C.C. Tatham & Associates Ltd.
Consulting Engineers

CAMPERDOWN CONDOMINIUMS

Town of The Blue Mountains

Transportation Brief

prepared by:

C.C. Tatham & Associates Ltd.
115 Sandford Fleming Drive, Suite 200
Collingwood, ON L9Y 5A6
Tel: (705) 444-2565 Fax: (705) 444-2327
info@cctatham.com

prepared for

2220740 Ontario Inc. c/o Romspen Investment Corp.

June 2018

CCTA File 117304

TABLE OF CONTENTS

APPENDICES

Appendix A: Highway 26/Grey Road 40 Class EA Excerpts

Appendix B: 2018 Intersection Operations

Appendix C: 2023 Future Background Intersection Operations

Appendix D: 2023 Future Total Intersection Operations

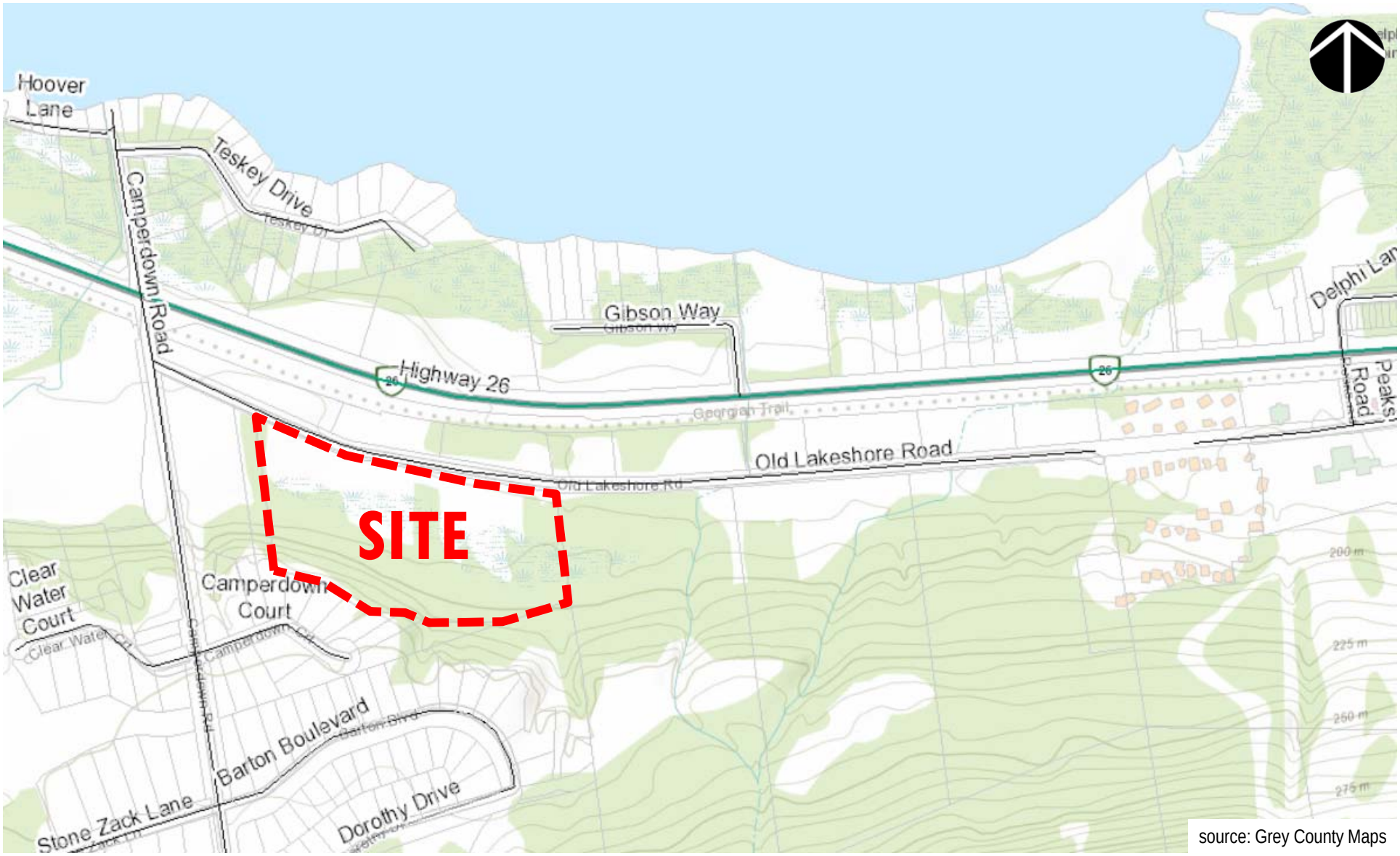
LIST OF TABLES

LIST OF FIGURES

1 Introduction

C.C. Tatham & Associates Ltd. has been retained by 2220740 Ontario Inc. to provide engineering services in support of a proposed residential development located on Old Lakeshore Road and Camperdown Road in the Town of The Blue Mountains (refer to Figure 1). Specifically, this report has been prepared to demonstrate that the surrounding road network can accommodate the development with minimal impact.

