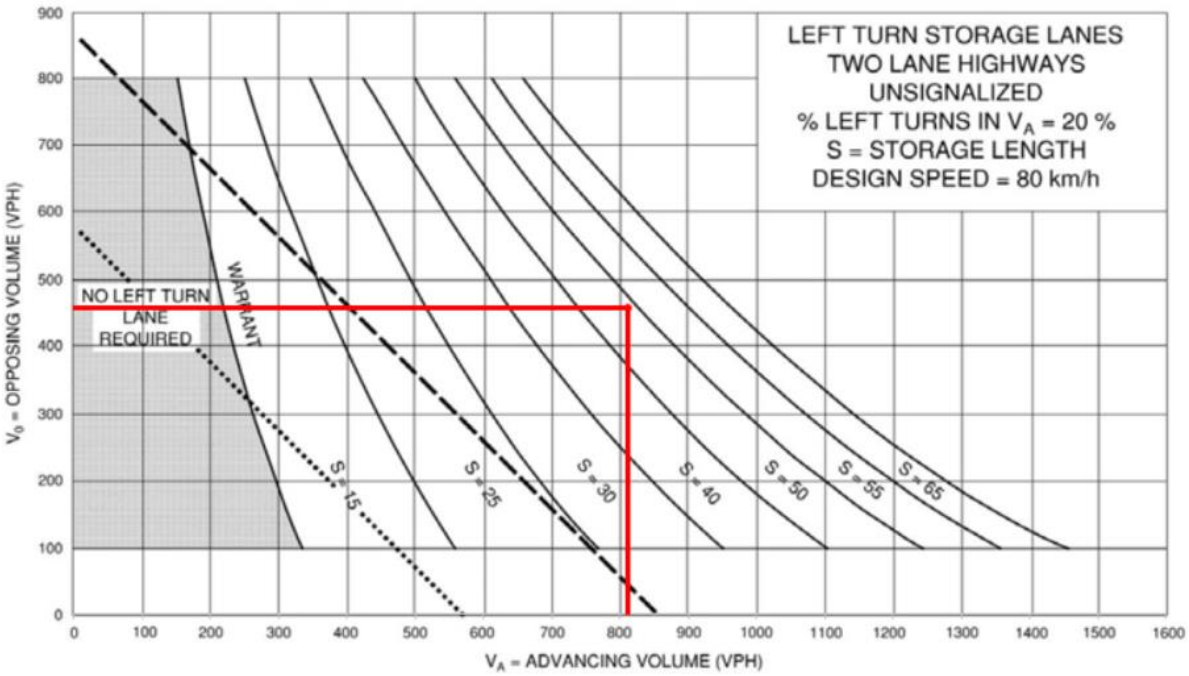
Eastbound Left Turn Warrant at Lockhart Road and Street "B" intersection

2041 Total Future Traffic Volumes (Residential Trips Only)

AM Peak Hour:



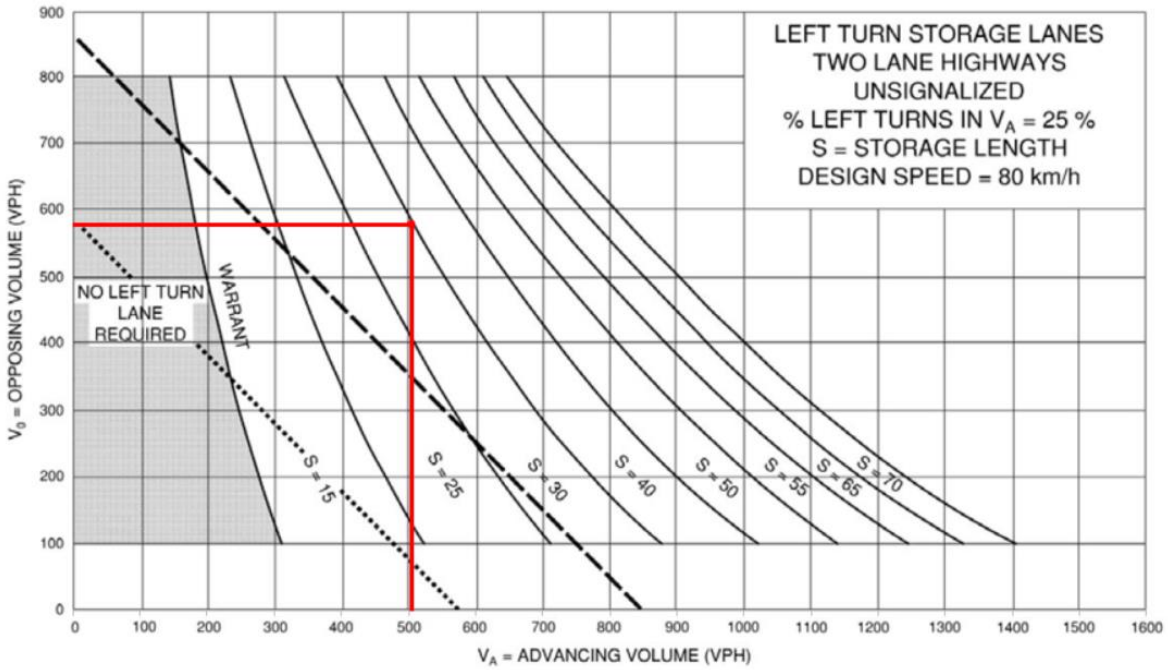
PM Peak Hour:



Eastbound Left Turn Warrant at Lockhart Road and Street "B" intersection

2041 Total Future Traffic Volumes (With School Trips)

AM Peak Hour:



PM Peak Hour: