Warsaw Residential Subdivision

Peterborough County Rd. 4

Township of Douro-Dummer

Traffic Impact Study

Prepared by:
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Prepared for:
Landmark Associates Limited
June, 2018

June 25, 2018

Landmark Associates Limited
380 Armour Road, Suite 140
Peterborough, ON K9H 7L7

Attn: Amanda Dougherty, B .A., Planner

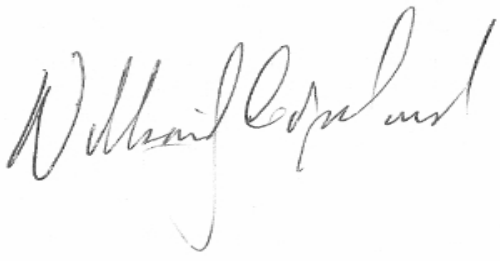
Dear Ms. Dougherty:

RE: Traffic Study for The Proposed Warsaw Residential Subdivision To Be Located on Peterborough County Road 4, Hamlet of Warsaw, Township of Douro-Dummer, County of Peterborough, ON

Tranplan Associates is pleased to present the results of the traffic study carried out to assess the potential traffic impacts of the proposed *Warsaw Residential Subdivision.* The traffic study has been based on a total of 20 residential lots. The final lot count has yet to be set but is expected to be less than the 20 lots assumed for the traffic study. The subdivision will be located on the east side of Peterborough County Road (CR) 4 on the north side of the Hamlet of Warsaw, Ontario. The future traffic volumes forecast to be generated by the 20 lot subdivision can be accommodated on the existing adjacent roads and intersections. Drivers entering and exiting the new local road to/from the subdivision to access CR 4 will face acceptable levels of delay.

The future CR 4/Site Entrance intersection operating with single lane approaches will support future site and background traffic. No auxiliary turning lanes or right turn tapers will be required at this intersection. The future local road connecting the new residences to CR 4 should be constructed to current County and Township standards. Tranplan Associates is pleased to have the opportunity to work with your study team on this project. If you should require any further information on the study analyses or reporting, please contact me at your convenience

Yours truly,



William Copeland, P.Eng.

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

1.1 Background

Tranplan Associates is pleased to present the results of a traffic study to determine the impact of the proposed *Warsaw Residential Subdivision* to be located in the Hamlet of Warsaw, Ontario, part of the amalgamated Township of Douro-Dummer. The subdivision will be located on what is essentially a green field site on the north side of the Hamlet along the west side of the Indian River. The traffic study has been based on 20 individual lots along a new local street that will access Peterborough County Road (CR) 4 on the north side of Hamlet about 85 m north of the intersection of English Line South and CR 4 adjacent to *Warsaw Public School* (see *Exhibit 1 - Key Map* following report text). The final lot count has yet to be set, but it is expected to be less than the 20 lots assumed for the traffic study analyses.

The proposed layout of the subdivision and its facilities are illustrated in *Exhibit 2 – Preliminary Site Plan*. Each lot will have direct access to the new local street via its own driveway. Nearby residential development, the English Line South/CR 4 intersection and the adjacent Warsaw Public School are illustrated in *Exhibit 3 - Site Context*.

This traffic study has been requested by the County of Peterborough and the Township of Douro-Dummer as part of the planning approval process for the proposed subdivision. Discussions were held with the study team and the County to establish the scope of the traffic study. Tranplan Associates staff have completed three site visits to collect peak hour traffic counts, observe current traffic operations, measure existing road cross-sections, review adjacent land uses and measure sight lines from the proposed site entrance to CR 4.

Traffic analyses completed for this study include intersection capacity analysis of the English Line South/CR 4 intersection and the proposed new entrance intersection with CR 4. Additional analyses included auxiliary lane warrant calculations to assess the need for southbound left turn lanes and northbound right turn taper/lanes on CR 4 at the intersections with English Line South and the new site entrance roadway. The analyses were based on future AM and PM peak hour volumes for a 10 year planning horizon to 2027. The total traffic volumes used in the analyses included traffic generated by full development of the new subdivision combined with growth in background traffic from 2017 to 2027.

1.2 Principal Findings

The principal findings derived from the study analyses include the following:

- The present study road network operates at good Levels of Service (LoS)[1] during weekday peak hour periods with residual capacity for future growth in traffic.

[1] See Technical Appendix – Intersection Capacity Analysis for definitions of Levels of Service.

- During future 2027 total traffic peak hour conditions, all traffic movements at the English Line South intersection are forecast to operate at the boundary of LoS “A/B”
- Traffic movements during 2027 peak hour periods at the new site entrance intersection with CR 4 are forecast to operate at the boundary of LoS “A/B" or better. This is considered a very good LoS for peak hour traffic conditions. Drivers accessing CR 4 from the new subdivision will face little delay.
- No new auxiliary lanes will be required at the English Line South/CR 4 intersection to support 2027 total peak hour traffic volumes. These peak hour volumes will include site traffic from the new *Warsaw Residential Subdivision*. The existing English Line South/CR 4 intersection geometrics will support future 2027 total peak hour volumes.
- A planned sidewalk/cycle path will be constructed to provide pedestrian and cycling connectivity to the *Warsaw Public School* and from there to the existing sidewalk along the east side of the CR 4. This will provide an active transportation link to commercial and retail destinations in the Hamlet.
- The site entrance intersection with CR 4, and the new local road should be designed to current County and Township standards for a local road located in a rural residential subdivision. It should be able to accommodate municipal service vehicles, EMS vehicles, school buses and vehicles supporting handicapped access.

The following sections of the Study Report contain the documentation and details of the analyses to support the principal findings of the study.

2. EXISTING CONDITIONS

This Section describes the roadway network, traffic volumes, operational analysis results and other notable characteristics under the baseline conditions.

2.1 The Study Site

The proposed *Warsaw Residential Subdivision* will be located in the geographic Township of Dummer now part of the amalgamated Township of Douro-Dummer. The subdivision will located on the northern edge of the Hamlet of Warsaw along the east side of CR 4 (see *Exhibit 1*). The subdivision will be located on a green-field site as illustrated in *Exhibit 3*. The proposed plan of subdivision will contain up to 20 individual lots for single family residential housing.

Each lot will have its own driveway accessing a new local street that will provide direct access to CR 4 as illustrated in *Exhibit 2*. Additional development information for the study site is contained in related planning documentation that will be submitted with this traffic report for the necessary planning approvals.

2.2 Adjacent Land Use

The study site is located on the northern edge of residential and commercial development in the Hamlet of Warsaw. *Warsaw Public School*, a local elementary school is located along the south boundary of the study site. Three rural residences are located opposite the study site and one residence is located along the north boundary of the site. One of the Township road maintenance depots is located further north on CR 4. A smaller aggregate pit operation is located just north of the Township maintenance yard. Lands beyond the CR 4 corridor are a mix of woodlots and low-end agricultural uses characteristic of this part of the Township.

The main part of the Hamlet is located south of the study site. It contains a mix of residential and commercial development including a gas station and auto repair business, a local non-franchise restaurant, a general store and an LCBO outlet. The businesses are characteristic of commercial and retail services provided to immediate areas surrounding the Hamlet. *Exhibit 3 – Site Context* illustrates the location of the study site in the context of the Hamlet.

2.3 Access to the Study Site

2.3.1 Peterborough County Road 4

Regional access to the *Warsaw Residential Subdivision* will be provided by County Road (CR) 4. This road is under the jurisdiction of the County of Peterborough. CR 4 functions as a rural collector road providing access to adjacent development as well as carrying some through traffic traveling on the County road network.

CR 4 south of the Hamlet of Warsaw is more commonly known as the Warsaw Road. It runs in a southwesterly direction linking the Hamlet, adjacent farms and

rural communities to the City of Peterborough. North of the Hamlet CR 4 (The English Line) runs north to connect to CR 6, the Stoney Lake Road with its connections west to Highway 28 and the Village of Lakefield. To the east CR 6 connects to the Hamlet of Halls Glen as well as to residences and seasonal dwellings along the south side of Stoney Lake (see *Exhibit 1*).

In the vicinity of the study site CR 4 was recently re-constructed to upgrade CR 4 to an urban cross-section. South of the English Line South intersection, CR 4 has a 1.5 m sidewalk that runs south from the school to the central area of the Hamlet. This sidewalk provides pedestrian connectivity south from the school to the core area of the Hamlet. North of the intersection, in the immediate vicinity of the study site, CR 4 has an urban cross-section with a 7.0 m asphalt platform with raised concrete curbs edged with 0. 5 m asphalt maintenance strips. This urban section extends about 40 – 50 m north beyond the proposed entrance to the study site. Beyond this urban section, the cross-section transitions to a standard rural open ditch cross-section with an asphalt platform and gravel shoulders.

The posted speed on CR 4 in the vicinity of the study site is 50 kph. Based on the Tranplan Associates traffic count data, CR 4 is estimated to carry a 2017 average daily traffic (ADT) volume of about 2,200 to 2,300 vehicles per day (vpd). Based on County criteria this section of CR 4 is a *Class B* County Road. A design speed of 60 kph (10 kph over posted) was assumed in assessing existing and potential future geometrics for any improvements to CR 4.

2.3.2 English Line South

English Line South is a local road under the jurisdiction of the Township of Douro-Dummer. Running east and south from CR 4, its principal role is to provide access to *Warsaw Public School* (see *Exhibit 3*). Past the school entrance it runs south to connect to a private road, River Lane. River Lane provides access to several residences located along the Indian River. Adjacent to CR 4, English Line South has a semi-urban cross-section with an 8.0 m asphalt platform that includes for two travelled lanes and a shallow ditching on the south side that is included in the road platform. Beyond the road platform on the south side is a 1.5 m concrete sidewalk extension from CR 4 to a marked cross-walk at the school entrance to English Line South. Beyond the school entrance, the road cross section transitions to a rural open ditch cross-section with about a 4 m all-weather platform and 0.5 m gravel shoulders.

2.3.3 The Intersection of English Line South and County Road 4

The English Line South/CR 4 intersection is a “T” intersection with the English Line South approach forming the “stem” of the “T”. The English Line South approach as the minor approach is STOP-controlled. There are no auxiliary turning lanes on any of the approaches. The approaches to the intersection are illustrated in *Exhibit 4*. During the recent re-construction of the intersection, appropriate curb “rounding” was provided for northbound right-turning vehicles onto English Line

South. This "rounding" presently accommodates school buses and other vehicles accessing English Line South from CR 4.

2.4 Current Traffic Data

Weekday AM and PM peak period traffic counts were collected at the CR 4/English Line South intersection. The counts provided weekday turning movement volumes at the intersection as well as the volumes on CR 4 travelling north past the proposed site entrance. The counts were carried out on Tuesday September 12, 2017 (PM) and Wednesday September 13, 2017 (AM). Since the Tranplan Associates counts were carried out on a representative school day, no seasonal adjustment factors were applied to the observed counts. It is noted that the elementary school volumes are a significant component of the peak period intersection traffic. Since this traffic tends to peak over a relatively short period of time, a peak hour factor (phf) of 0.7 was applied to the observed volumes. This phf factors up the volumes to be more representative of conditions during peak periods of demand when traffic is accessing the school. The resulting "factored" 2017 design hour volumes (DHV) are illustrated in *Exhibit 5 – 2017 Design Hour Volumes*. These DHV were subsequently applied to the study analyses.

2.5 Current Traffic Operations

Highway Capacity Manual (HCM) capacity analyses based on the 2017 DHV (see *Exhibit 5*) show that all intersection movements operate at the Level of Service (LoS) "A/B" or better. This is a very good LoS for peak hour conditions. Drivers accessing the CR 4 corridor from English Line South will experience acceptable delay. There is considerable residual capacity to accommodate future growth in background traffic. Detailed printouts of the 2017 capacity analysis are included in the *Technical Appendix – Intersection Capacity Analyses*.

2.6 Spot Speed Study

There is no restriction on sight distance to the north along CR 4 from the new site entrance. To the south, sight lines are limited by the horizontal curve south of the English Line South intersection. As part of the field work a spot speed study was carried out to determine a representative 85th percentile speed of northbound traffic on CR 4 to assure that the assumed design speed of 60 kph was appropriate. This design speed is based on 10 kph over "posted" for Class B County Road. Twenty spot speed observations were taken at the proposed site entrance. The 85th percentile speed for northbound traffic was found to be 61 kph. The maximum observed speed was 63 kph. The assumed 60 kph design speed is appropriate for designing the new entrance to the study site. A copy of the spot speed data is contained in the *Technical Appendix – Spot Speed Study*.

3. THE PROPOSED DEVELOPMENT

This Section describes the proposed changes to the subject site and the development of the site generated traffic.

3.1 Trip Generation Forecasts

The traffic analyses for the *Warsaw Residential Subdivision* was based on 20 new building lots for single family dwelling units. The layout of the proposed subdivision with its individual lots fronting on a new local street that will access the east side of CR 4 as illustrated in *Exhibit 2*. It is noted that *Exhibit 2* illustrates 17 new lots plus 2 lots fronting on CR 4 that will access the new internal road. Site trip generation forecasts were computed based on rates taken from the current Institute of Transportation Engineers (ITE) *Trip Generation Manual* (10th ed.). The selected land use was *Single-Family Detached Housing* (LU 210). *Table 1* following, summarizes the site trip generation for the proposed residential development.

Table 1: Forecast Site Trip Generation (vph)

	Units	AM Peak Hour			PM Peak Hour		
		In[A]	Out	**Total**	In[A]	Out	**Total**
Warsaw Subdivision (ITE LU 210)	20	4	11	**15**	12	7	**19**

A – In/out distribution split based on ITE surveys for LU 210.

The proposed development is forecast to generate a total of 15 new vehicle trips during the weekday AM peak hour and 19 new vehicle trips during the weekday PM peak hour. Since the proposed development is a residential subdivision, no trip volume reductions were made for "linked trips", "diverted trips" or "pass-by" trips.

It is noted that the forecast future traffic volumes during the PM peak hour will be, on the average about 1 vehicle every 3 minutes added to the CR 4 travel corridor. This will have little impact on present traffic operations in existing travel corridors.

3.2 Site Trip Distribution

The proposed subdivision can attract future residents with employment destinations in various parts of the County, the City of Peterborough, the Village of Lakefield as well as the surrounding areas. It is expected that more site traffic will be attracted to the south to the elementary school, the core of the Village for non-work and school trips and to the City of Peterborough for work trips. There are three potential "Gateways" that traffic can arrive/depart to/from the study site as follows:

- CR 4 North
- CR 4 South
- Warsaw Public School

The percentage distributions to each of these gateways were derived from the observed travel patterns to/from each of the gateways during each of the two weekday peak hour periods. The resulting assumed trip distributions are summarized in *Table 2* following.

Table 2: Site Trip Distribution

Gateway	AM Peak Hr	PM Peak Hour
CR 4 North	35%	45%
CR 4 South	55%	45%
Elementary School	10%	10%
Total	***100%***	***100%***

There was some observed difference in the distribution of travel between the AM and PM peak hour periods. Some of this can be attributed to the different make up of trip purposes in each of the peak hour periods. The AM peak hour is comprised mostly of work trips and school trips. However, there is a greater mix of other trip purposes in the PM peak hour.

4. FUTURE CONDITIONS

This Section summarizes the assumptions used to develop future year traffic volumes, the operational analysis results and associated impacts to the transportation infrastructure.

4.1 Future Background Traffic

Future background traffic forecasts were developed for a 10 year planning horizon to 2027. It is assumed that site build out will occur over the next few years. The 10 year planning horizon will allow for planning approvals, build out of the study site and time for additional growth in background traffic. A 2% annual traffic growth rate is commonly applied to background traffic forecasts for traffic studies in Peterborough County. While it tends to overstate the historic growth rates in the County, it is considered appropriate for use in these traffic studies. The 2% per year (compounded) traffic growth factor was applied to the 2017 design hour volumes as illustrated in *Exhibit 5* to forecast 2027 weekday AM and PM background peak hour volumes.

4.2 Future Total Traffic

The 2027 total weekday AM and PM peak hour volumes for the study road network were computed by adding the new subdivision traffic to 2027 background traffic. The new site traffic was distributed to the study road network based on the assumptions described in *Section 3.2*. The resulting total peak hour volumes are illustrated in *Exhibit 6 - 2027 Total Peak Hour Volumes*. The site traffic volumes are also illustrated in this exhibit.

4.3 Site Traffic Impacts

Detailed intersection capacity analyses were carried out to assess the impact of future site traffic on the study intersection. This was done using current 2010 HCM intersection capacity analyses procedures as contained in *Trafficware's Synchro 8* software. The analyses were based on the 2027 total weekday peak hour volumes as illustrated in *Exhibit 6*. The results are contained in *Table 3* following.

Table 3: Summary - Intersection Capacity Analyses

Intersection of County Road 10 & English Line South (unsignalized)						
	AM Peak Hour – Critical Movement			**PM Peak Hour – Critical Movement**		
	LoS (Delay)	**Vol/Cap**	**Queue[A]**	**LoS (Delay)**	**Vol/Cap**	**Queue[A]**
2017 Design Hr Vol	WB L-R "A/B" (9.8s)	0.04	< 1 veh	WB L-R "A/B" (10.0s)	0.07	< 1 veh
2027 Total Peak Hr	WB L-R "A/B" (10.1s)	0.05	< 1 veh	WB L-R: "A/B" (10.4s)	0.09	< 1 veh

A – Queue is the 95th percentile vehicle queue length measured in vehicles.

Intersection of County Road 10 & Site Entrance (unsignalized)						
	AM Peak Hour – Critical Movement			**PM Peak Hour – Critical Movement**		
	LoS (Delay)	**Vol/Cap**	**Queue[A]**	**LoS (Delay)**	**Vol/Cap**	**Queue[A]**
2027 Total Peak Hr	WB L-R "A/B" (9.6s)	0.02	0 veh	WB L-R "A/B" (9.7s)	0.01	0 veh

A – Queue is the 95th percentile vehicle queue length measured in vehicles.

During future 2027 Total weekday peak hour conditions the CR 4/English Line South intersection critical turning movements are forecast to operate at the boundary of LoS "A/B". This is considered to be a good LoS for AM and PM peak hour periods. There will be considerable residual capacity with a volume/capacity (v/c) ratio of 0.09 (9%) or less. In reviewing *Table 3,* it is noted that the combined growth in background traffic plus new site traffic will only increase average driver delay by about 0.5 seconds in the PM peak hour. Drivers entering the CR 4 corridor from English Line South will experience little delay. Based on the low v/c ratios, there will be considerable residual capacity in the CR 4 traffic stream to accommodate traffic from the proposed subdivision. Site traffic will have an acceptable level of impact on the CR 4 corridor. There will be residual capacity in the corridor for growth in traffic beyond the 2027 study planning horizon.

As summarized in *Table 3*, the future site entrance intersection with CR 4 is forecast to operate at LoS "A/B" during weekday peak hour periods. Drivers entering the CR 4 corridor will face acceptable levels of delay there will be considerable residual capacity at this intersection for future growth in background traffic beyond the 2027 planning horizon. Detailed printouts of the capacity analyses for the two study intersections for 2027 peak hour conditions are included in the *Technical Appendix - Intersection Capacity Analyses*.

4.4 Auxiliary Lane Warrant Analyses

Left turn lane warrant analyses were carried out to determine the need for southbound left turn lanes on CR 4 at the English Line South intersection and the new site entrance intersection. Current *Ministry of Transportation Ontario* (MTO) criteria, standards, and process for these warrant analyses were applied to the intersections. The analyses were based on total 2027 total peak hour volumes as illustrated in *Exhibit 6*. Left turn warrant nomographs (60 kph design speed) from the current MTO manual *Geometric Design Standards for Ontario Highways* (GDSOH) were used for the analysis. Based on MTO criteria, there is no warrant for either a southbound left turn lane on CR 4 at English Line South or at the new site entrance.

The MTO GDSOH manual does not provide a specific warrant procedure for assessing the need for right turn taper/lanes. Northbound right turn lane warrant analyses were carried out for the CR 10/English Line South intersection based on the 2027 total peak hour volumes. The analyses were based on the current *Virginia Department of Transportation* (VDOT) right turn lane warrant procedure. This right turn lane warrant methodology has been used in a number of other traffic studies in Peterborough County and found acceptable. No warrant was found for a northbound right turn taper/lane at the either the CR 10/English Line South or new site entrance intersection to CR 4. The existing northbound right turn "rounding" will accommodate right-turning vehicles at English Line South. An appropriate "rounding" within the new urban cross-section on CR 4 at the new site entrance will accommodate northbound right-turning vehicles. The "rounding" constructed to current County standards will be sufficient

A copy of the VDOT calculation sheet/nomographs used for the right turn warrant analyses are provided in the *Technical Appendix – Auxiliary Lane Warrant Analyses*.

4.5 Future Site Access

Access to the *Warsaw Residential Subdivision* will be provided by a new local street running east from CR 4. *Exhibit 2* illustrates the details of the street layout and lotting. The *Street A* will serve 14 of the proposed lots. *Street B* running south will serve and additional 5 lots. It is noted that *Street B* intersects *Street A* an angle of about 106 degrees of arc. This falls within the TAC acceptable range of 70 to 110 degrees for such angles of intersection.

Current standards for development on "dead end" roads or "culs-de-sac" vary somewhat among the approving agencies. With the assumed 20 lots and an ITE trip generation rate of 10 trips per day per household, the total daily volume (2-way) will be about 200 trips per day. This is an acceptable daily volume for such a road.

The location of the proposed site entrance was field checked to assure that it had adequate turning site distance (TSD) and stopping sight distance (SSD) for a 60 kph design speed as defined in current 2017 TAC design guidelines. As described in Section 4.5 there are no restrictions to sight lines from the proposed site entrance to the north along CR 4. To the south, the entrance sight line is restricted by a horizontal curve. The Intersection or Turning Sight Distance (ISD or TSD) to the south was measured following the field procedures as laid out in the *Section Visibility*, on page 2 of the *Commercial Site Access Policy and Standard Designs* (MTO pub., 1994). The ISD was measured to be 140 m. This is the maximum distance a driver exiting the future entrance will be able to see a vehicle travelling from the south in the northbound direction. The "tail light" Stopping Sight Distance (SSD) to the south was measured to be 125 m. This is the maximum distance to the north that a northbound vehicle, south of the site entrance can see a "stalled" vehicle that has exited the driveway to travel north. The posted speed in the vicinity of the proposed site entrance is 50 kph. Based on County standards for a Class "B" County Road, the design speed is 60 kph. The ISD sight distance taken from the 2017 TAC manual1 for 60 kph is 130 m. About 140 m of ISD is available. Available SSD is 125 m. Required SSD for 60 kph is 85 m. The new site entrance to CR 4 will have adequate sight distance to allow site traffic to safely enter the CR 4 traffic stream.

4.6 Pedestrian Connectivity

The plan for the new subdivision will include a pedestrian walkway that will provide direct access to the *Warsaw Public School*. This link forms a "Safe Route to School" for children and parents in the new subdivision. From the school, existing pedestrian linkages are available along CR 4 to link the subdivision to the retail and commercial areas within the core area of the Hamlet. An additional pedestrian connection links the new subdivision to recreational areas along the Indian River.

[1] Table 9.9.4, pg. 68, Chapter 9, Geometric Design Guide for Canadian Roads, TAC pub., 2017

5. CONCLUSIONS AND RECOMMENDATIONS

This Section summarizes the salient findings of the analyses and identifies any necessary changes to the transportation infrastructure.