Chapter 2 of this report addresses the proposed development and the ensuing vehicle trips that it will generate. Chapter 3 presents the existing conditions, detailing the road system and corresponding traffic volumes and operations. Chapter 4 addresses future conditions, both with and without consideration for the proposed development, and will address the expected growth in the traffic levels and the resulting operating conditions. Lastly, Chapter 5 summarizes the report and the key findings.



C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Site Location

Figure

1

2 Camperdown Condominiums Development

2.1 Site Description & Surrounding Land Use

The development site has an area of approximately 6.61 ha with frontage on Old Lakeshore Road. Currently, the site is zoned Residential Hold (R3-H), Public Open Space (OS1) and Hazard (H) in accordance with Town By-law 2006-22. It is legally described as Part Lot 26 Concession 6 in the former Collingwood Township. A portion of the proposed development resides within the Nipissing Ridge geological region of the Georgian Bay Peninsula.

2.2 Existing Land Use

The site is located at the base of the Nipissing Ridge formation on a flat plateau containing forested and open space areas with the land sloping from southwest to northeast between 2% and 5%.

2.3 Proposed Development

The current site plan prepared by Innovative Planning Solutions (IPS), as presented in Figure 2, illustrates the proposed development consisting of 34 single family residential units, open space (non-developable land), a walking trail and a stormwater management block Build out and occupancy is expected within the next several years.

2.4 Site Access & On-Site Circulation

A condominium road (10 metre allowance) will be constructed internal to the development, with 2 points of access to/from Old Lakeshore Road (as noted in Figure 2 and Figure 3). Old Lakeshore Road provides access to/from Camperdown Road which in turn provides access to/from Highway 26.

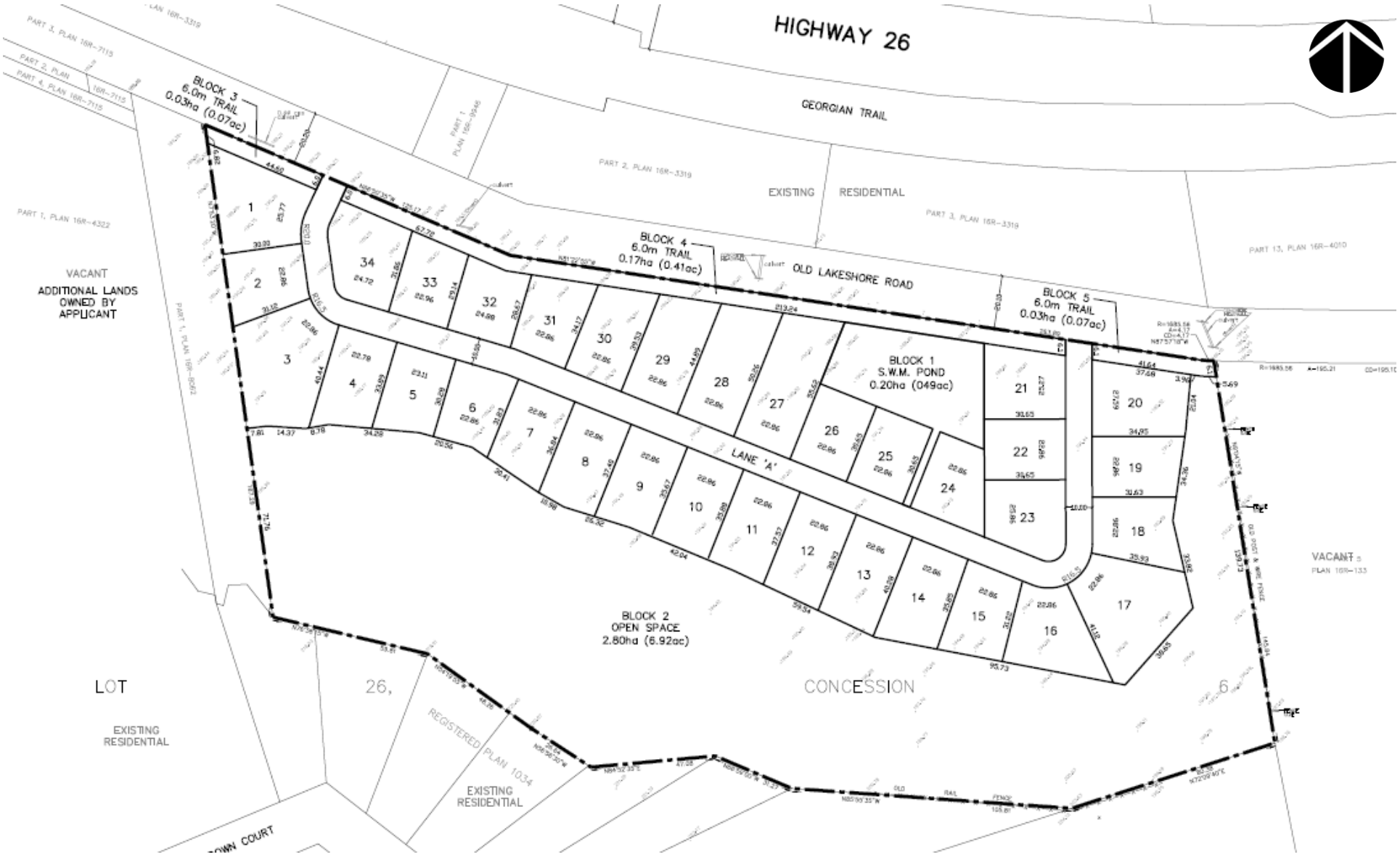
2.5 Site Generated Trips

Trip Generation

The number of vehicle trips to be generated by the site for the weekday AM and PM peak hours has been determined based on type of use, development size, and trip generation rates as per the *ITE Trip Generation Manual 9th Edition*[1]. The following ITE land use has been considered:

- *single family detached residential* (ITE code 210).

[1] *ITE Trip Generation Manual, 9th Edition*. Institute of Transportation Engineers, 2012.



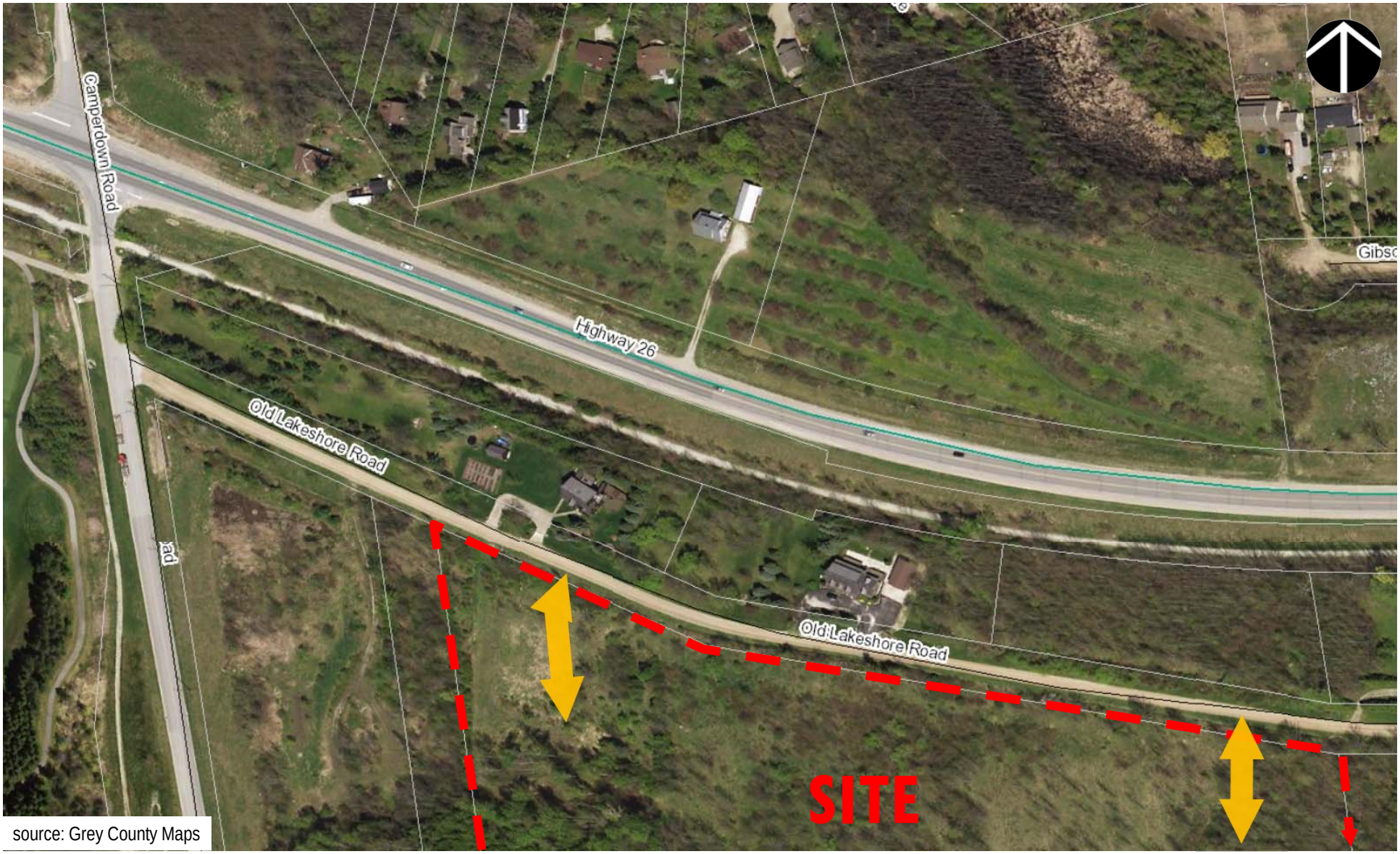
C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Conceptual Draft Plan of Subdivision

