Proposed New Parking Lot Development

St. Joseph's Catholic Elementary School, Douro
Township of Douro-Dummer
County of Peterborough

Traffic Impact Assessment

Prepared by:

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Prepared for:

PVNCCD School Board

March, 2022

March 11, 2022

Mr. James Jeffery
Salter Pilon Architecture Inc.
151 Ferris Lane, Suite 400,
Barrie, Ontario
L4M 6C1

Dear Mr. Jeffery:

Re: Traffic Impact Assessment Study for the Proposed New Parking Lot at St. Joseph's Catholic Elementary School, Douro, Township of Douro-Dummer, County of Peterborough

As requested, we have conducted a Traffic Impact Assessment Study in support of the proposed New Parking Lot at St. Joseph's Catholic Elementary School (St. Joseph's CES) on Douro 4th Line (4th Line) and Peterborough County Road 8 (CR 8) in Douro, in the Township of Douro-Dummer. This document describes the study process and the study findings.

1. Introduction

The St. Joseph's Catholic Elementary School on 4th Line and CR 8 northeast quadrant in Douro, in the Township of Douro-Dummer had been the subject of traffic assessment in 2018 as part of the "Traffic Assessment Study" to provide initial findings and suggestions for improvements regarding the school's traffic related issues, such as, no on-site school parking lot and students bus loading/unloading in front of the school on 4th Line and the general drop-off/pick-up of students using passenger vehicles at the school's front entrance. The study was carried out by Tranplan Associates, retained by the Peterborough Victoria Northumberland and Clarington Catholic District School Board (PVNCCDSB). The 2018 study provided the following conclusions and recommendations:

- St. Joseph's Elementary School in Douro currently operates without a dedicated parking lot on site. The school has permissions to use St. Joseph's church parking lot (across the street) most of the time when there are no special events scheduled at church. During the special event days, the school related parking moves to on-street parking on County Road 8 or on Douro 4th Line.

- In general, most of the school related traffic (other than school buses) activities are largely spread out between on-street near the school or the at the St. Joseph's Church during the peak AM drop-off and PM pick-up times.

- There are no reported (significant) or observed traffic issues during field surveys carried out at the school during the AM and PM peak times at St. Joseph's.

- At the school main entrance on 4th Line, where the school bus loading and unloading take place, is limited in terms of functionality due to the size of the bus loop and the room required for the number of school buses when all buses arrive at the same time.

- If opportunities arise to provide major improvements, such as, to develop an on-site parking facility with driveway access on County Road 8 east of Douro 4th Line intersection, to create an on-site drop-off/pick-up, loading/un-loading operations, every attempt should be made to provide safe access to school by pedestrians and to separate the school bus and private vehicle operations as it relates to students' drop-off/pick-up operations.

Since then, the PVNC School Board has developed a plan to provide an on-site parking lot in addition to the proposed addition to the existing school facility to replace the portable classrooms. The new parking lot will mainly be for staff and visitors with the parking lot access driveway on CR 8. It allows for the staff who will be at the school for the duration of the school day to park on site, while maintaining the church and on-street parking be available for short-term/

temporary parking needs. Exhibit 1.1 shows the location of the study site and shows the proposed parking lot.

2. Extent of the Analysis

This traffic impact assessment Terms of Reference for the new parking lot at St. Joseph's Catholic Elementary Public School was provided by the County of Peterborough and the study consisted of the following process:

1. Contacted Peterborough County staff to determine their concerns and requirements.
2. Reviewed initial plans for the development.
3. Visited the site and inspected the access routes to/from the site.
4. Reviewed and commented on the revised plans after the assessment of initial findings from the field observations and data collection.
5. Assessed the traffic impact assessments for the new parking lot driveway to ensure conformity to County standards as well as safe vehicle movements and circulation throughout the parking lot.
   **It is noted that the intersection capacity analysis is not carried out or necessary/requested since based on field observation from 2018 and 2021, there are no traffic congestion/capacity related issues on the school access associated roadways.*
6. Prepared this documentation of the analysis.

3. Existing Conditions/Operations

Tranplan conducted field observations and field data collection at the subject school during the month of October 2021. It is noted that the field observations were carried out during COVID-19 when the provincial travel restrictions were relaxed and when the schools were open to in-class learning. However, it was found that overall traffic patterns in the vicinity of the school have changed, the peak hour traffic volumes were found to be lower, but the school related

Exhibit 1.1: Study Site and Proposed New Parking Lot

activities remained relatively same when compared to 2018 observations. As such, the pre-COVID, 2018 conditions/traffic volumes are used for study assessments (see, Appendix A). It would be considered the "worst case" scenario.

Currently, the school operating times for St. Joseph's CES is between 8:45 AM and 3:20 PM. It is served by five school buses, arriving at various times between 8:30 AM and 8:40 AM in the morning and between 2:50 PM and 3:15 PM in the afternoon. The school bus loading/un-loading takes place in the loading/un-loading area in front of the school. The loading/un-loading area is one-way driveway system (all vehicles are to enter through the south driveway and exit via the north driveway). If the buses are parked perfectly, up to four long school buses can fit in the school bus loading/un-loading driveway loop. However, during the morning drop-off operation, only one school bus drops off the students at a time where in the afternoon pick-up operations, four school buses are parked in the driveway loop waiting for students to be let out of the school. One school bus wait on street until opening comes up and picks up students at the designated loading/unloading area driveway loop.

The following are relevant traffic observations during the peak AM and PM drop-off and pick-up times:

<u>AM Peak Drop-off Operation</u>

- In the morning between 8:20 AM and 9:20 AM, total of approximately 20 vehicles (including five school buses) were observed entering the school driveway loop site and the same number of vehicles were observed leaving the school driveway loop.
- Approximately 25 vehicles were observed to park on Douro 4th Line, County Road 8 and three vehicles were parked at the church parking lot.
- In total, 20 student/pedestrians were observed having to cross Douro 4th Line to get to school.
- The field observations indicate that most of the students are dropped-off between 8:30 AM and 8:45 AM at the same time when the school buses

are unloading the students.

- In total, five school buses were observed. The average unloading of the students took less than two minutes (time observed in a bus arriving into the loading area, unloading of the students and departing) per school bus.
- In the morning, even though the school buses arrive at different times, only the buses within the loading area are allowed to let the children off the school buses. As such, significant queuing takes place as the school buses wait to get in to the loading area. On the day of the site visit, two school buses were waiting to enter the loading area effectively extending the queue on Douro 4th Line to the Douro 4th Line/County Road 8 intersection.
- Furthermore, on the day of the field observation, a funeral was held at the church, thereby limiting the church parking lot use by the school traffic. As such, the drop-off operations were being conducted on-street.
- On-Street parking is available on Douro 4th Line and on County Road 8. It provides legal short-term parking for drop-off operation (park the vehicle and walk the student into school).

PM Peak Pick-up Operation

The pick-up operation takes place between 2:45 PM and 3:45 PM (students are let out at 3:20 PM). The first school bus arrives around 2:45 PM and by 3:05 PM, four school buses occupy all available waiting spaces for school buses in the loading/unloading driveway loop. The fifth school bus arrived at 3:15 PM, waits in queue, on street when the children are let out at 3:20 PM. On the day of the field work and traffic surveys, the following (mainly passenger vehicle observations) were recorded:

- There were 10 vehicles that arrived between 2:45 PM and 3:20 PM to pick-up the students, where 5 vehicles parked on church parking lot and five vehicles were parked on-street on Douro 4th Line.

- Five additional vehicles arrived after 3:20 PM to pick-up students after the last bell. All five vehicles parked on-street and picked-up the students when they came out of the school.
- At 3:25 PM, school buses begin to leave the school driveway loop and all five school buses leave the school by 3:30 PM.
- The majority of pedestrian movements were observed when the parents cross Douro 4th Line from the church parking lot to the school and back with the students when they are let out.
- People walking from the parked vehicles to the school's front door to pick-up the children and walking back to the vehicles were the only pedestrians observed during the afternoon pick-up times.
- Most of the school buses left the loading area within ten minutes after the students were let out of the school. Each school bus pick-up operation took about a minute (less than a minute) to load the students and drive away.

4. Proposed Site Plan/New Parking Lot Review

The proposed site plan, Exhibit 1.2, shows the new parking lot at the St. Joseph's Catholic Elementary School with driveway access on County Road 8. It indicates a parking lot capacity of 25 passenger vehicles. It is our understanding that, all parking spaces will be dedicated to long-term parking for all school staff (including teachers) and some visitors. For school drop-off and pick-up operations, the current operations on 4th Line and (to the less extent) the use of Church parking lot will be maintained.

4.1 Parking Lot Driveway Intersection Spacing Review

The intersection spacing assessment is carried out based on the County of Peterborough/TAC Design Criteria, for the proposed parking lot driveway in relation to intersection of County Road 8/4th Line. The intersection spacing review is illustrated in Exhibit 1.3. TAC Chapter 8, Section 8.8, including Table 1.1: Figure 8.8.2: Suggested Minimum Corner Clearances to

Exhibit 1.2: Proposed Site Plan/New Parking Lot

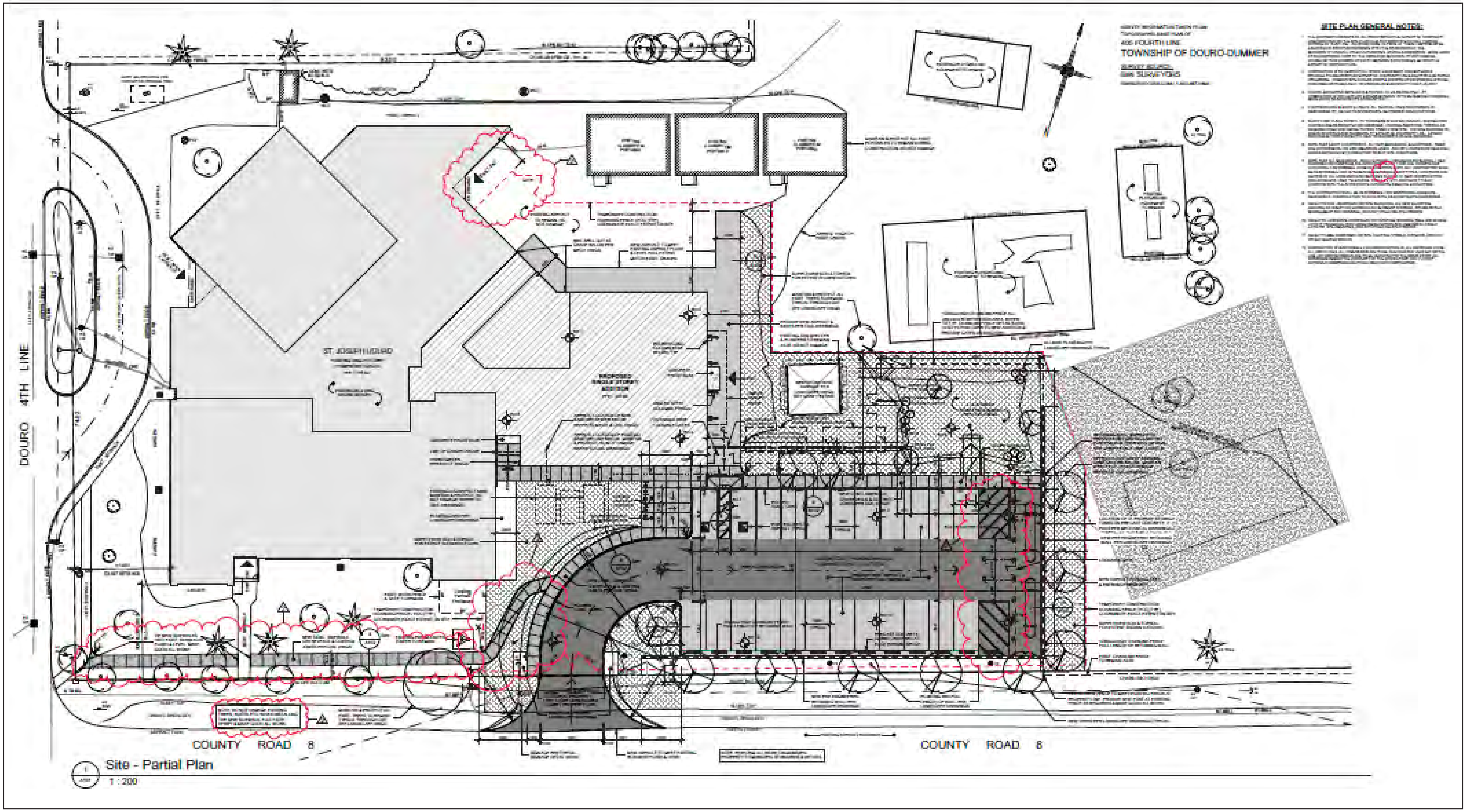
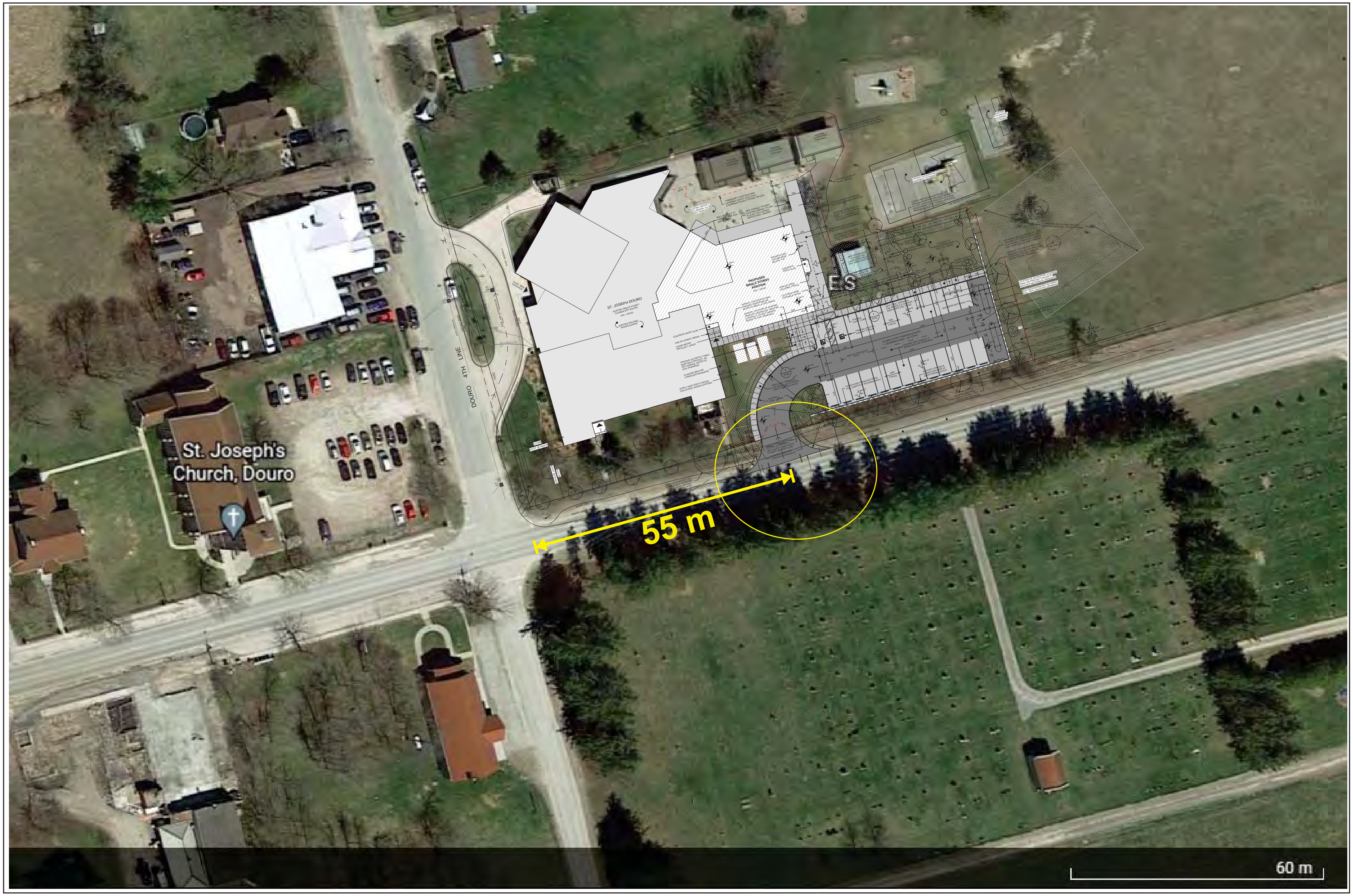
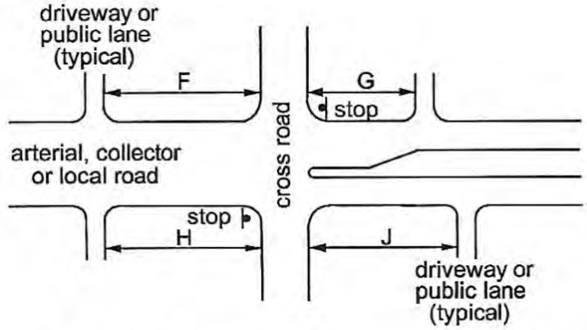


Exhibit 1.3: New Parking Lot Driveway Distance from 4th Line/County Road 8 Intersection



Accesses or Public Lanes at Major Intersections, the following is provided:

Table 1.1: Figure 8.8.2: Suggested Minimum Corner Clearances to Accesses or Public Lanes at Major Intersections



item	min. clearance, m		
	arterial	collector [b]	local [b]
F	35	20	15
G	# [a]	25	15
H	25	25	15
J	35	20	15

Notes: a. Distance (#) positions driveway or public lane in advance of the left turn storage length (min.) plus bay taper (des.).
b. Lesser values reflect lower volumes and reduces level of service on collectors and locals.

stop control at the cross road

Figure 8.8.2: Suggested Minimum Corner Clearances to Accesses or Public Lanes at Major Intersections

As Figure 8.8.2 in Table 1.1 indicates, the suggested minimum corner clearance is 35 m. The proposed driveway is approximately 55 m.

4.2 Parking Lot Driveway Sight Distance Review

The excerpt of the relevant section of the Transportation Association, Canada (TAC) Geometric Design Guide for Canadian Roads, 2017, is provided in the Technical Appendix appended to this report (see Appendix B: Excerpts from TAC Chapter 9 – Intersections). It defines the intersection sight distance, on page 60 of Chapter 9, as "the sight distance available from a point where vehicles are required to stop on the intersection road, while drivers are looking left and right along the major roadway, before entering the intersection. The intersection sight distance is adequate when it allows the design vehicles to safely make all maneuvers that are permitted by the layout (e.g., left turns, right turns, through moves), without significantly affecting vehicles travelling on the main roadway".

Furthermore, in determining the intersection sight distance requirements, TAC has adopted the gap acceptance methodology outlined in "AASHTO's Policy on Geometric Design of Highways and Streets, 6th Editions, 2011". The "gap acceptance" is measured in seconds, a time required for a "minor-road vehicle to accelerate from a stop and complete a left turn without unduly interfering with major-road traffic operations."

Based on TAC standards, the available sight distance can be measured by a reviewing the sightlines as per the proposed site access road/parking lot driveway location from the Site Plan and the available topographic survey/air photo overlay and confirmed through field measurements, or by a "travel time" survey (measuring travel time of available sight distance) of traffic passing through the site access road/parking lot driveway on County Road 8.

Based on the TAC Geometric Design Guide for Canadian Roads, 2017, Section 9.9, the following table provides the intersection sight distance standards for 70 km/h – 80 km/h design speed:

Table 1.2: Intersection Sight Distances

	Intersection Sight Distance			
Design Speed	Minimum Stopping Distance (m)	Left Turns from Minor Road (m)	Right Turns from Minor Road (m)	Left Turns from Major Road (m)
Time Gap		7.5 sec.	6.5 sec.	5.5 sec.
70 km/h	**105**	**150**	**130**	**110**
80 km/h	**130**	**170**	**145**	**125**

Exhibit 1.4 provides approximate "airline" distances of relevant sight distances measured (showing proposed frontage of proposed parking lot

Exhibit 1.4: New Parking Lot Driveway Sight Distance to East

driveway on CR 8) using Google Aerial Photo Distance Measure Function from the approximate location of the proposed driveway on CR 8. It indicates that minimum sight distance (to east) of approximately 170 m is available. This "airline" distance was confirmed through field measurements (using Walking Measuring Wheel) of available sight distance to the east from the approximate location of the proposed parking lot driveway, as illustrated in Exhibit 1.4.

Time Gap Survey

A "time gap" measurement study was carried out by Tranplan Associates during the field survey conducted in the afternoon of October 28, 2021 and recorded the "travel time" of traffic passing through the proposed parking lot driveway on CR 8 using video recordings. It is noted that the time gap survey observed and measured travel time of only 5 vehicles (observed for approximately 15 minutes period) travelling westbound on CR 8. The vehicles approaching the driveway were observed to measure travel time from the point where the vehicle was visible (nearest point) from the driveway to the vehicle passing through the driveway. Exhibit 1.5 describes the start and end locations for travel time measurement. The average travel time or "time gap" for the observed vehicles was 10.8 seconds. Based on the survey results, there are sufficient "time gaps" on County Road 8 for 80 km/h design speed for a vehicle to make a left turn from the proposed parking lot driveway to head west on CR 8.

4.3 Auxiliary Lanes at Parking Lot Driveway

Auxiliary turning lanes (right turn and left turn lanes) analysis at the proposed parking lot driveway is based on Tranplan observed 2018 data as well as County of Peterborough reported 2018 AADT for the section of CR 8 (identified in County Files as 008-03080) between CON.4/5, HAMLET OF DOURO-to-COUNTY ROAD 38, which indicates daily traffic of 1,250 vehicles. In general, peak hour volume represents approximately 10% of the daily traffic, which would indicate approximately 125 vehicles travelling in both direction in CR 8 in the vicinity of the proposed parking

Exhibit 1.5: Travel Time Measurement Start and End Locations

lot driveway. As a "worst case" scenario, for the purposes of right turn lane and the left turn lane warrant analysis, the study considered 125 vehicles travelling in one direction (in advancing direction) and assumed 75% (approximately 95 vehicles) of the traffic to be in the opposing direction for the peak hour of analysis. Furthermore, for a right turn lane warrant analysis, all parking lot related vehicles (25 vehicles) would be making a right turns into the parking lot and for left turn lane warrant analysis, all vehicles are assumed to make left turns into the parking lot.

Auxiliary turning lanes (right turn and left turn lanes) warrant analysis, see Appendix C, indicates that the peak hour traffic volumes on CR 8 are so low that it doesn't meet the minimum required warrant volumes.

5. Internal Site Circulation

The proposed parking lot was reviewed for parking lot layout, regular passenger vehicles circulations and general access. The site access and the internal circulation are based on the Transportation Association, Canada (TAC) Passenger Design Vehicle Standards. The access to the site and the vehicle movements from the site entrance to the parking area and the maneuvering in and out of the parking stalls have been tested using *AutoTurn* Software version 9 (submitted as autocad file). The vehicle turning diagram indicates that the passenger vehicles have ease of access/egress using the proposed driveways. There are no issues with any of the parking stalls for the vehicle to maneuver in and out of the parking stalls.

6. Summary

In summary, the proposed parking lot is designed appropriately. The driveway access on County Road 8 is located sufficiently away (approximately 55 m) from

CR 8/4th Line intersection and has sufficient sight distance for the vehicles to safely turn to/from the parking lot driveway onto County Road 8 traffic stream. The study analysis also indicated that auxiliary turning lanes are not required at the proposed parking lot driveway and no mitigation measures are required on County Road 8 or on Douro 4th Line.

Additional background information on the study analysis is available in the study working files. If you should require any additional information on the study analysis, please do not hesitate to contact me at your convenience.

Yours truly,

Seo-Woon Im, B.E.S.
Senior Transportation Planner
Tranplan Associates

TECHNICAL APPENDIX

APPENDIX A: 2018 Observed Traffic Data

DATE	03-Apr-2018	VIDEO AUDIT of ST. Joseph C.E.S. (Duoro) Vehicular and Pedestrian Traffic				
TIME	Observation	school related?	from	Action	to	Trip Details
before footage	SCHOOLBUS #1 IN DRIVEWAY	yes	unknown	Park/Stop	driveway	origin unknown
8:30:20 AM	PED west to east from Vehicle DROP OFF	yes	Westside of 4th Line	crossing	school	1xPED, silver sedan, south facing
8:30:20 AM	PED west to east from Vehicle DROP OFF	yes	Westside of 4th Line	crossing	school	1xPED, silver sedan, south facing
8:30:20 AM	PED west to east from Vehicle DROP OFF	yes	Westside of 4th Line	crossing	school	1xPED, silver sedan, south facing
8:30:32 AM	SCHOOLBUS #2	yes	Hwy 8	EBL	4th Line	NBR to school driveway
8:30:50 AM	SCHOOLBUS #3	yes	Hwy 8	EBL	4th Line	NBR to school driveway
8:30:55 AM	PED east to west return to Vehicle	yes	school	crossing	West of 4th Line	1xPED, silver sedan, south facing
8:31:20 AM	Vehicle EXIT	yes	4th Line	SBR	Hwy 8	silver sedan
8:33:07 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	Westside of 4th Line	1xPED, black pickup, north facing
8:33:07 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	Westside of 4th Line	1xPED, black pickup, north facing
8:33:21 AM	SCHOOLBUS #1 EXITS	yes	driveway	WBL	4th Line	SBL @ Hwy8/4thLine
8:33:42 AM	Vehicle EXIT	yes	Eastside of 4th Line	NBT	4th Line	black pickup
8:33:49 AM	SCHOOLBUS #4	yes	4th Line @HWY8	NBT	4th Line @HWY8	NBR to school driveway
8:34:22 AM	PED from Vehicle DROP OFF	yes	Westside of 4th Line	U-turn	Eastside of 4th Line	1XPED, dark Pickup, behind bus, drop off likely
8:35:25 AM	SCHOOLBUS #2 EXITS	yes	driveway	WBL	4th Line	SBR @ Hwy8/4thLine
8:35:43 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	Eastside of 4th Line	1xPED, black minivan, north facing
8:35:43 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	Eastside of 4th Line	1xPED, black minivan, north facing
8:35:50 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	Eastside of 4th Line	1xPED, red sedan, north facing
8:35:58 AM	Vehicle EXIT	yes	Eastside of 4th Line	NBT	4th Line	dark pickup, behind bus now in view
8:36:00 AM	SCHOOLBUS #5	yes	4th Line @HWY8	NBT	4th Line @HWY8	NBR to school driveway
8:36:19 AM	Vehicle EXIT	yes	Eastside of 4th Line	U-turn	Westside of 4th Line	red sedan, north facing, SBR @ Hwy8/4thLine
8:36:49 AM	SCHOOLBUS #3 EXITS	yes	driveway	WBL	4th Line	SBR @ Hwy8/4thLine
8:36:56 AM	Vehicle EXIT	yes	Eastside of 4th Line	U-turn	Westside of 4th Line	black minivan, north facing, SBR @ Hwy8/4thLine
8:36:59 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	Eastside of 4th Line	1xPED, black pickup, north facing
8:37:05 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	Eastside of 4th Line	1xPED, red sedan, north facing
8:37:19 AM	Vehicle Entry	yes	Hwy 8	EBL	4th Line	silver minivan, NBL to church Lot
8:37:32AM	Vehicle EXIT	yes	Eastside of 4th Line	U-turn	Westside of 4th Line	red sedan, north facing, SBR @ Hwy8/4thLine
8:37:40 AM	Vehicle EXIT	yes	Eastside of 4th Line	U-turn	Westside of 4th Line	black pickup, north facing, SBR @ Hwy8/4thLine
8:38:06 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	Eastside of 4th Line	1xPED, silver pickup, north facing
8:38:06 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	Eastside of 4th Line	1xPED, silver pickup, north facing
8:38:16 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	driveway	1xPED, silver SUV, NBR to driveway
8:38:20 AM	SCHOOLBUS #4 EXITS	yes	driveway	WBL	4th Line	SBR @ Hwy8/4thLine
8:38:27 AM	SCHOOLBUS #5 EXITS	yes	driveway	WBR	4th Line	NBT on 4th Line
8:39:40 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	4th Line	1xPED, silver hatchback, NBR to driveway
8:40:05 AM	PED from Vehicle DROP OFF	yes	4th Line	SBL	driveway	1xPED, dark hatchback
8:40:07 AM	PED west to east from Vehicle DROP OFF	yes	church lot	crossing	school	1xPED, silver minivan in church lot
8:40:07 AM	PED west to east from Vehicle DROP OFF	yes	church lot	crossing	school	1xPED, silver minivan in church lot
8:40:07 AM	PED west to east from Vehicle DROP OFF	yes	church lot	crossing	school	1xPED, silver minivan in church lot
8:40:33 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	silver SUV, SBR @ Hwy8/4thLine
8:40:38 AM	Vehicle EXIT	yes	driveway	WBR	4th Line	silver pickup, NBT @ 4thLine
8:40:55 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
8:41:39 AM	Vehicle EXIT	yes	church lot	EBR	4th Line	blue sedan, SBT @ Hwy8/4th
8:42:35 AM	PED from Vehicle DROP OFF	yes	4th Line	SBL	driveway	1xPED, dark sedan
8:42:37 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
8:42:55 AM	PED south to north ENTRY	yes	SE corner of hwy8/4thLine	crossing	NE corner of hwy8/4thLine	1xPedestrian
8:43:04 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	dark hatchback, SBL @ Hwy8/4thLine
8:44:00 AM	Vehicle EXIT	yes	driveway	WBR	4th Line	dark sedan, NBT @ 4thLine
8:44:07 AM	Vehicle EXIT	yes	church lot	EBR	4th Line	silver minivan, SBR @ Hwy8/4th
8:44:24 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	4th Line	1xPED, red minivan, NBR to driveway
8:44:40 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	4th Line	1xPED, white sedan, NBR to driveway
8:45:00 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	4th Line	1xPED, black hatchback, NBR to driveway
8:45:10 AM	PED west to east ENTRY	yes	NW corner of hwy8/4thLine	crossing	NE corner of hwy8/4thLine	1xPedestrian
8:45:10 AM	PED west to east ENTRY	yes	NW corner of hwy8/4thLine	crossing	NE corner of hwy8/4thLine	1xPedestrian
8:45:48 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	red minivan, SBL @ Hwy8/4thLine
8:46:14 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	white sedan, SBR @ Hwy8/4thLine
8:46:30 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	4th Line	1xPED, black pickup, NBR to driveway
8:46:40 AM	PED east to west EXIT	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian, parent after drop off of child
8:47:00 AM	PED west to east from Vehicle DROP OFF	yes	Westside of 4th Line	crossing	school	1xPED, White SUV, south facing, SBT on 4thLine
8:47:00 AM	PED west to east from Vehicle DROP OFF	yes	Westside of 4th Line	crossing	school	1xPED, White SUV, south facing, SBT on 4thLine
8:47:30 AM	PED from Vehicle DROP OFF	yes	4th Line	SBL	driveway	1xPED, dark minivan
8:49:00 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	black pickup, SBR @ Hwy8/4thLine
8:49:02 AM	Vehicle EXIT	yes	driveway	WBR	4th Line	black sedan, NBT @ 4thLine
8:50:56 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
8:51:26 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
8:51:50 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
8:52:00 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	dark minivan, SBT @ Hwy8/4thLine
8:52:30 AM	Vehicle EXIT	yes	Westside of 4th Line	SBR	Hwy 8	westside parked White SUV south facing
8:52:33 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	4th Line	1xPED, black pickup, NBR to driveway
8:52:37 AM	Vehicle EXIT	yes	church lot	EBR	4th Line	silver sedan, SBR @ Hwy8/4th
8:52:39 AM	Vehicle Entry	yes	Hwy 8	EBL	4th Line	white sedan, NBL to church Lot
8:52:52 AM	PED from Vehicle DROP OFF	yes	4th Line	SBL	driveway	1xPED, dark minivan
8:53:22 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
8:53:34 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	white pickup, SBR @ Hwy8/4thLine
8:53:35 AM	Vehicle EXIT	yes	church lot	EBR	4th Line	black minivan, SBT @ Hwy8/4th
8:53:49 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	dark minivan, SBR @ Hwy8/4thLine
8:53:55 AM	PED from Vehicle DROP OFF	yes	church lot	crossing	school	1xPedestrian
8:57:06 AM	Vehicle Entry	yes	4th Line	SBR	church lot	grey sedan
8:57:42 AM	PED south to north ENTRY	yes	SE corner of hwy8/4thLine	crossing	NE corner of hwy8/4thLine	1xPedestrian
8:57:51 AM	Vehicle EXIT	yes	church lot	EBR	4th Line	white SUV, SBR @ Hwy8/4th
9:00:00 AM	PED EXIT	yes	school	EASTBOUND	eastwards	ped walks on lawn eastwards

9:00:15 AM	PED west to east from Vehicle DROP OFF	yes	church lot	crossing	school	1xPedestrian
9:00:39 AM	PED from Vehicle DROP OFF	yes	Hwy 8	WBR	4th Line	1xPED, dark sedan, NBR to driveway
9:01:02 AM	PED from Vehicle DROP OFF	yes	Hwy 8	EBL	4th Line	1xPED, dark sedan, NBR to driveway
9:01:20 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	dark sedan, SBR @ Hwy8/4thLine
9:03:07 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	dark sedan, SBR @ Hwy8/4thLine
9:11:45 AM	PED Entry	yes	eastwards	NORTHBOUND	school	ped walks on lawn northwards from eastside
9:24:30 AM	PED from Vehicle DROP OFF	yes	4th Line	SBL	driveway	1xPED, dark hatchback
9:27:40 AM	Vehicle EXIT	yes	driveway	WBL	4th Line	dark hatchback, SBL @ Hwy8/4thLine
9:29:40 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
9:29:40 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
9:29:40 AM	PED east to west return to Vehicle	yes	school	crossing	church lot	1xPED, return to vehicle
9:29:42 AM	Vehicle Entry	yes	Hwy 8	EBL	4th Line	BOX TRUCK, NBR to driveway
9:30:00 AM	end of video viewing	NO				

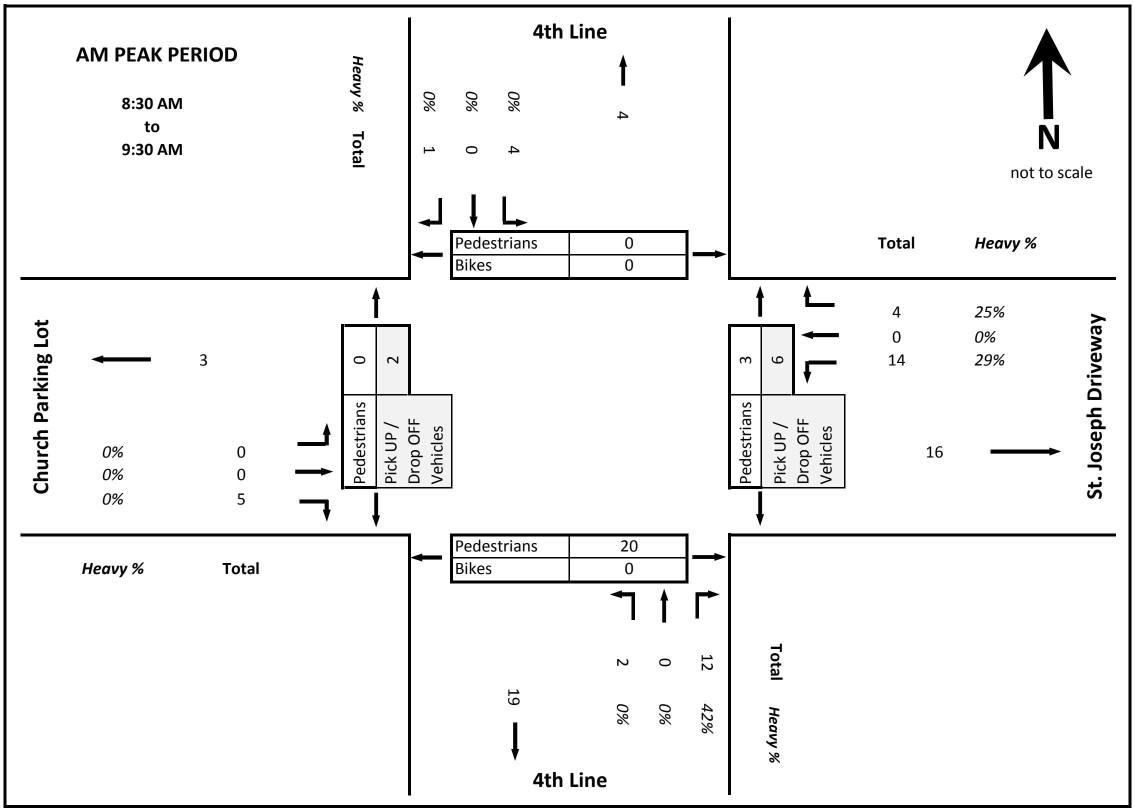
DATE	03-Apr-2018	VIDEO AUDIT of ST. Joseph C.E.S. (Duoro) Vehicular and Pedestrian Traffic				
TIME	**Observation**	**school related?**	**from**	**Action**	**to**	**Trip Details**
before footage	SCHOOLBUS #1 on street parked Eastside	yes	unknown	Park/Stop	Eastside of 4th Line	origin unknown
2:45:00 PM	VIEWING BEGINS	NO				
2:50:59 PM	Vehicle Entry	yes	4th Line	NBL	church lot	White SUV, from EBL hwy8/4thLine
2:52:16 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
2:53:55 PM	SCHOOLBUS #1 on street parked Eastside	yes	4th Line	NBR	driveway	SCHOOL BUS #1 enters driveway
2:55:07 PM	SCHOOLBUS #2	yes	Hwy 8	EBL	4th Line	NBR to eastside of 4th Line
2:57:03 PM	SCHOOLBUS #3	yes	Hwy 8	EBL	4th Line	NBR to school driveway
3:05:55 PM	SCHOOLBUS #4	yes	Hwy 8	EBL	4th Line	NBR to school driveway
3:09:44 PM	Vehicle Entry	yes	4th Line	NBL	church lot	black sedan, from EBL hwy8/4thLine
3:13:57 PM	Vehicle Entry	yes	4th Line	NBL	church lot	dark red pickup, from WBR hwy8/4thLine
3:14:01 PM	SCHOOLBUS #5	yes	Hwy 8	EBL	4th Line	NBR to school driveway
3:14:15 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
3:14:32 PM	Vehicle Entry	yes	4th Line	NBR	driveway	brown pickup, from EBL hwy8/4thLine
3:15:26 PM	Vehicle Entry	yes	4th Line	to	Westside of 4th Line	silver minivan, from EBL hwy8/4th, northfacing on street
3:15:41 PM	Vehicle Entry	yes	4th Line	to	Eastside of 4th Line	silver minivan, from EBL hwy8/4th, not in view
3:16:48 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
3:16:48 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
3:16:48 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
3:17:14 PM	PED west to east	yes	NW corner of hwy8/4thLine	crossing	NE corner of hwy8/4thLine	1xPedestrian
3:19:03 PM	PED east to west PICK UP	yes	school	crossing	church lot	1xPedestrian
3:19:03 PM	PED east to west PICK UP	yes	school	crossing	church lot	1xPedestrian
3:19:03 PM	PED east to west PICK UP	yes	school	crossing	church lot	1xPedestrian
3:19:55 PM	Vehicle EXIT	yes	church lot	EBR	4th Line	black pickup, SBL @ Hwy8/4th
3:19:59 PM	Vehicle Entry	yes	4th Line	NBR	driveway	white sedan, from EBL hwy8/4thLine
3:20:44 PM	Vehicle Entry	yes	Eastside of 4th Line	U-turn	Westside of 4th Line	silver SUV, from NBT hwy8/4thLine
3:20:50 PM	Vehicle Entry	yes	4th Line	NBL	church lot	dark blue hatchback, from WBR hwy8/4thLine
3:21:23 PM	PED east to west	yes	school	to	NW corner of hwy8/4thLine	1xPedestrian
3:21:23 PM	PED east to west	yes	school	to	NW corner of hwy8/4thLine	1xPedestrian
3:21:23 PM	PED EXIT	yes	school	EASTBOUND	eastwards	1xPedestrian
3:21:35 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
3:21:38 PM	PED west to east	yes	NW corner of hwy8/4thLine	crossing	NE corner of hwy8/4thLine	1xPedestrian
3:21:45 PM	PED west to east	yes	church lot	crossing	school	1xPedestrian
3:21:48 PM	PED east to west	yes	school	to	NW corner of hwy8/4thLine	1xPedestrian
3:23:20 PM	Vehicle EXIT	yes	driveway	WBR	4th Line	brown pickup, NBT on 4th Line
3:23:24 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:23:24 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:23:24 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:23:35 PM	PED east to west PICK UP	yes	school	to	Westside of 4th Line	1xPedestrian, white SUV, south facing
3:23:35 PM	PED east to west PICK UP	yes	school	to	Westside of 4th Line	1xPedestrian, white SUV, south facing
3:23:35 PM	PED east to west PICK UP	yes	school	to	Westside of 4th Line	1xPedestrian, white SUV, south facing
3:23:41 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:23:41 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:23:41 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:23:57 PM	Vehicle EXIT	yes	4th Line	SBT	Hwy 8	white SUV, westside southfacing
3:24:00 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:24:00 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:24:09 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:24:09 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:24:09 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:24:58 PM	Vehicle EXIT	yes	Eastside of 4th Line	U-turn	Westside of 4th Line	white sedan, exits SBR hwy8/4thLine
3:25:05 PM	PED PICK UP	yes	southside of Hwy8	U-turn	NE corner of hwy8/4thLine	red sedan, exits WBT hwy8/4thLine
3:25:20 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:25:20 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:25:20 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:25:20 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:25:20 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:25:34 PM	SCHOOLBUS #1 EXITS	yes	driveway	WBL	4th Line	SBL @ Hwy8/4thLine
3:25:35 PM	Vehicle Entry	yes	4th Line	SBR	church lot	silver minivan, from SBT 4thLine
3:25:50 PM	Vehicle EXIT	yes	church lot	EBR	4th Line	dark blue hatchback, SBL @ Hwy8/4th
3:25:53 PM	SCHOOLBUS #3 EXITS	yes	driveway	WBR	4th Line	NBT on 4thLine
3:26:55 PM	On street Parking - Vehicle Pick UP	yes	Hwy 8	WBR	Eastside of 4th Line	white pickup, eastside of 4thLine, north facing
3:27:01 PM	SCHOOLBUS #4 EXITS	yes	driveway	WBL	4th Line	SBR @ Hwy8/4thLine
3:27:06 PM	SCHOOLBUS #2 EXITS	yes	4th Line	NBT	4th Line	from eastside of 4thLine curb
3:27:25 PM	Vehicle EXIT	yes	church lot	EBL	4th Line	black sedan, NBT on 4thLine
3:28:01 PM	PED PICK UP	yes	school	to	Eastside of 4th Line	1xPedestrian, no street crossing, white pickup
3:28:03 PM	Vehicle EXIT	yes	4th Line	NBT	4th Line	white pickup, eastside of 4thLine, north facing
3:28:20 PM	SCHOOLBUS #5 EXITS	yes	driveway	WBL	4th Line	SBT @ Hwy8/4thLine
3:28:49 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:29:25 PM	PED EXIT	yes	school	EASTBOUND	eastwards	1xPedestrian
3:29:50 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:29:50 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:31:00 PM	PED EXIT	yes	school	EASTBOUND	eastwards	1xPedestrian
3:31:00 PM	PED EXIT	yes	school	EASTBOUND	eastwards	1xPedestrian
3:31:58 PM	Vehicle EXIT	yes	church lot	EBL	4th Line	white SUV, NBT on 4thLine
3:34:01 PM	Vehicle Entry	yes	NE corner of hwy8/4thLine	EBT	Hwy 8	grey hatchback, EBT goes to opposing traffic lane to pick up
3:34:13 PM	Vehicle Entry	yes	4th Line	SBL	driveway	white SUV, from SBT on 4thLine
3:35:08 PM	PED east to west	yes	NE corner of hwy8/4thLine	crossing	NW corner of hwy8/4thLine	1xPedestrian
3:35:09 PM	PED EXIT	yes	school	EASTBOUND	eastwards	1xPedestrian
3:35:09 PM	PED EXIT	yes	school	EASTBOUND	eastwards	1xPedestrian
3:35:25 PM	PED east to west	yes	school	to	church lot	1xPedestrian
3:36:15 PM	Vehicle EXIT	yes	4th Line	SBL	Hwy 8	teacher? Black pickup on westside of 4thLine
3:36:38 PM	Vehicle EXIT	yes	church lot	EBR	4th Line	grey hatchback, SBR @ Hwy8/4th
3:37:23 PM	PED north to south EXIT	yes	NE corner of hwy8/4thLine	crossing	SE corner of hwy8/4thLine	1xPedestrian
3:41:30 PM	Vehicle EXIT	yes	Eastside of 4th Line	NBT	4th Line	1xped enters vehicle on Eastside of 4th
3:43:00 PM	Vehicle EXIT	yes	Eastside of 4th Line	NBT	4th Line	1xped enters vehicle on Eastside of 4th, uses driveway to leave, exits SBR @ hwy8/4th
3:43:43 PM	Vehicle EXIT	yes	driveway	WBL	4th Line	white sedan, SBR @ Hwy8/4thLine
3:44:40 PM	Vehicle EXIT	yes	NE corner of hwy8/4thLine	WBT	Hwy 8	1xped enters vehicle on NE corner of hwy8 parked on grass, exits WBT @ hwy8/4th
3:45:00 PM	END OF FOOTAGE VIEWING	NO				

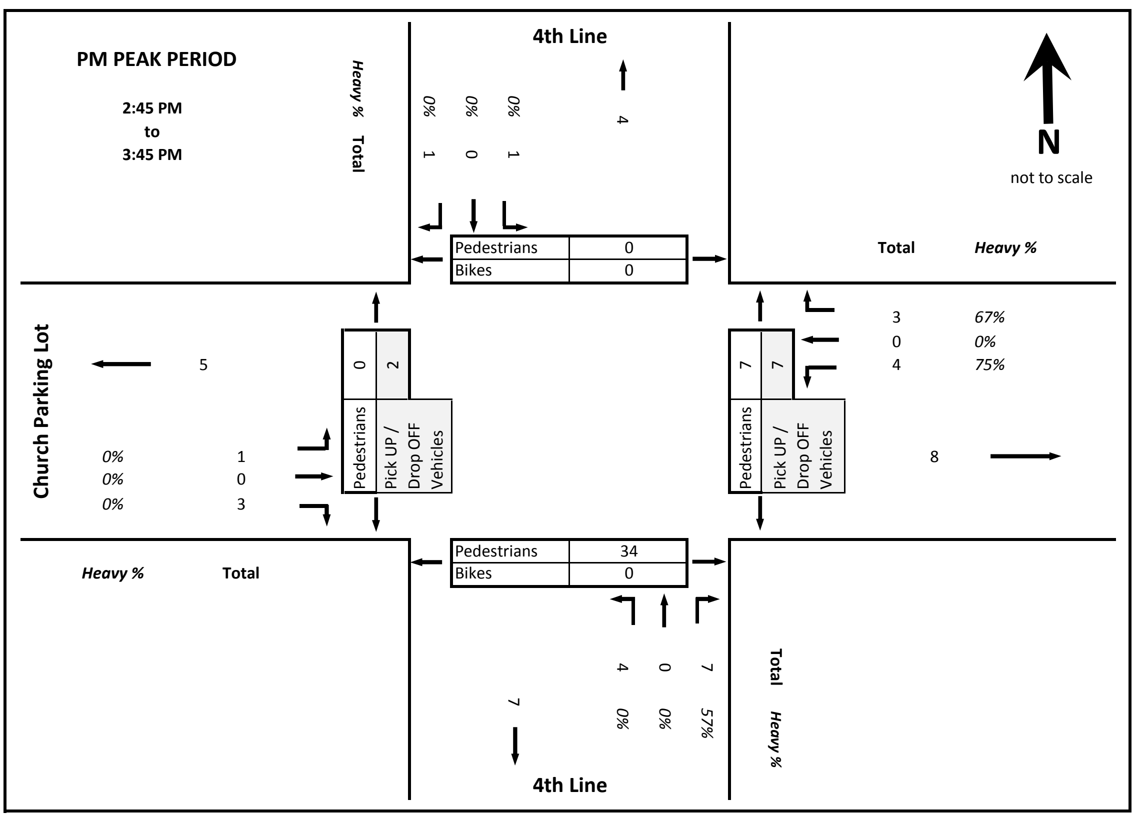
TURNING MOVEMENT DIAGRAMS

North-South Road: 4th Line | Municipality: Duoro | Day: Tuesday

East-West Road: Church Parking Lot / St. Joseph Driveway | Weather: Mainly Clear | Survey Date: April 3, 2018

tranplan associates





APPENDIX B: TAC Sight Distance Excerpts

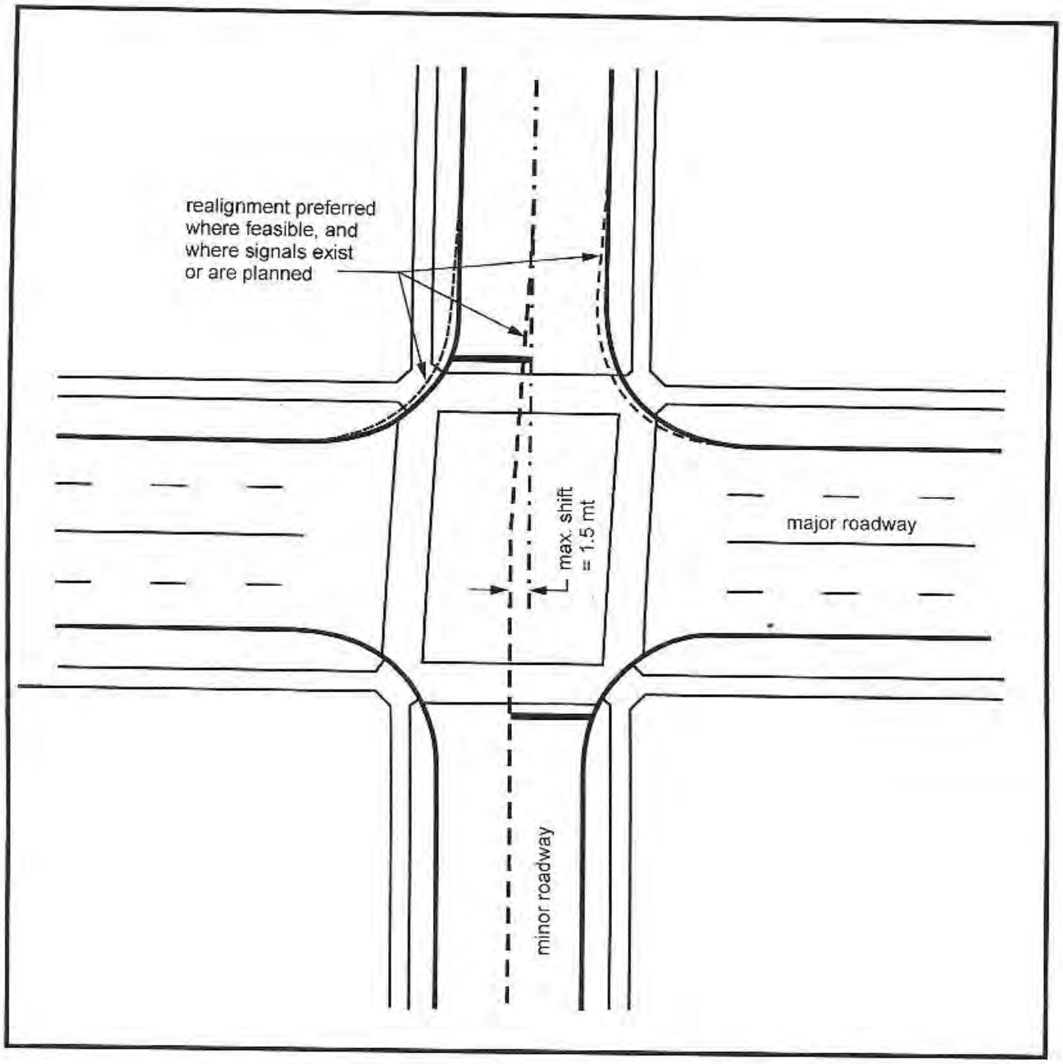


Figure 9.7.11: Shifts in Horizontal Alignment across Intersections

9.8 SIGHT DISTANCE

Potential road user (e.g., vehicles, cyclists and pedestrians) conflicts exist at every intersection. However, the possibility of these conflicts actually occurring can be greatly reduced through proper channelization and appropriate traffic controls. The avoidance of collisions and the efficiency of operation must still depend, to a large extent, on the judgement, capabilities, and responses of the individual road user. The intersection design must therefore provide sufficient sight distance for road users to perceive potential conflicts and to carry out the actions needed to negotiate the intersection safely.

Sight distance requirements must be considered both for approaching the intersection and departing from the stopped position at the intersection.

The minimum sight distance criterion for vehicles approaching an intersection, or travelling along a turning roadway, is stopping sight distance based on design speed. However, due to the relatively complex situations that drivers often encounter at intersections, it is desirable to provide more than the minimum stopping sight distance to enhance safety.

Providing decision sight distance is desirable wherever feasible, and is particularly desirable in advance of the critical intersection decision points. These include locations where drivers must make instantaneous decisions, where information and potential conflicts are difficult to perceive, and where unexpected maneuvers may be required. Values for stopping sight distance and for decision sight distance for different design vehicles over a range of design speeds are provided in **Chapter 2**.

Intersection sight distance is defined as the sight distance available from a point where vehicles are required to stop on the intersecting road, while drivers are looking left and right along the major roadway, before entering the intersection. The intersection sight distance is adequate when it allows the design vehicles to safely make all the maneuvers that are permitted by the layout (e.g., left turns, right turns, through moves), without significantly affecting vehicles travelling on the main roadway, as is described in further detail throughout this section.

Intersection sight distance is also a function of design vehicles. The design vehicle is typically defined as a vehicle that uses a given intersection daily or on a regular basis. It does not include a vehicle that may occur irregularly. As a result, very large vehicles such as long combination vehicles (LCVs) are rarely used as design vehicles. However, LCVs may be selected as design vehicles for some western Canadian highways, where they are common. In such a case, the designer must keep in mind that LCVs require more time than smaller vehicles to execute a turn or crossing maneuver, and therefore require more sight distance. Data for regionally-specific vehicles should be developed by the affected road authority to complement guidelines presented in this Guide.

For a discussion on sight distance considerations for pedestrians and cyclists at intersections, refer to **Chapter 6** and **Chapter 5** respectively.

9.9 AASHTO INTERSECTION SIGHT DISTANCE MODEL

9.9.1 PREFACE

This section presents the methodology for determining intersection sight distance requirements. This methodology reflects the most current North American approach adopted by AASHTO and is thoroughly grounded in research and technical analysis. In preparing this section on intersection sight distance, the gap acceptance methodology outlined in AASHTO's *Policy on Geometric Design of Highways and Streets*, 6th Edition, 2011 was adopted. The text in this section has been adapted, and in some cases used verbatim, from this AASHTO document.

9.9.2 SIGHT TRIANGLES

Specified areas along intersection approach legs and across their included corners should be clear of obstructions that might block a driver's view of potentially conflicting vehicles. These specified areas are known as clear sight triangles. The dimensions of the legs of the sight triangles depend on the design speeds of the intersecting roadways and the type of traffic control used at the intersection. These dimensions are based on observed driver behaviour and are documented by space-time profiles and speed choices of drivers on intersection approaches.[65] Two types of clear sight triangles are considered in intersection design: approach sight triangles and departure sight triangles.

9.9.2.1 Approach Sight Triangles

Each quadrant of an intersection should contain a triangular area free of obstructions that might block an approaching driver's view of potentially conflicting vehicles. The length of the legs of this triangular area, along both intersecting roadways, should be such that the drivers can see any potentially conflicting vehicles in both the horizontal and vertical plane in sufficient time to slow or stop before colliding within the intersection. **Figure 9.9.1** shows typical clear sight triangles to the left and to the right for a vehicle approaching an uncontrolled or yield-controlled intersection.

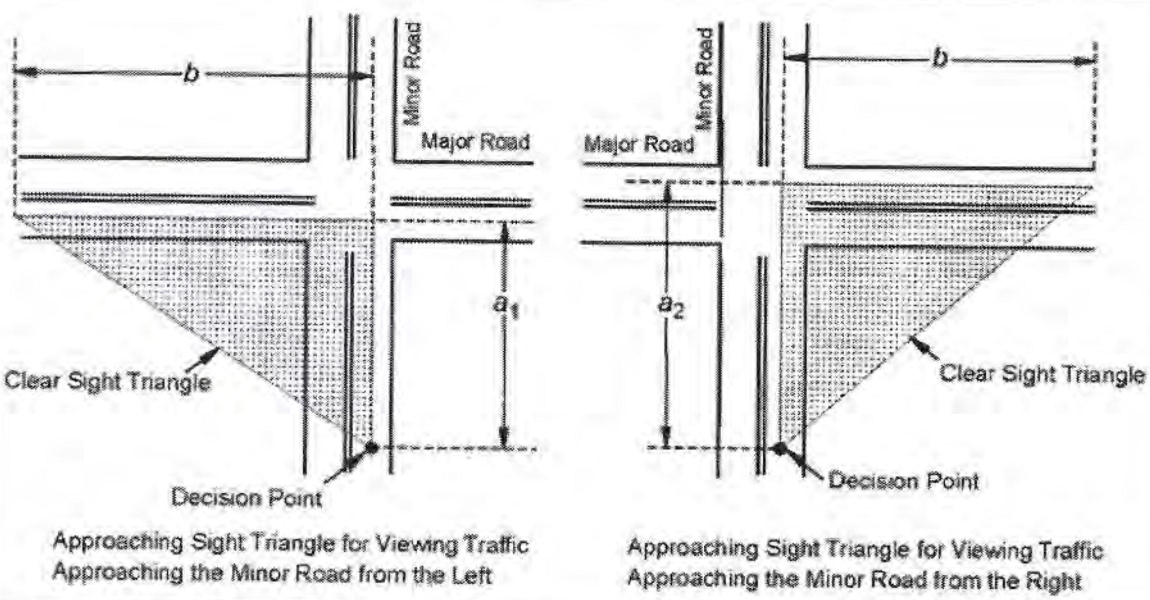


Figure 9.9.1: Approach Sight Triangle (Uncontrolled or Yield-Controlled)

The vertex of the sight triangle on a minor-road approach (or an uncontrolled approach) represents the decision point for the minor-road driver (see **Figure 9.9.1**). This decision point is the location at which the minor-road driver should begin to brake to a stop if another vehicle is present on an intersecting approach. The distance from the major road, along the minor road, is illustrated by the distance a_1 to the left and a_2 to the right. Distance a_2 is equal to distance a_1 plus the width of the lane(s) departing from the intersection on the major road to the right. Distance a_2 should also include the width of any median present on the major road unless the median is wide enough to permit a vehicle to stop before entering or crossing the roadway beyond the median.

The geometry of a clear sight triangle is such that when the driver of a vehicle without the right-of-way sees a vehicle that has the right-of-way on an intersecting approach, the driver of that potentially conflicting vehicle can also see the first vehicle. Distance b illustrates the length of this leg of the sight triangle. Thus, providing a clear sight triangle for vehicles without the right-of-way also allows the drivers of vehicles with the right-of-way to slow, stop, or avoid other vehicles if necessary.

Although desirable at higher volume intersections, approach sight triangles like those shown in Figure **Figure 9.9.1** may not be needed for intersection approaches controlled by stop signs or traffic signals. In that case, the need for approaching vehicles to stop at the intersection is determined by the traffic control devices and not by the presence or absence of vehicles on the intersecting approaches.

9.9.2.2 Departure Sight Triangles

A second type of clear sight triangle provides sight distance sufficient for a stopped driver on a minor-road approach to depart from the intersection and enter or cross the major road. **Figure 9.9.2** shows typical departure sight triangles to the left and to the right of the location of a stopped vehicle on the minor road.

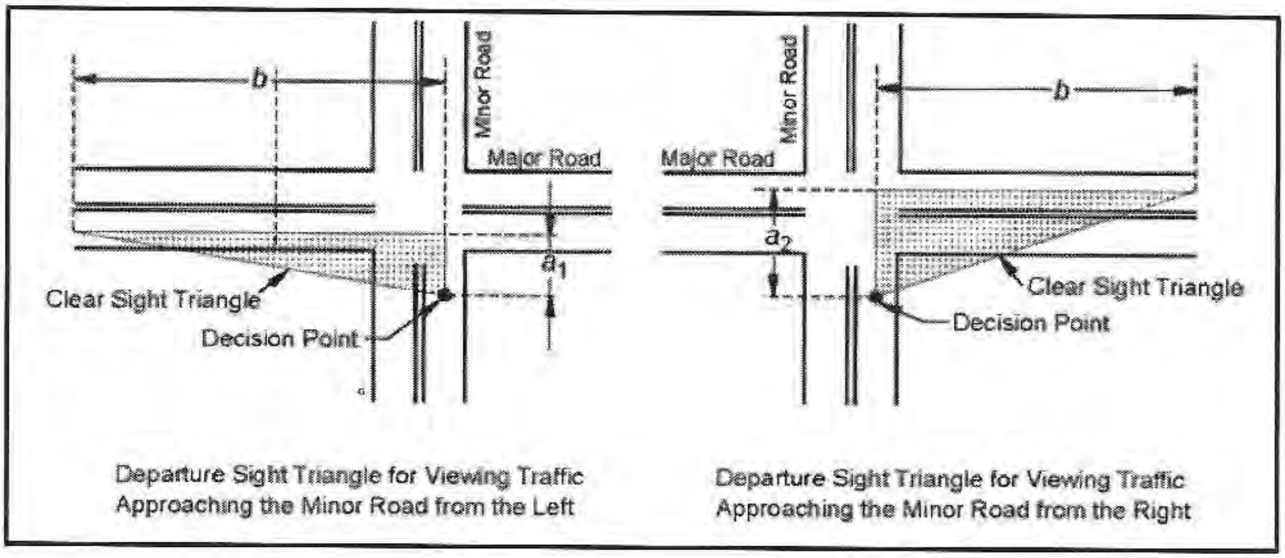


Figure 9.9.2: Departure Sight Triangles (Stop-Controlled)

Departure sight triangles should be provided in each quadrant of each intersection approach controlled by stop or yield signs. Departure sight triangles should also be provided for some signalized intersection approaches. Distance a_2 in **Figure 9.9.2** is equal to distance a_1 plus the width of the lane(s) departing from the intersection on the major road to the right. Distance a_2 should also include the width of any median present on the major road, unless the median is wide enough to permit a vehicle to stop before entering or crossing the roadway beyond the median. The appropriate measurement of distances a_1 and a_2 for departure sight triangles depends on the placement of any marked stop line that may be present and may therefore vary with site-specific conditions.

The recommended dimensions of the clear sight triangle for desirable traffic operations where stopped vehicles enter or cross a major road are based on assumptions derived from field observations of driver gap-acceptance behaviour.[66] Providing clear sight triangles like those shown in **Figure 9.9.2** also allows the drivers of vehicles on the major road to see any vehicles stopped on the minor-road approach and to be prepared to slow or stop, if needed.

9.9.2.3 Intersection Control

The recommended dimensions of the sight triangles vary with the type of traffic control used at an intersection because different types of control impose different legal constraints on drivers and, therefore, result in different driver behaviour. Procedures to determine sight distances at intersections are presented below, according to different types of traffic control, as follows:

- Case A – Intersections with no control
- Case B – Intersections with stop control on the minor road

- Case B1 – Left turn from the minor road
- Case B2 – Right turn from the minor road
- Case B3 – Crossing maneuver from the minor road
- Case C – Intersections with yield control on the minor road
- Case C1 – Crossing maneuver from the minor road
- Case C2 – Left or right turn from the minor road
- Case D – Intersections with traffic signal control
- Case E – Intersections with all-way stop control
- Case F – Left turns from the major road

Case A – Intersections with No Control

For intersections not controlled by yield signs, stop signs, or traffic signals, the driver of a vehicle approaching an intersection should be able to see potentially conflicting vehicles in sufficient time to stop before reaching the intersection. The location of the decision point (driver's eye) of the sight triangles on each approach is determined from a model that is analogous to the stopping sight distance model, with slightly different assumptions.

While some perceptual tasks at intersections may need substantially less time, the detection and recognition of a vehicle that is a substantial distance away on an intersecting approach, and is near the limits of the driver's peripheral vision, may take up to 2.5 s. The distance to brake to a stop can be determined from the same braking coefficients used to determine the stopping sight distance in **Table 2.5.2** (see Section 2.5 of this Guide).

Field observations indicate that vehicles approaching uncontrolled intersections typically slow to approximately 50% of their mid-block running speed. This occurs even when no potentially conflicting vehicles are present.[67] This initial slowing typically occurs at deceleration rates up to 1.5 m/s^2. Deceleration at this gradual rate has been observed to begin even before a potentially conflicting vehicle comes into view. Braking at greater deceleration rates, which can approach those assumed in stopping sight distance, can begin up to 2.5 s after a vehicle on the intersecting approach comes into view. Thus, approaching vehicles may be traveling at less than their mid-block running speed during all or part of the perception-reaction time and can, therefore, where needed, brake to a stop from a speed less than the mid-block running speed.

Table 9.9.1 shows the distance traveled by an approaching vehicle during perception-reaction and braking time, as a function of the design speed of the roadway on which the intersection approach is located. These distances should be used as the legs of the sight triangles shown in **Figure 9.9.1** as dimensions a_1 and b. Distance a_2 is longer than distance a_1, as defined in **Section 9.2.1**. Referring to **Figure 9.9.1**, a major roadway with an assumed design speed of 80 km/h and a minor roadway with an assumed design speed of 50 km/h needs a clear sight triangle with legs extending at least 75 m and 45 m along the major and minor roadways, respectively.

Table 9.9.1: Length of Sight Triangle Leg – Case A, No Traffic Control

Design Speed	Length of Leg (m)
20	20
30	25
40	35
50	45
60	55
70	65
80	75
90	90
100	105
110	120
120	135
130	150

Where the grade along an intersection approach exceeds 3%, the leg of the clear sight triangle along that approach should be adjusted by multiplying the appropriate sight distance from **Table 9.9.1** by the appropriate adjustment factor from **Table 9.9.2**.

Table 9.9.2: Adjustment Factors for Sight Distance Based on Approach Grade

Approach Grade (%)	Design Speed (km/h)													
	20	30	40	50	60	70	80	90	100	110	120	130	—	—
-6	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	—	—
-5	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	—	—
-4	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	—	—
-3 to +3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	—	—
+4	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	—	—
+5	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	—	—
+6	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	—	—

The departure sight triangle like that shown in **Figure 9.9.2** is typically not needed at an uncontrolled intersection since these intersections typically have very low traffic volumes. If a motorist needs to stop at an uncontrolled intersection because of a conflicting vehicle on an intersecting approach, it is very unlikely another potentially conflicting vehicle will be encountered as the first vehicle departs the intersection.

This clear triangular area will allow the vehicles on either road to stop, if needed, before reaching the intersection. If the design speed of any approach is not known, it can be estimated by using the 85th percentile of the mid-block running speeds for that approach.

The distances shown in **Table 9.9.1** are generally less than the corresponding values of stopping sight distance for the same design speed. This relationship is illustrated in **Figure 9.9.3**. Where a clear sight triangle has legs that correspond to the stopping sight distances on their respective approaches, an even greater margin of efficient operation is provided. However, since field observations show that motorists slow down to some extent on approaches to uncontrolled intersections, it is not essential to provide a clear sight triangle with legs equal to the full stopping sight distance.

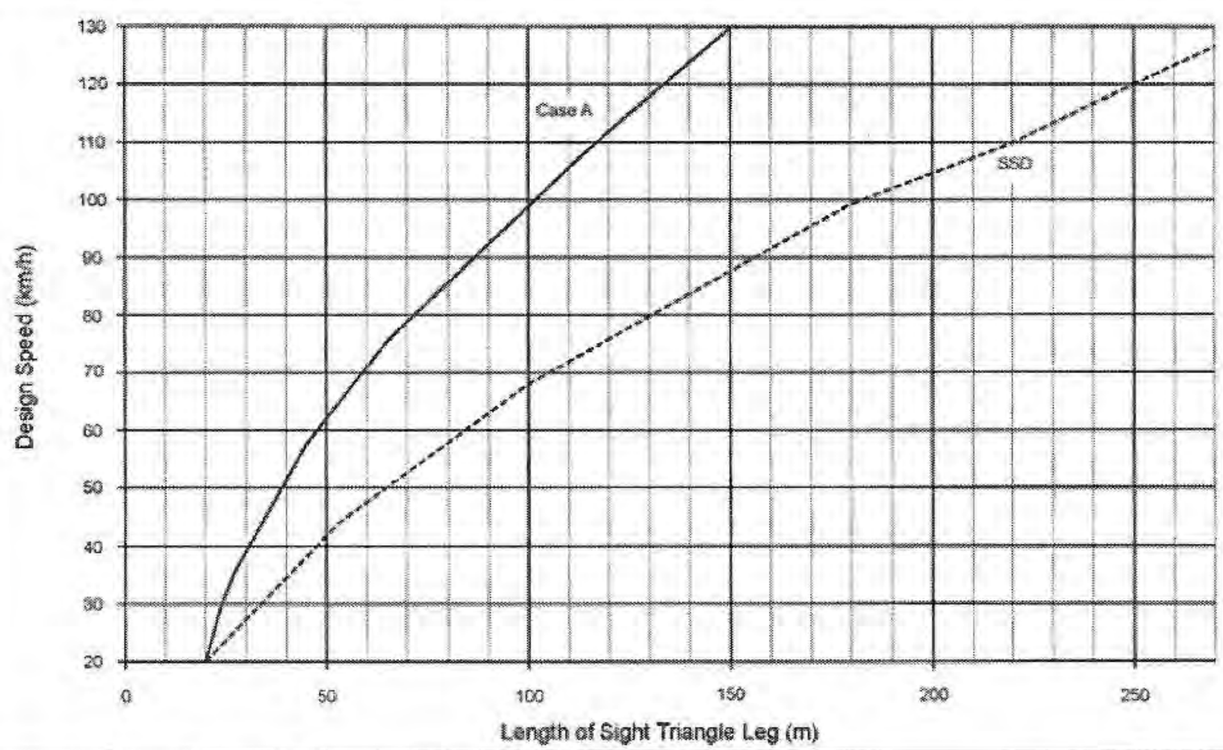


Figure 9.9.3: Length of Sight Triangle Leg – Case A, No Traffic Control

Case B – Intersections with Stop Control on the Minor Road

Departure sight triangles for intersections with stop control on the minor road should be considered for three situations:

- Case B1 – Left turns from the minor road
- Case B2 – Right turns from the minor road
- Case B3 – Crossing the major road from a minor-road approach

Intersection sight distance criteria for stop-controlled intersections are longer than the minimum stopping sight distance to allow the intersection to operate smoothly. Minor-road vehicle operators can wait until they can proceed safely without forcing a major-road vehicle to slow to less than 70% of their initial speed.