5.1 Conclusions

The following conclusions have been drawn from the traffic impact analyses completed for the proposed *Warsaw Residential Subdivision.* They include the following:

- The present study road network operates at a good LoS during weekday peak hour periods with residual capacity for future growth in traffic.
- The auxiliary lane warrant analyses for the English Line South and new site entrance intersections with CR 4 have determined that no auxiliary lanes or right turn tapers will be required on CR 4 to support access to either minor road.
- During future Total 2027 peak hour conditions, all traffic movements at two study intersections with CR 4 are forecast to operate at the boundary of Level of Service (LoS) "A/B" or better (see *Table 3*). This is considered a good LoS for peak hour traffic conditions. Drivers accessing CR 4 from new subdivision road will experience acceptable delay.
- Available Intersection Sight Distance (ISD) from the new site entrance along CR 4 will meet/exceed current 2017 TAC requirements for both TSD and SSD sight distances based on a 60 kph design speed.
- Planned pedestrian facilities for the new subdivision will provide direct connectivity to *Warsaw Public School* and from there to other parts of the Hamlet.

5.2 Recommendations

The following recommendations have been developed from the study analyses and conclusions:

- The new access roads that will provide access to the individual lots should designed to current County of Peterborough and Township of Douro standards for such a roadway. The curb “roundings” at the entrance to CR 4 should be designed to accommodate commercial delivery vehicles, school buses, municipal service vehicles and EMS vehicles.
- To meet County requirements, the two most westerly lots facing CR 4 should have their driveways aligned to access the new *Street A* rather than CR 4. These driveways should be located at or near the eastern boundaries of the lots to maximize “corner clearance” distance to CR 4.
- The two individual culs-de-sac at the termini of *Streets A* and *Street B* should be designed to accommodate all vehicle types entering the subdivision as per the site entrance requirements. Recommended TAC guidelines for the design of the culs-de-sac are contained in *Section 8-10* of the current 2017 TAC *Geometric Design Guide.*

- As required, all signage and pavement markings should be constructed in accordance with the guidance provided in the *Ontario Traffic Manual* (OTM) and *the Manual of Uniform Traffic Control Devices of Canada* (MUTCDC).

Study analyses have shown the existing road network has the capacity to accept future site traffic from the *Warsaw Residential Subdivision.* With the site entrance roadways constructed to current County and Township standards, new site traffic will have an acceptable impact on adjacent roads and intersections. No other new road infrastructure will be required to support new traffic from the *Warsaw Residential Subdivision.*

REPORT EXHIBITS

Exhibit 1
Key Map

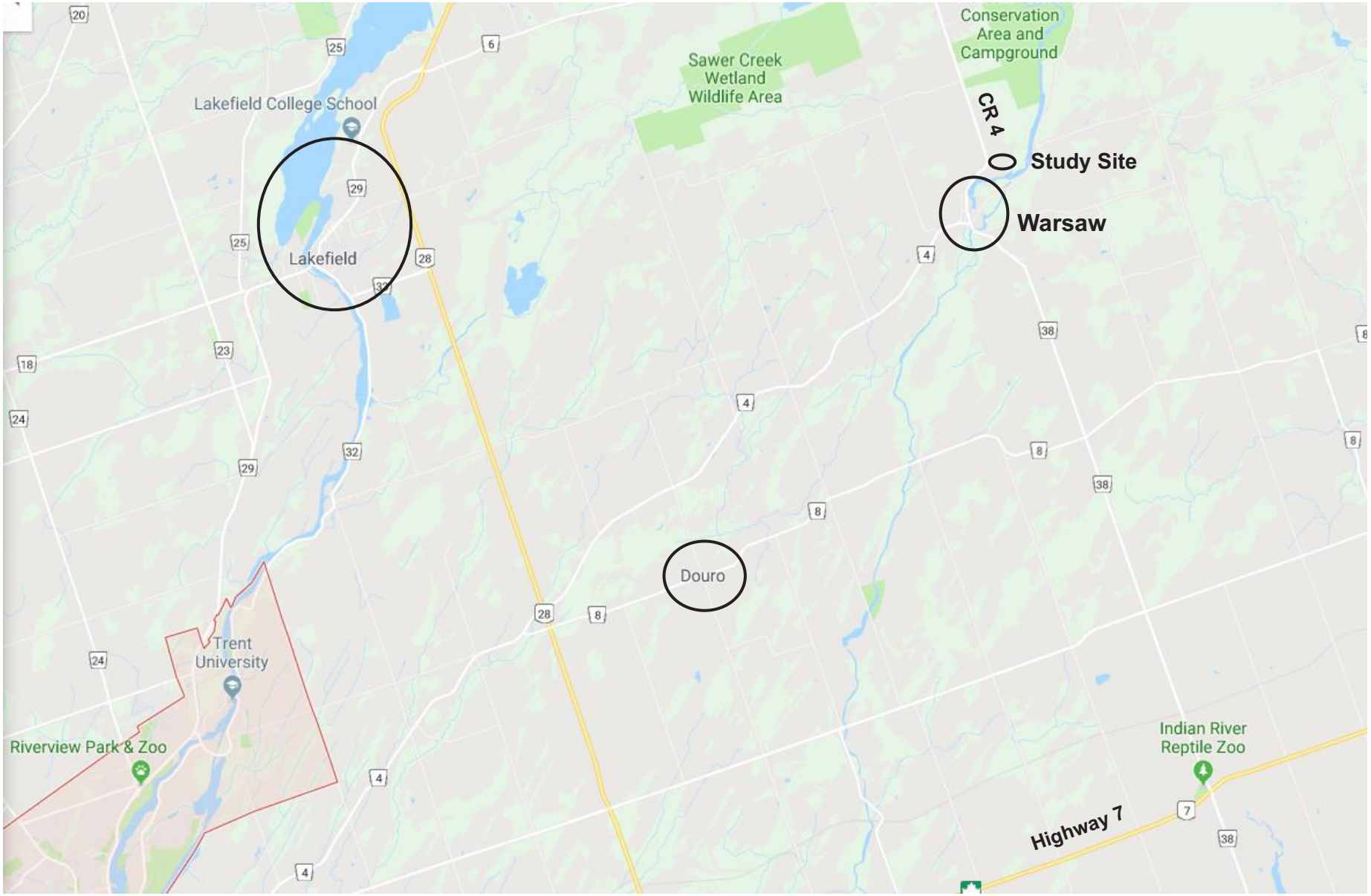


Exhibit 2
Preliminary Site Plan

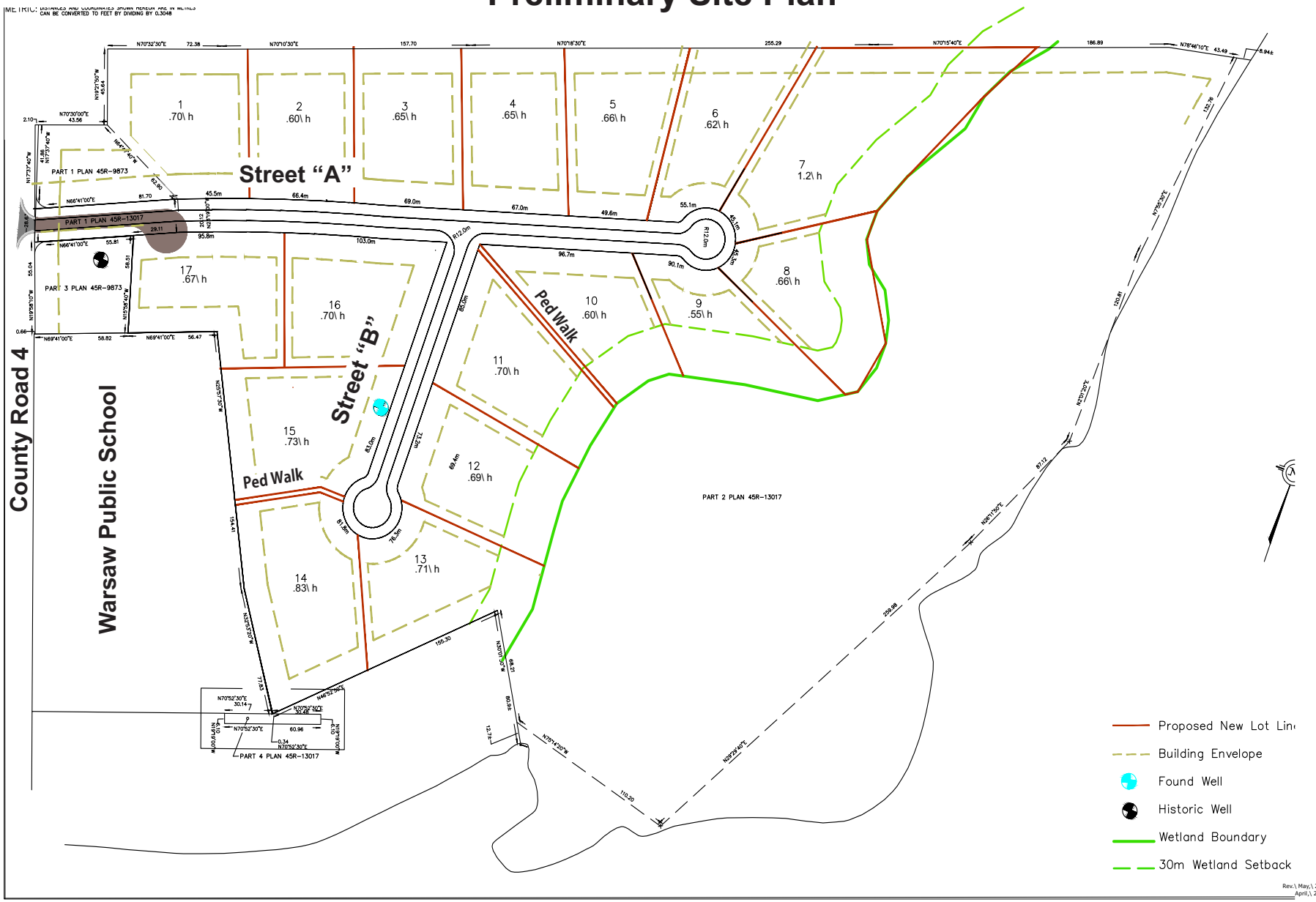


Exhibit 3 - Site Context

County of Peterborough

Proposed Warsaw Subdivision-Part Lot 13
Concession 22 (Dummer)

Legend

Roads < 50,000
- PRIV ; Private; PRIV
- City Arterial
- City Collector and Local
- City Owned Unclassified
- Provincial
- County
- Township
- Water Access Only

Outside Roads < 50,000
- Major Roads
- Local Roads

First Nations

Civic Address

Parcel Fabric

Parcel First Nations - Canada L

Rivers
- Intermittent
- Permanent

Clean Water Act Policies Appl y

Image
- Red: Band_1
- Green: Band_2
- Blue: Band_3

Notes

254.0 0 127.00 254.0 Meters

NAD83_CSRS98_UTM_zone_17N

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

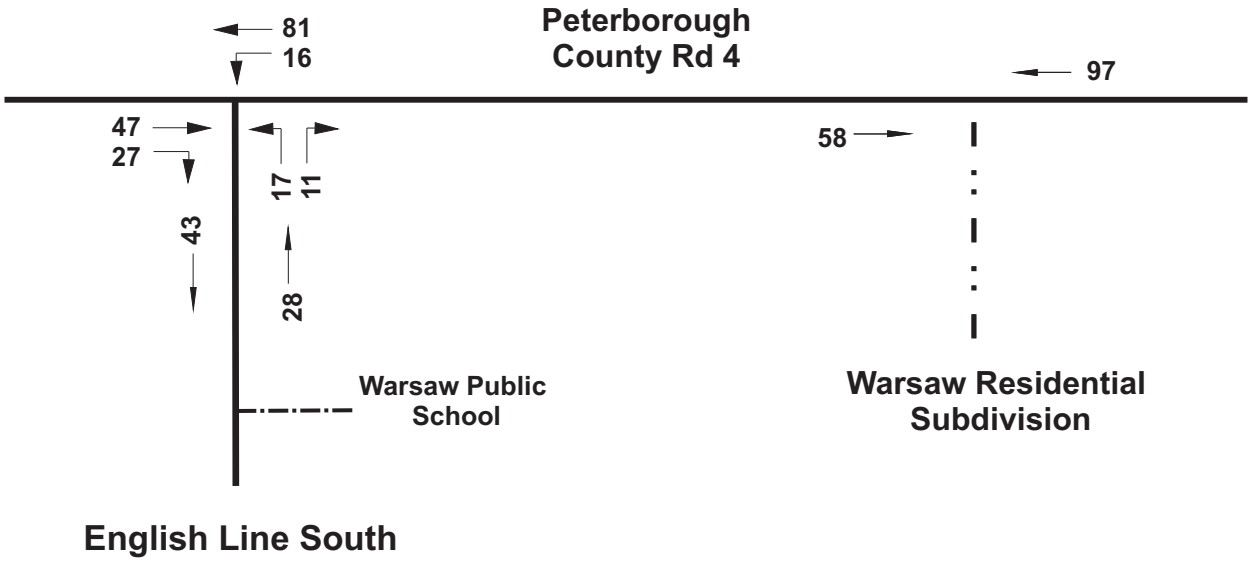
Exhibit 4
Intersection CR 4 and English Line South

CR 4 Looking North
English Line South
East Approach

English Line South
East Approach to CR 4
Warsaw Public School
Entrance Driveway

Exhibit 5
2017 Design Hour Volumes

AM Peak Hour



PM Peak Hour

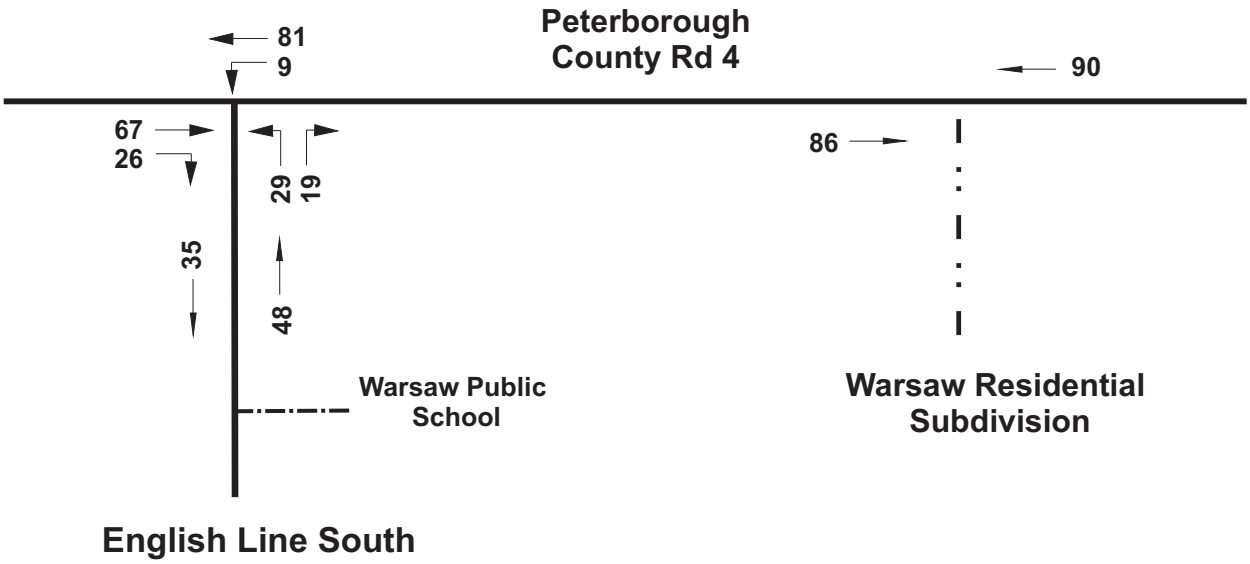
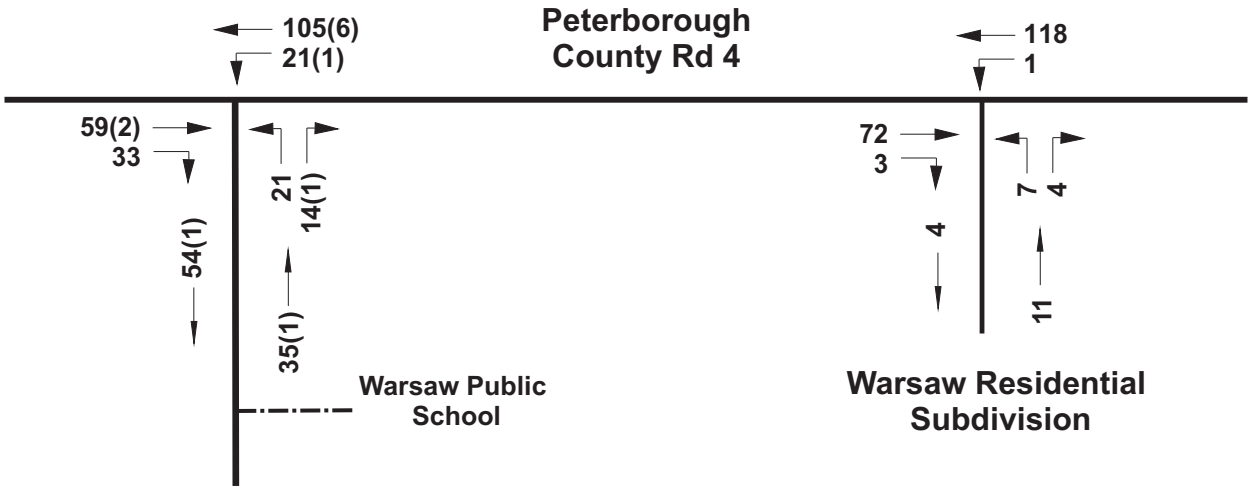
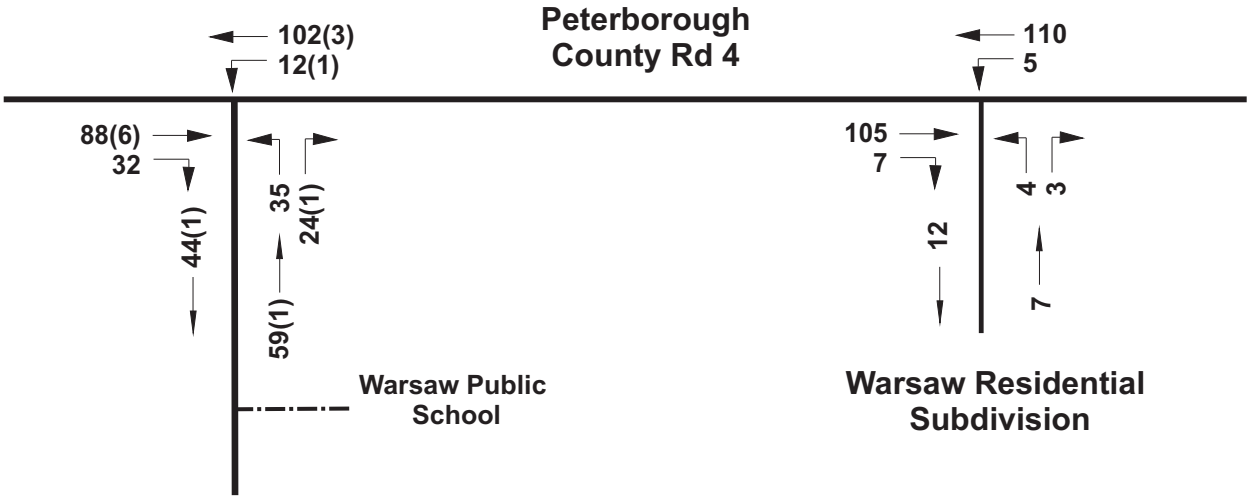


Exhibit 6
2027 Total Peak Hr Volumes

AM Peak Hour



PM Peak Hour



xx - Total Traffic
(xx) - Site Traffic

TECHNICAL APPENDIX

Intersection Capacity Analyses

DEFINITION OF LEVELS OF SERVICE
Automobile Mode

UNSIGNALIZED INTERSECTIONS

Analysis of the Level of Service for unsignalized intersections is based on the ***Highway Capacity Manual*** *(HCM 2010)* procedures using current software for unsignalized intersections. The Level of Service for intersections is based on *Control Delay*. At two way stop controlled intersections (TWSC), *Control Delay* is the total elapsed time from a vehicle joining the queue until its departure from the stopped position at the head of the queue. The *Control Delay* also includes the time required to decelerate from a stop and to accelerate to the free-flow speed.

The analysis of individual movements at TWSC intersections can also include the estimate of the ratio of volume or demand to available capacity for the movements. This is commonly know as the (v/c) ratio. The v/c ratio provides some indication of how well these individual intersection movements will function during peak hour periods.

Level of Service definitions for unsignalized intersections as defined by the ***Highway Capacity Manual*** are summarized in the table below.

Definition of Level of Service for Unsignalized Intersections
(see Exhibit 19-1, Highway Capacity Manual 2010)

Level of Service	Average Delay (seconds)
A	0 - 10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	More than 50s and/or v/c > 1

Level of Service (LoS) for a TWSC intersection is determined by the computed or measured *Control Delay* and is defined for each minor movement at the intersection. LoS is not defined for the major street approaches or the intersection as a whole. LoS “F” is considered to be undesirable for design or planning purposes. However, many individual turning movements at TWSC intersections and commercial entrances along urban arterial corridors operate at LoS “F” during peak hour periods.

Intersection	
Int Delay, s/veh	2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	17	11	47	27	16	81
Conflicting Peds, #/hr	20	20	0	20	20	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	3	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	10	20	20	10
Mvmt Flow	18	12	51	29	17	88

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	209	106	0	0	100	0
Stage 1	86	-	-	-	-	-
Stage 2	123	-	-	-	-	-
Critical Hdwy	7.02	6.52	-	-	4.3	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.38	-
Pot Cap-1 Maneuver	753	940	-	-	1387	-
Stage 1	924	-	-	-	-	-
Stage 2	884	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	721	911	-	-	1364	-
Mov Cap-2 Maneuver	721	-	-	-	-	-
Stage 1	911	-	-	-	-	-
Stage 2	858	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	9.8	0	1.3
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	785	1364	-
HCM Lane V/C Ratio	-	-	0.039	0.013	-
HCM Control Delay (s)	-	-	9.8	7.7	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.1	0	-

Intersection	
Int Delay, s/veh	2.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	29	19	67	26	9	81
Conflicting Peds, #/hr	20	20	0	20	20	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	3	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	10	20	20	10
Mvmt Flow	32	21	73	28	10	88

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	215	127	0	0	121	0
Stage 1	107	-	-	-	-	-
Stage 2	108	-	-	-	-	-
Critical Hdwy	7.02	6.52	-	-	4.3	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.38	-
Pot Cap-1 Maneuver	746	913	-	-	1362	-
Stage 1	901	-	-	-	-	-
Stage 2	900	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	718	885	-	-	1339	-
Mov Cap-2 Maneuver	718	-	-	-	-	-
Stage 1	888	-	-	-	-	-
Stage 2	878	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10	0	0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	776	1339	-
HCM Lane V/C Ratio	-	-	0.067	0.007	-
HCM Control Delay (s)	-	-	10	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.2	0	-

Intersection	
Int Delay, s/veh	2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	21	14	59	33	21	105
Conflicting Peds, #/hr	20	20	0	20	20	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	3	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	10	20	20	10
Mvmt Flow	23	15	64	36	23	114

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	262	122	0	0	120	0
Stage 1	102	-	-	-	-	-
Stage 2	160	-	-	-	-	-
Critical Hdwy	7.02	6.52	-	-	4.3	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.38	-
Pot Cap-1 Maneuver	696	920	-	-	1363	-
Stage 1	907	-	-	-	-	-
Stage 2	846	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	663	892	-	-	1340	-
Mov Cap-2 Maneuver	663	-	-	-	-	-
Stage 1	894	-	-	-	-	-
Stage 2	817	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.1	0	1.3
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	739	1340	-
HCM Lane V/C Ratio	-	-	0.051	0.017	-
HCM Control Delay (s)	-	-	10.1	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.2	0.1	-

Intersection	
Int Delay, s/veh	2.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	35	24	88	32	12	102
Conflicting Peds, #/hr	20	20	0	20	20	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	3	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	10	20	20	10
Mvmt Flow	38	26	96	35	13	111

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	270	153	0	0	150	0
Stage 1	133	-	-	-	-	-
Stage 2	137	-	-	-	-	-
Critical Hdwy	7.02	6.52	-	-	4.3	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.38	-
Pot Cap-1 Maneuver	688	882	-	-	1328	-
Stage 1	874	-	-	-	-	-
Stage 2	869	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	660	855	-	-	1306	-
Mov Cap-2 Maneuver	660	-	-	-	-	-
Stage 1	862	-	-	-	-	-
Stage 2	845	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.4	0	0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	727	1306	-
HCM Lane V/C Ratio	-	-	0.088	0.01	-
HCM Control Delay (s)	-	-	10.4	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0	-

Intersection	
Int Delay, s/veh	0.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	7	4	72	3	1	118
Conflicting Peds, #/hr	15	15	0	15	15	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	2	-	-	-2
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	15	2	2	15
Mvmt Flow	8	4	78	3	1	128

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	225	110	0	0	97	0
Stage 1	95	-	-	-	-	-
Stage 2	130	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	763	943	-	-	1496	-
Stage 1	929	-	-	-	-	-
Stage 2	896	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	744	921	-	-	1477	-
Mov Cap-2 Maneuver	744	-	-	-	-	-
Stage 1	918	-	-	-	-	-
Stage 2	884	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	9.6	0	0.1
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	800	1477	-
HCM Lane V/C Ratio	-	-	0.015	0.001	-
HCM Control Delay (s)	-	-	9.6	7.4	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	0.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	4	3	105	7	5	110
Conflicting Peds, #/hr	15	15	0	15	15	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	2	-	-	-2
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	15	2	2	15
Mvmt Flow	4	3	114	8	5	120

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	263	148	0	0	137	0
Stage 1	133	-	-	-	-	-
Stage 2	130	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	726	899	-	-	1447	-
Stage 1	893	-	-	-	-	-
Stage 2	896	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	706	878	-	-	1429	-
Mov Cap-2 Maneuver	706	-	-	-	-	-
Stage 1	883	-	-	-	-	-
Stage 2	881	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	9.7	0	0.3
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	771	1429	-
HCM Lane V/C Ratio	-	-	0.01	0.004	-
HCM Control Delay (s)	-	-	9.7	7.5	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Spot Speed Study

Warsaw Subdivision
Spot Speed Study

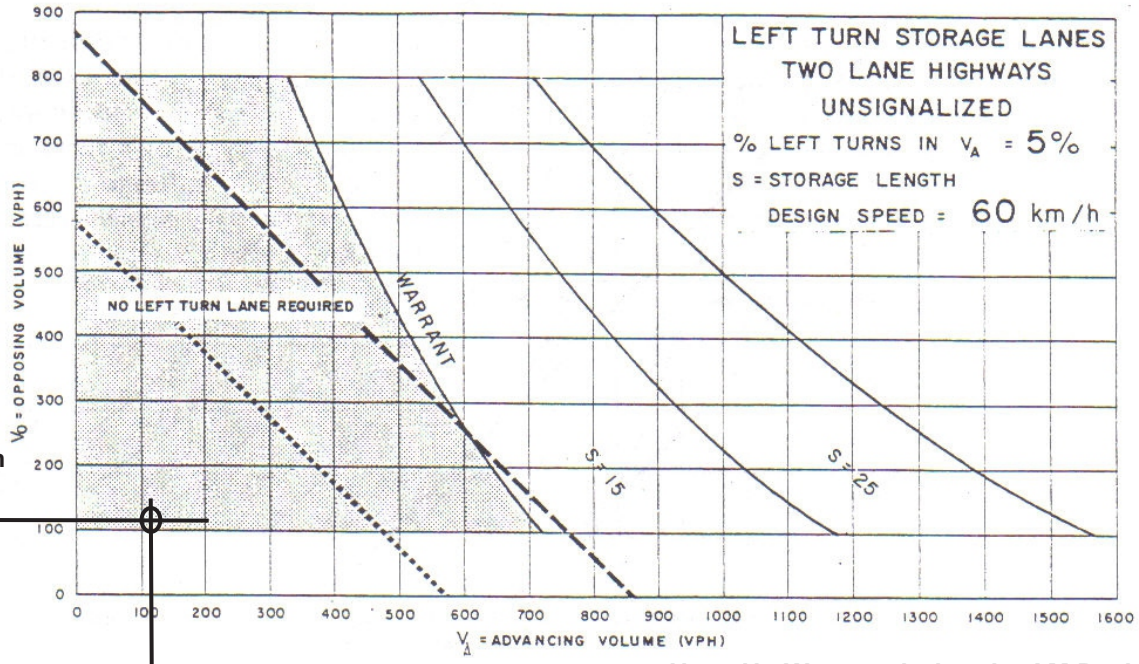
No	Obs NB	Sorted	
1	63	43	
2	58	45	
3	51	47	
4	55	50	
5	61	50	
6	51	51	
7	50	51	
8	56	51	
9	61	53	
10	47	55	
11	58	56	
12	60	58	
13	61	58	
14	51	60	
15	50	60	
16	45	60	
17	60	61	85th Perctile
18	60	61	
19	43	61	
20	53	63	

Observed Free Flow 1:25 to 1:53 PM

Auxiliary Lane Warrant Analysis

Left Turn Lane Warrant Analyses

Southbound Left Turns
CR 4 at New Site Entrance

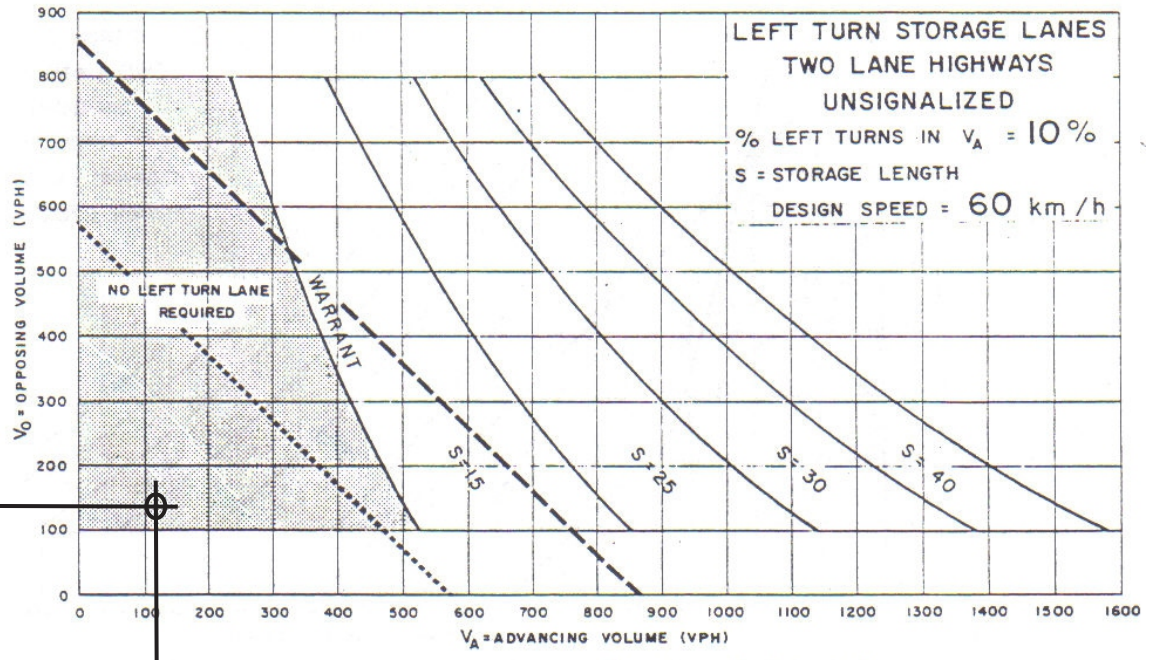


V_O = 112 vph
(PM Pk Hr)

V_A = 115 vph
V_L = 5 ~ 4.4%

***Note*: No Warrant during the AM Peak**
Left Turns less than 2.5%
of the advancing traffic Stream

Southbound Left Turns
CR 4 at English Line South

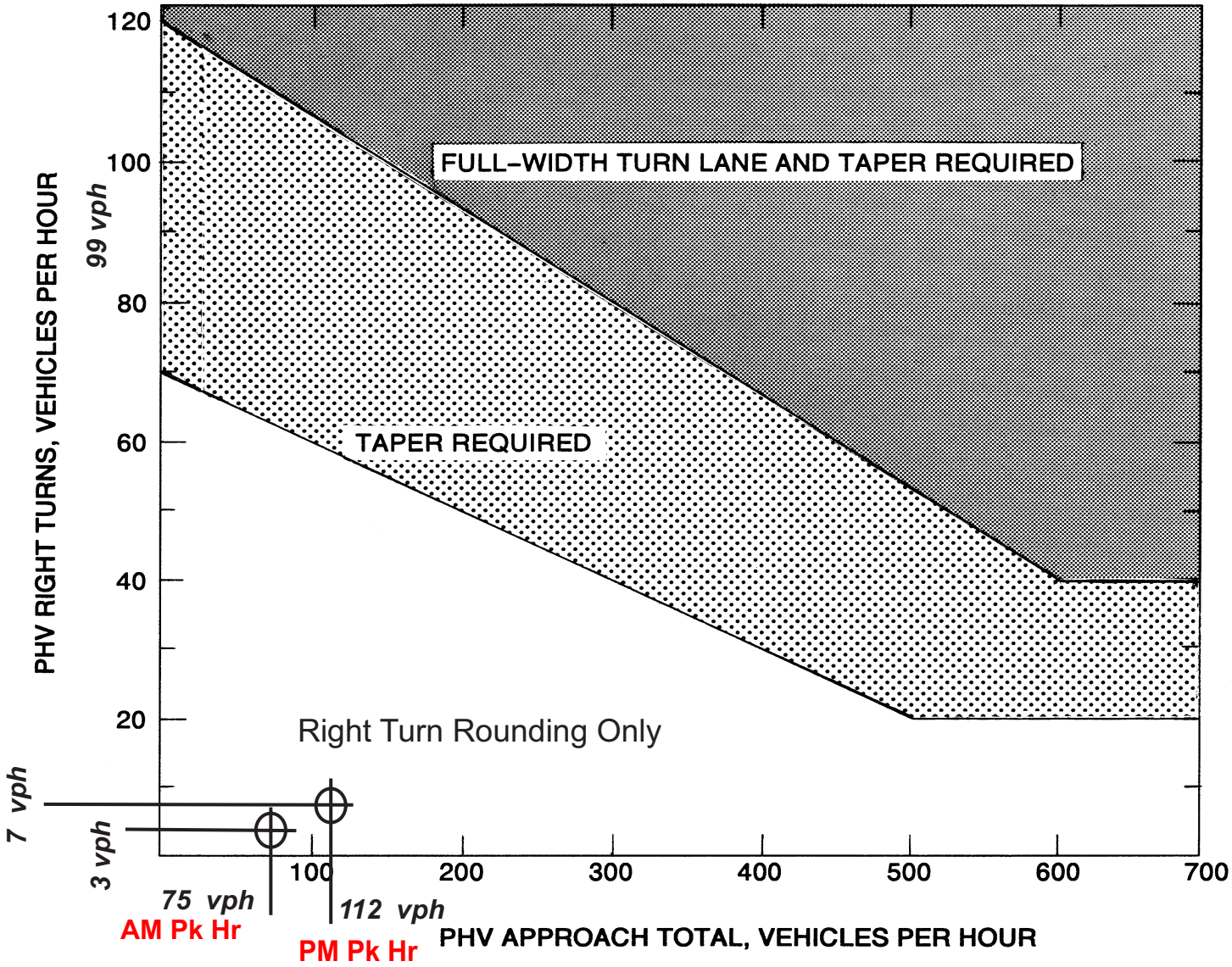


V_O = 120 vph
(PM Pk Hr)

V_A = 114 vph
V_L = 12 ~ 10.5%

***Note*: No Warrant during the AM Peak**
Opposing CR 4 Volumes less than 100 vph

VDOT Guidelines for Right Turn Treatment (NB)
Cty Rd 4 & Site Entrance



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

LEGEND

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

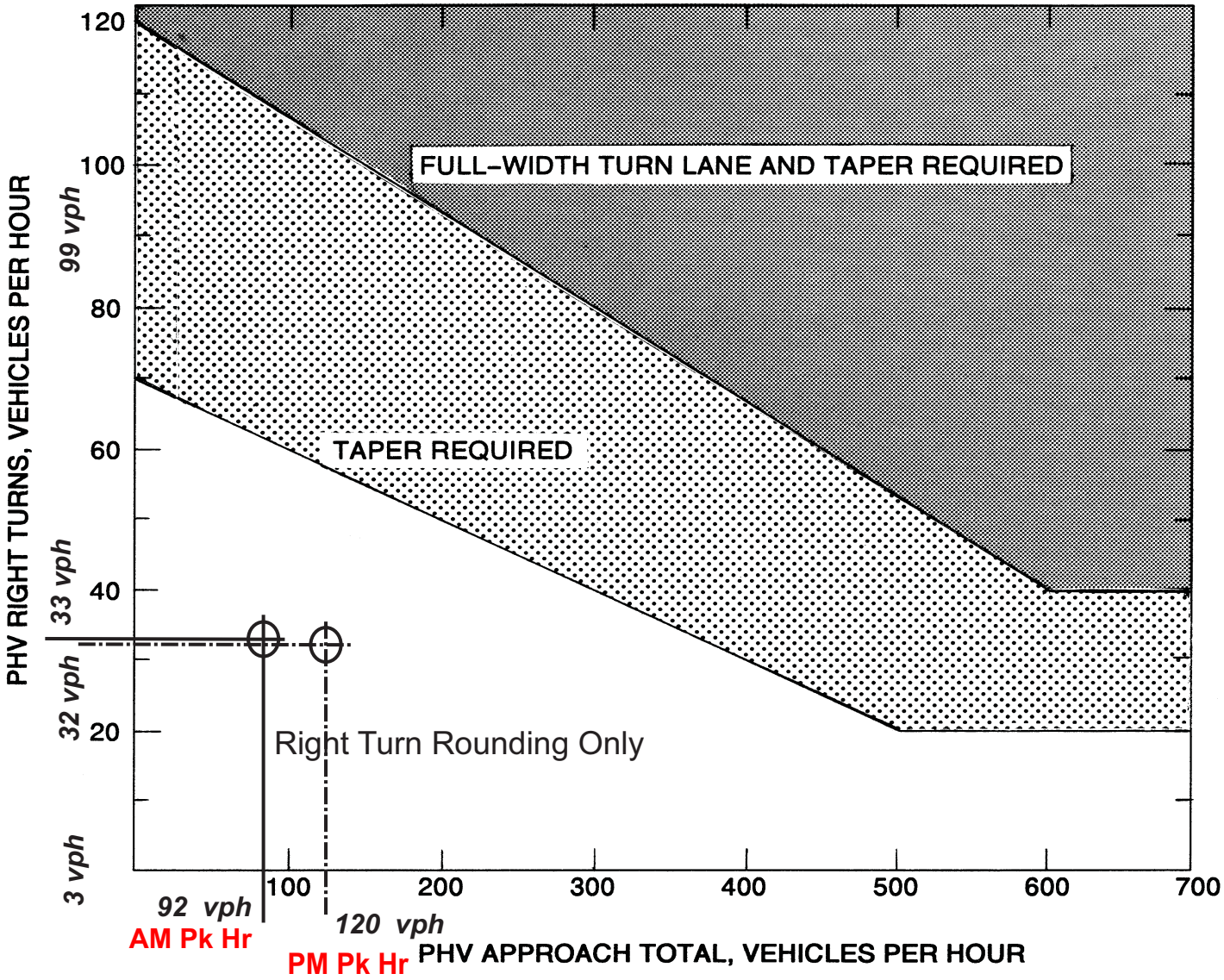
Adjustment for Right Turns

For posted speeds at or under 70 kph, 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.

VDOT Guidelines for Right Turn Treatment (NB)
Cty Rd 4 & English Line South



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

LEGEND

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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.