Figure

2



source: Grey County Maps

C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Camperdown Condominiums Site Access

Figure

3

A summary of the corresponding trip rates and estimates is provided in Table 1. The rates represent the AM and PM peak hour of the adjacent street, which typically coincide with the peak hour of residential land-use trip generators.

Table 1: Trip Generation

Land Use	rate/ estimate	Unit/ Size	AM Peak Hour			PM Peak Hour		
			in	out	total	in	out	total
single detached units	rate	unit	0.19	0.56	0.75	0.63	0.37	1.0
	estimate	34 units	6	19	25	21	13	34
Total Estimate			6	19	25	21	13	34

Overall, the proposed development is expected to generate 25 trips during the weekday AM peak hour and 34 trips during the weekday PM peak hour.

Trip Distribution & Assignment

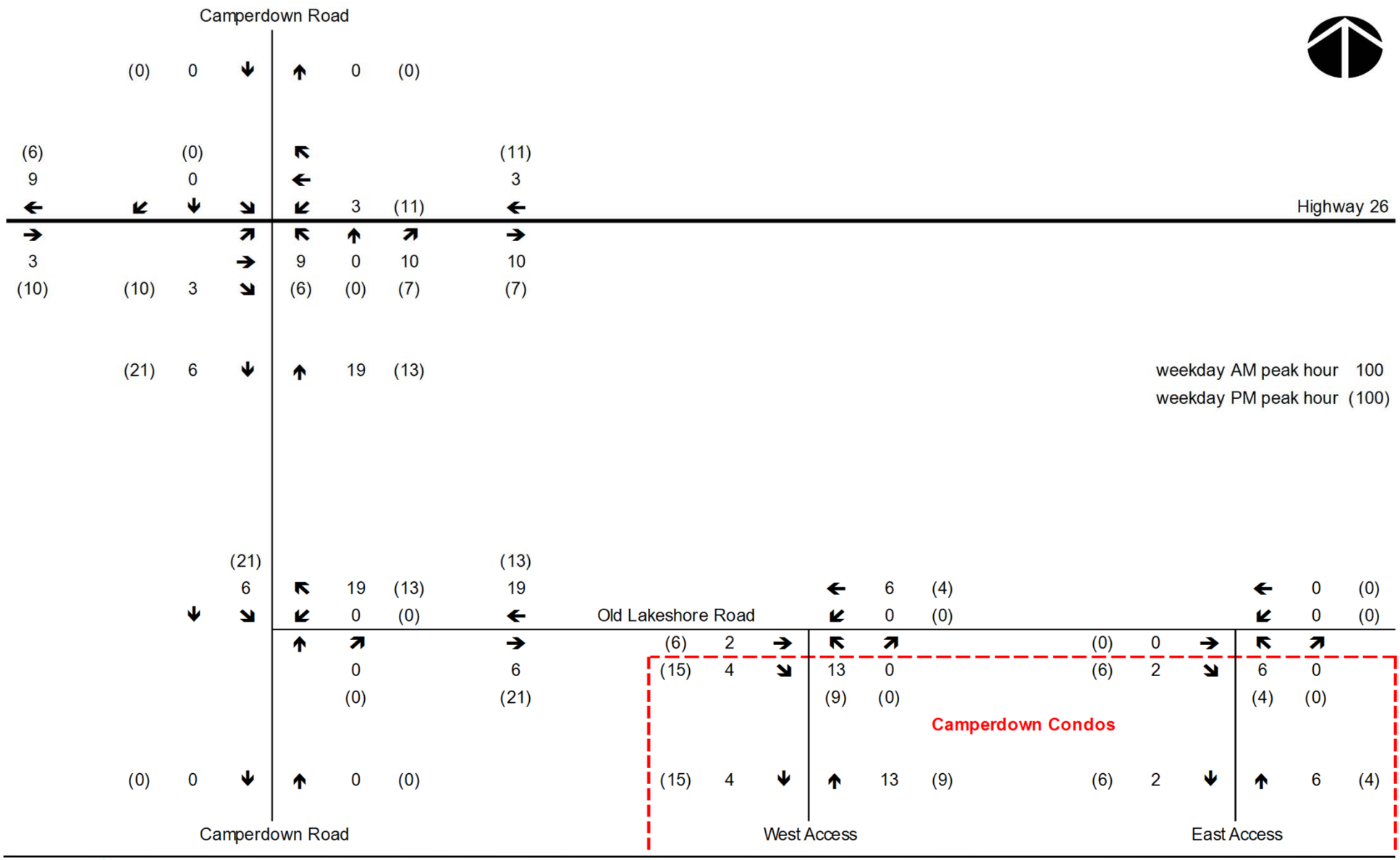
The distribution of the site generated trips to the area road system was based on the location of the site within the Town of The Blue Mountains, its proximity to surrounding local development within Thornbury, the Blue Mountain Village and surrounding area and Collingwood, expected travel routes and the local road network. The following has been assumed:

- 50% will travel to/from Highway 26 west;
- 50% will travel to/from Highway 26 east; and
- 0% will travel to/from Camperdown Road south (given that it is a dead-end road).

With respect to the assignment of the site trips to the site access points, the following has been assumed (based on the extent of the internal road and the layout and location of the 34 building lots):

- 24 of the 34 units will use the West Access as their primary access (71%); and
- 10 of the 34 units will use the East Access as their primary access (29%).

The resulting site generated traffic assigned to the area road network is illustrated in Figure 4. It is noted that all site traffic will travel to/from the west on Old Lakeshore Road (while Old Lakeshore Road is connected to Wensley Drive to the east, through travel is not possible for automobile traffic). As indicated, the development will add in the order of 3 to 11 trips per direction to Highway 26, which is considered minimal.



C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Camperdown Condominiums Site Traffic

Figure 4

3 Existing Conditions

3.1 Road Network

The study area road network is presented in Figure 5 through Figure 7 and detailed below.

Road Sections

As per the *Official Plan of The Town of the Blue Mountains*, Highway 26 is classified as a provincial highway. The road is oriented east-west through the study area and has a 2-lane rural cross section (one lane per direction). In the immediate area, Highway 26 has a posted speed limit of 80 km/h, thus a design speed of 100 km/h would apply (posted speed limit + 20 km/h for higher speed roads).

Both Camperdown Road and Old Lakeshore Road are classified as local roads in the Town's Official Plan, with speed limits of 50 km/h (assumed as not otherwise posted) and design speeds of 60 km/h (posted + 10 km/h for lower speed roads). Camperdown Road has a paved surface and an urban cross-section (curb and gutter with storm sewers) in the immediate area of Old Lakeshore Road, which then transitions to a rural cross-section upon approach to Highway 26. Old Lakeshore Road has a rural cross-section with a gravel road surface. Both roads have posted "No Exit" signs at their beginnings. As per the *Town of The Blue Mountains Road Needs Study 2009 - 2013*[2], Camperdown Road has an 8.5 metre platform width with 1.0 metres shoulders (and thus a 6.5 metre road width), whereas Old Lakeshore Road has a 6 metre platform width with 1.0 metre shoulders (and thus a 4.0 metre road width).

For the purpose of this review, Highway 26 is assumed to have a planning capacity of 900 to 1100 vehicles per hour per lane (vphpl). The lower threshold of 900 vphpl has been employed to ensure a conservative approach to this study. For Camperdown Road and Old Lakeshore Road, a capacity of 400 vphpl has been assumed for each reflective of their local road designations.

Intersections

The intersection of Highway 26 with Camperdown Road is a 4-leg intersection, stop controlled on Camperdown Road (the minor road). There are exclusive right turn tapers and left turn lanes in both the eastbound and westbound directions on Highway 26 (the eastbound left turn lane has a combined storage and parallel length of approximately 20 metres, whereas the westbound lane measures approximately 105 metres). The approaches on Camperdown Road are single lanes (ie. shared left-through-right lanes).

The intersection of Camperdown Road with Old Lakeshore Road is a 3-leg T intersection, stop controlled on Old Lakeshore Road. Each approach provides a single, shared-lane.

[2] *Town of The Blue Mountains Road Needs Study 2009 - 2013.* R.J. Burnside & Associates Limited, March 2010.

source: Grey County Maps

source: Google Maps

↑ Aerial photo of Highway 26 intersection with Camperdown Road

← Looking east on Highway 26 from Camperdown Road

→ Looking west on Highway 26 from Camperdown Road

source: Google Maps

C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Area Road System – Highway 26

Figure 5

source: Grey County Maps

source: Google Maps

↑ Looking south on Camperdown Road from Highway 26

← Aerial photo of Highway 26 intersection with Camperdown Road

↓ Looking north on Camperdown Road to Highway 26 from Old Lakeshore Road

source: Google Maps

C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Area Road System – Camperdown Road

Figure 6

source: Grey County Maps

source: Google Maps

↑ Aerial photo of Old Lakeshore Road across the front of the Camperdown Condominiums development side

← Looking east on Old Lakeshore Road from Camperdown Road

→ Looking west on Old Lakeshore Road to Camperdown Road

source: Google Maps

C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

Area Road System – Old Lakeshore Road

Figure 7

3.2 Traffic Volumes

Traffic volumes on Highway 26 for the 2018 horizon year, reflective of existing conditions, have been established from the *Highway 26 / Grey Road 40 Intersection Improvements Municipal Class Environmental Assessment Schedule B Project File Report*[3] as reported at the adjacent intersection of Highway 26 and Grey Road 40. Relevant excerpts of the noted Class EA are provided in Appendix A.