Case B1 – Left Turn from the Minor Road

Departure sight triangles for traffic approaching from either the right or the left, like those shown in **Figure 9.9.2**, should be provided for left turns from the minor road onto the major road for all stop-controlled approaches. The length of the leg of the departure sight triangle along the major road in both directions, shown as distance b in **Figure 9.9.2**, is the recommended intersection sight distance for Case B1.

The vertex (decision point) of the departure sight triangle on the minor road should be 4.4 m from the edge of the major-road traveled way. This represents the typical position of the minor-road driver's eye when a vehicle is stopped relatively close to the major road. Field observations of vehicle stopping positions found that, where needed, drivers will stop with the front of their vehicle 2.0 m or less from the edge of the major-road traveled way. Measurements of passenger cars indicate that the distance from the front of the vehicle to the driver's eye for the current North American passenger car population is nearly always 2.4 m or less.[68] Where practical, it is desirable to increase the distance from the edge of the major-road traveled way to the vertex of the clear sight triangle from 4.4 m to 5.4 m. This increase allows 3.0 m from the edge of the major-road traveled way to the front of the stopped vehicle, providing a larger sight triangle. The length of the sight triangle along the minor road (distance a in **Figure 9.9.2**) is the sum of the distance from the major road plus ½ lane width for vehicles approaching from the left, or 1½ lane widths for vehicles approaching from the right.

Field observations of the gaps in major-road traffic actually accepted by drivers turning onto the major road have shown that the values in **Table 9.9.3** provide sufficient time for the minor-road vehicle to accelerate from a stop and complete a left turn without unduly interfering with major-road traffic operations. The time gap acceptance time does not vary with approach speed on the major road. A constant value of time gap, independent of approach speed, can be used as a basis for intersection sight distance determinations. Observations have also shown that major-road drivers will reduce their speed to some extent when minor-road vehicles turn onto the major road. Where the time gap acceptance values in **Table 9.9.3** are used to determine the length of the leg of the departure sight triangle, most major-road drivers should not need to reduce speed to less than 70% of their initial speed.[69]

The intersection sight distance in both directions should be equal to the distance traveled at the design speed of the major road during a period of time equal to the time gap. In applying **Table 9.9.3**, it can usually be assumed that the minor-road vehicle is a passenger car; however, road authorities may provide more precise guidance on selection of the required design vehicle. Where substantial volumes of heavy vehicles enter the major road (e.g., from a ramp terminal), the use of tabulated values for single-unit or combination trucks should be considered.

Table 9.9.3 includes appropriate adjustments to the gap times for the number of lanes on the major road and for the approach grade of the minor road. The adjustment for the grade of the minor-road approach is needed only if the rear wheels of the design vehicle would be on an upgrade that exceeds 3% when the vehicle is at the stop line of the minor-road approach.

Table 9.9.3: Time Gap for Case B1, Left Turn from Stop

Design Vehicle	Time Gap (t_g)(s) at Design Speed of Major Road
Passenger car	7.5
Single-unit truck	9.5
Combination truck (WB 19 and WB 20)	11.5
Longer truck	To be established by road authority

Notes: Time gaps are for a stopped vehicle to turn left onto a two-lane highway with no median and with grades of 3% or less. The table values should be adjusted as follows:

- For multi-lane highways: For left turns onto two-lane highways with more than two lanes, add 0.5 s for passenger cars and 0.7 s for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.
- For minor approach grades: If the approach grade is an upgrade that exceeds 3%, add 0.2 s for each percent grade for left turns.
- Some road authorities use higher values for certain specialized vehicles (e.g., Alberta uses 22 s for very long log trucks).

The intersection sight distance along the major road (distance b in **Figure 9.9.2**) is determined by:

$$ISD = 0.278\, V_{major}\, t_g \qquad (9.9.1)$$

Where:

ISD = intersection sight distance (length of the leg of sight triangle along the major road) (m)

V_{major} = design speed of the major road (km/h)

t_g = time gap for minor road vehicle to enter the major road (s)

For example, a passenger car turning left onto a two-lane major road should be provided sight distance equivalent to a time gap of 7.5 s in major-road traffic. If the design speed of the major road is 100 km/h, this corresponds to a sight distance of 0.278(100)(7.5) = 208.5 or 210 m, rounded for design.

A passenger car turning left onto a four-lane undivided roadway will need to cross two near lanes, rather than one. This increases the recommended gap in major-road traffic from 7.5 to 8.0 s. The corresponding value of sight distance for this example would be 223 m. If the minor-road approach to such an intersection is located on a 4% upgrade, then the time gap selected for intersection sight distance design for left turns should be increased from 8.0 to 8.8 s, equivalent to an increase of 0.2 s for each percent grade.

The design values for intersection sight distance for passenger cars are shown in **Table 9.9.4**. **Figure 9.9.4** includes design values, based on the time gaps for the design vehicles included in **Table 9.9.3**.

No adjustment of the recommended sight distance values for the major-road grade is generally needed because both the major- and minor-road vehicle will be on the same grade when departing from the intersection. However, if the minor-road design vehicle is a heavy truck and the intersection is located near a sag vertical curve with grades over 3%, then an adjustment to extend the recommended sight distance based on the major-road grade should be considered.

Table 9.9.4: Design Intersection Sight Distance – Case B1, Left Turn From Stop

Design Speed (km/h)	Stopping Sight Distance (m)	Intersection Sight Distance for Passenger Cars	
		Calculated (m)	Design (m)
20	20	41.7	45
30	35	62.6	65
40	50	83.4	85
50	65	104.3	105
60	85	125.1	130
70	105	146.0	150
80	130	166.8	170
90	160	187.7	190
100	185	208.5	210
110	220	229.4	230
120	250	250.2	255
130	285	271.1	275

Note: Intersection sight distance shown is for a stopped passenger car to turn left onto a two-lane highway with no median and grades 3% or less. For other conditions, the time gap should be adjusted and the sight distance recalculated.

Sight distance design for left turns at divided-highway intersections should consider multiple design vehicles and median width. If the design vehicle used to determine sight distance for a divided-highway intersection is larger than a passenger car, then sight distance for left turns will need to be checked for that selected design vehicle and for smaller design vehicles as well. If the divided-highway median is wide enough to store the design vehicle with a clearance to the through lanes of approximately 1 m at both ends of the vehicle, no separate analysis for the departure sight triangle for left turns is needed on the minor-road approach for the near roadway to the left. In most cases, the departure sight triangle for right turns (case B2) will provide sufficient sight distance for a passenger car to cross the near roadway to reach the median. Possible exceptions are addressed in the discussion of case B3.

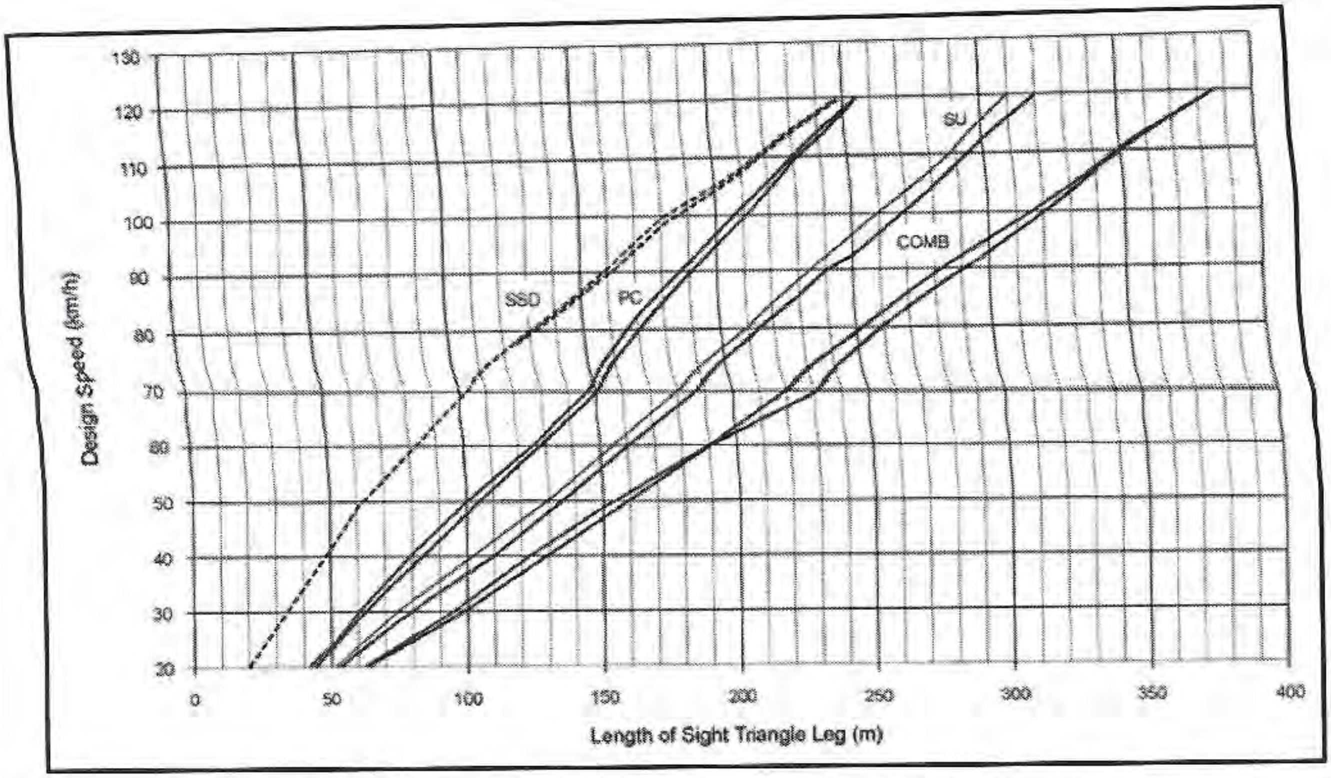


Figure 9.9.4: Intersection Sight Distance – Case B1, Left Turn from Stop (Calculated and Design Values Plotted)