For Camperdown Road and Old Lakeshore Road, traffic volumes have been estimated in consideration of the limited development along both roads and the Average Annual Daily Traffic (AADT) volumes reported in the Town's Road Needs Study as follows (generally, the peak hour volumes are in the order of 10% of the daily traffic volumes):

- Camperdown Road north of Highway 26 210 vehicles;
- Camperdown Road south of Highway 26 380 vehicles; and
- Old Lakeshore Road 20 vehicles.

The resulting 2018 traffic volumes are illustrated in Figure 8. While it is acknowledged that the traffic data presented is referenced from secondary sources and/or estimated based on daily volumes as opposed to being established based on current traffic counts, such is considered reasonable for this transportation brief given the limited traffic volumes that the subject site will generate and the minimal impacts of such on the road system.

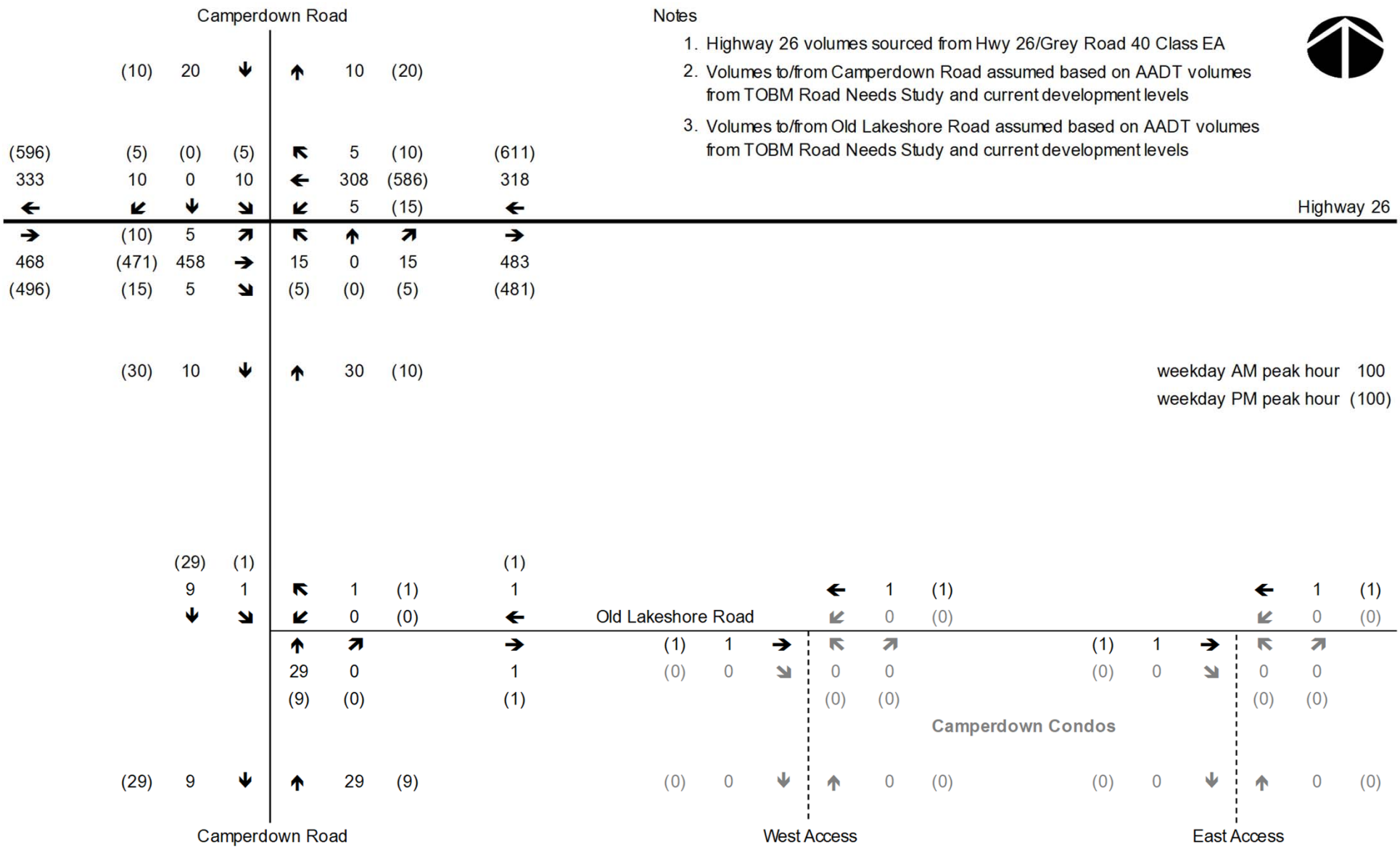
3.3 Traffic Operations

The assessment of existing conditions provides the baseline from which the future traffic volumes and operations (both with and without the subject development) can be assessed. The capacity, and hence operations, of a road system is effectively dictated by its intersections. As such, the analysis focused on the intersection operations, albeit consideration is also given to link volumes and operations.

Intersection Operations

The intersection operations analyses are based on the 2018 traffic volumes, the existing configuration and control for each intersection and procedures outlined in the *2000 Highway Capacity Manual*[4] (using Synchro v.9 software). A summary of the analyses is provided in Table 2 with results for the unsignalized intersections in the form of average delay (measured in seconds), level of service (LOS) and volume to capacity (v/c) for the critical movements, namely the stop movements on the minor street.

[3] *Highway 26 / Grey Road 40 Intersection Improvements Municipal Class Environmental Assessment Schedule B Project File Report.* R.J. Burnside & Associates Limited, May 2016.
[4] *Highway Capacity Manual*. Transportation Research Board, Washington DC, 2000.



C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

2018 Traffic Volumes

Figure 8

Level of service A corresponds to the best operating condition with minimal delays whereas level of service F corresponds to poor operations resulting from high intersection delays. A v/c ratio of less than 1.0 indicates the intersection movement/approach is operating at less than capacity while a v/c ratio of 1.0 indicates capacity has been reached. Detailed operations worksheets for the existing traffic conditions are included in Appendix B.