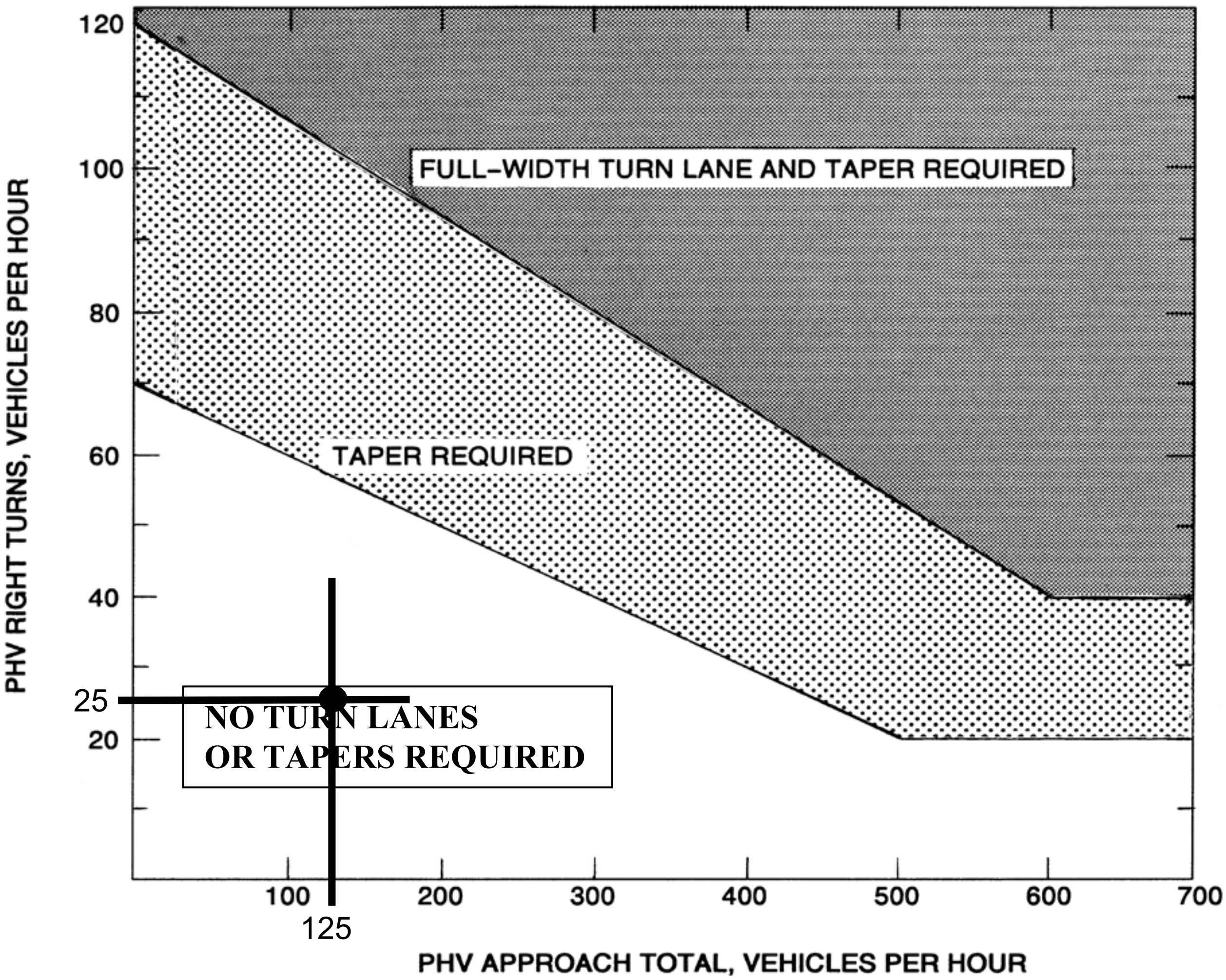
If the design vehicle can be stored in the median with adequate clearance to the through lanes, a departure sight triangle to the right for left turns should be provided for that design vehicle turning left from the median roadway. Where the median is not wide enough to store the design vehicle, a departure sight triangle should be provided for that design vehicle to turn left from the minor-road approach.

The median width should be considered in determining the number of lanes to be crossed. The median width should be converted to equivalent lanes. For example, a 7.2-m median should be considered as two additional lanes to be crossed in applying the multilane highway adjustment for time gaps in **Table 9.9.3**. Furthermore, a departure sight triangle for left turns from the median roadway should be provided for the largest design vehicle that can be stored on the median roadway with adequate clearance to the through lanes. If a divided highway intersection has a 12 m median width and the design vehicle for sight distance is a 22 m combination truck, departure sight triangles should be provided for the combination truck turning left from the minor-road approach and through the median. In addition, a departure sight triangle should also be provided to the right for a 9 m single unit truck turning left from a stopped position in the median.

Case B2 – Right Turn from the Minor Road

A departure sight triangle for traffic approaching from the left like that shown in **Figure 9.9.2** should be provided for right turns from the minor road onto the major road. The intersection sight distance for right turns is determined in the same manner as for case B1, except that the time gaps (t_g) in **Table 9.9.3** should be adjusted. Field observations indicate that, in making right turns, drivers generally accept gaps that are slightly shorter than those accepted in making left turns.[70]

APPENDIX C: Auxiliary Turning Lane Warrants



Appropriate Radius required at all Intersections and Entrances (Commercial or Private).

LEGEND

PHV - Peak Hour Volume (also Design Hourly Volume equivalent)

Adjustment for Right Turns

For posted speeds at or under 45 mph, PHV right turns > 40, and
PHV total < 300.
Adjusted right turns = PHV Right Turns - 20
If PHV is not known use formula: PHV = ADT x K x D

K = the percent of AADT occurring in the peak hour
D = the percent of traffic in the peak direction of flow

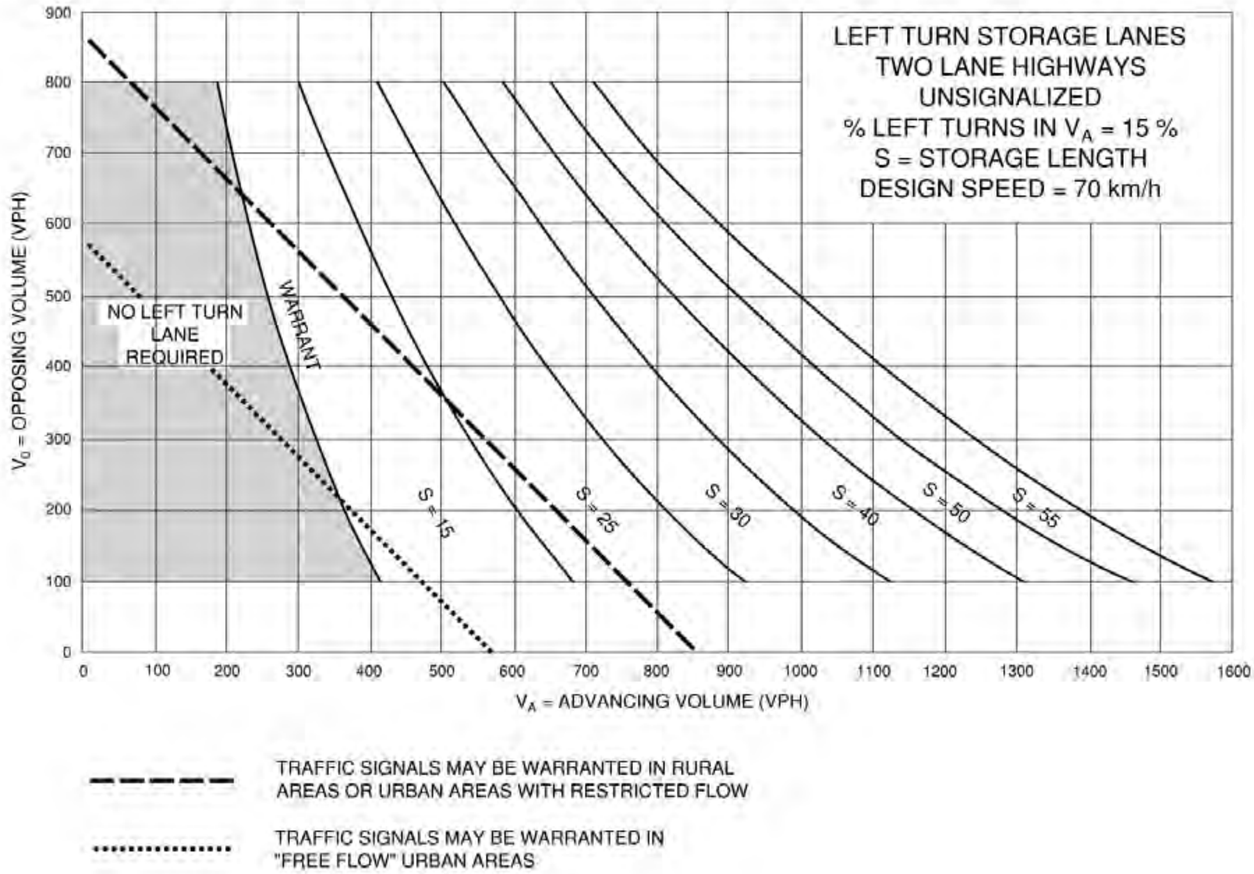
Note: An average of 11% for K x D will suffice.

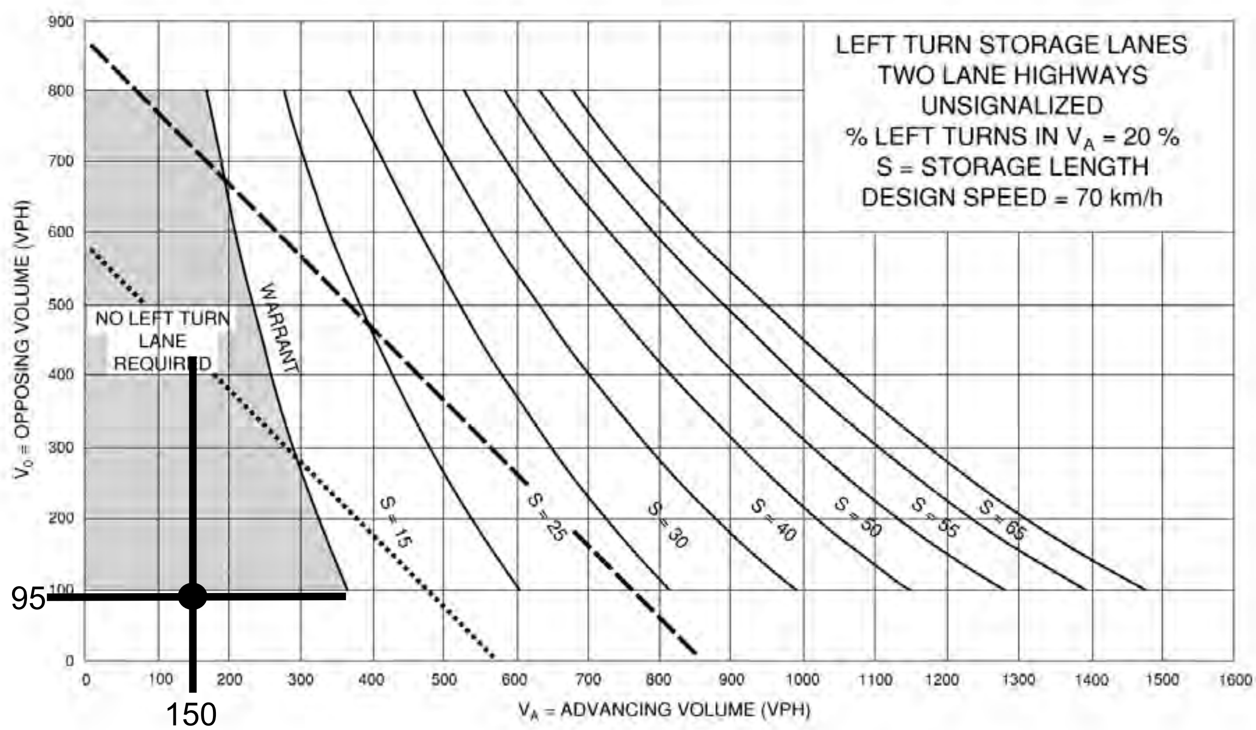
When right turn facilities are warranted, see Figure 3-1 for design criteria.*

FIGURE 3-26 WARRANTS FOR RIGHT TURN TREATMENT (2-LANE HIGHWAY)

* Rev. 1/15

Exhibit 9A-11





Advancing volume = 150, includes Left Turn volume 25 (17%)