Table 2: Intersection Operations - 2018 Conditions

Intersection and Movement		Control	Weekday AM Peak Hour			Weekday PM Peak Hour		
			delay	LOS	v/c	delay	LOS	v/c
Highway 26 & Camperdown Road	NB	stop	16	C	0.09	21	C	0.05
	SB	stop	15	C	0.06	22	C	0.05
Camperdown Road & Old Lakeshore Road	WB	stop	9	A	0.00	9	A	0.00

Based on the 2018 volumes, the study area intersections provide good overall levels of service (LOS C or better) with nominal delays during both peak hours for the critical movements. As such, no improvements are necessary to address existing conditions.

Link Operations

The peak directional peak hour volumes (ie. the greatest volume per direction during each of the AM and PM peak hours) are summarized in Table 3, as are the resulting volume to capacity ratios based on the assumed planning capacities. It is noted that capacity is denoted as vehicles per hour per lane (vphpl) with only 1 lane per direction on all roads.

Table 3: Link Operations - 2018 Conditions

Road	Capacity vphpl	Weekday AM Peak Hour		Weekday PM Peak Hour	
		volume	v/c	volume	v/c
Highway 26	900	483	0.54	611	0.68
Camperdown Road	400	30	0.08	30	0.08
Old Lakeshore Road	400	1	0.00	1	0.00

As noted, Highway 26 is currently operating in the order of 54% of its capacity during the AM peak hour and 68% during the PM peak hour. Camperdown Road is estimated to operate at less than 10% of its capacity, and operations on Old Lakeshore Road are negligible given the limited development and limited associated traffic volumes.

Need for Improvements

Based on the intersection and link operations, there are no operational issues with the existing road system and hence no need for road improvements.

4 Future Conditions

4.1 Traffic Volumes

To assess the future traffic impacts of the proposed development, a 5-year horizon has been assumed. While it is typical to consider 5 and 10-year horizons beyond full build-out of a development, given the limited size and associated volumes, and the reduced volumes on the local road system, a 5-year horizon is considered appropriate.

The 2023 traffic volumes have been established in the same manner as the 2018 volumes, namely from the *Highway 26 / Grey Road 40 Intersection Improvements Municipal Class Environmental Assessment Schedule B Project File Report* and in consideration of daily volumes and existing development on Camperdown Road and Old Lakeshore Road.

Figure 9 illustrates the 2023 traffic volumes without the Camperdown Condominium development (referred to as background traffic), whereas Figure 10 illustrates the volumes with it (referred to as total traffic).

4.2 Traffic Operations

Turn Lane Requirements

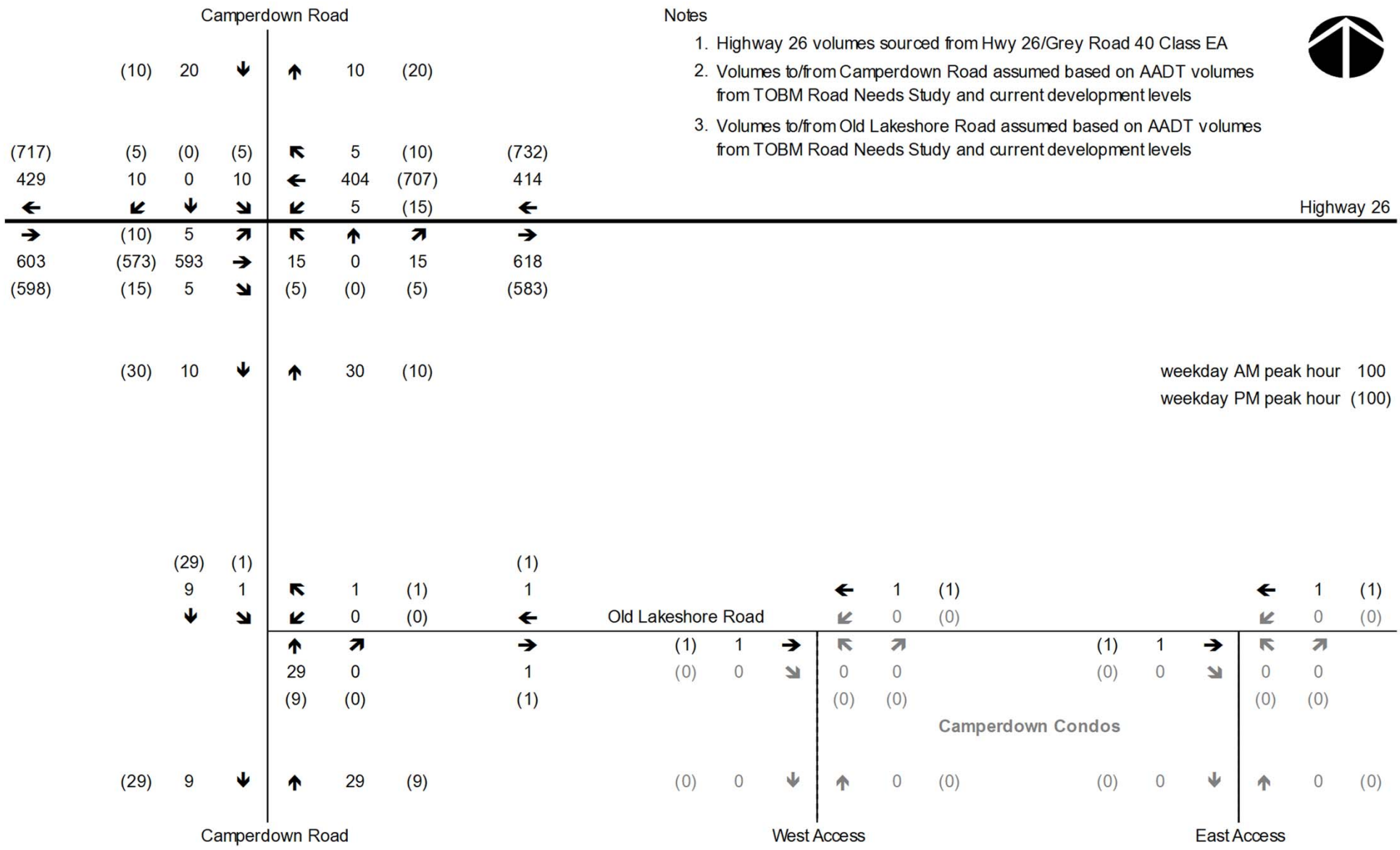
Left turn lanes and right turn tapers are currently provided on Highway 26 at the Camperdown Road intersection. While the development will increase the westbound left turn lanes (11 additional left turns during the PM peak hour are estimated), such is not significant enough to warrant improvements to the existing turn lane.

Given the volumes on Camperdown Road and the limited turning traffic to/from Old Lakeshore Road, turn lanes on Camperdown Road are not required. Likewise, volumes on Old Lakeshore Road do not warrant exclusive turn lanes at either site access.

Intersection Operations

The intersection operations were repeated under the 2023 background and 2023 total traffic scenarios, the results of which are summarized in Table 4 and Table 5 respectively; detailed worksheets are provided in Appendix C and Appendix D.

In all cases, the intersection operations remain acceptable and the impact of the additional traffic associated with the Camperdown Condominiums is marginal (increase in delays of 2 to 3 seconds).



Notes

1. Highway 26 volumes sourced from Hwy 26/Grey Road 40 Class EA
2. Volumes to/from Camperdown Road assumed based on AADT volumes from TOBM Road Needs Study and current development levels
3. Volumes to/from Old Lakeshore Road assumed based on AADT volumes from TOBM Road Needs Study and current development levels

Highway 26

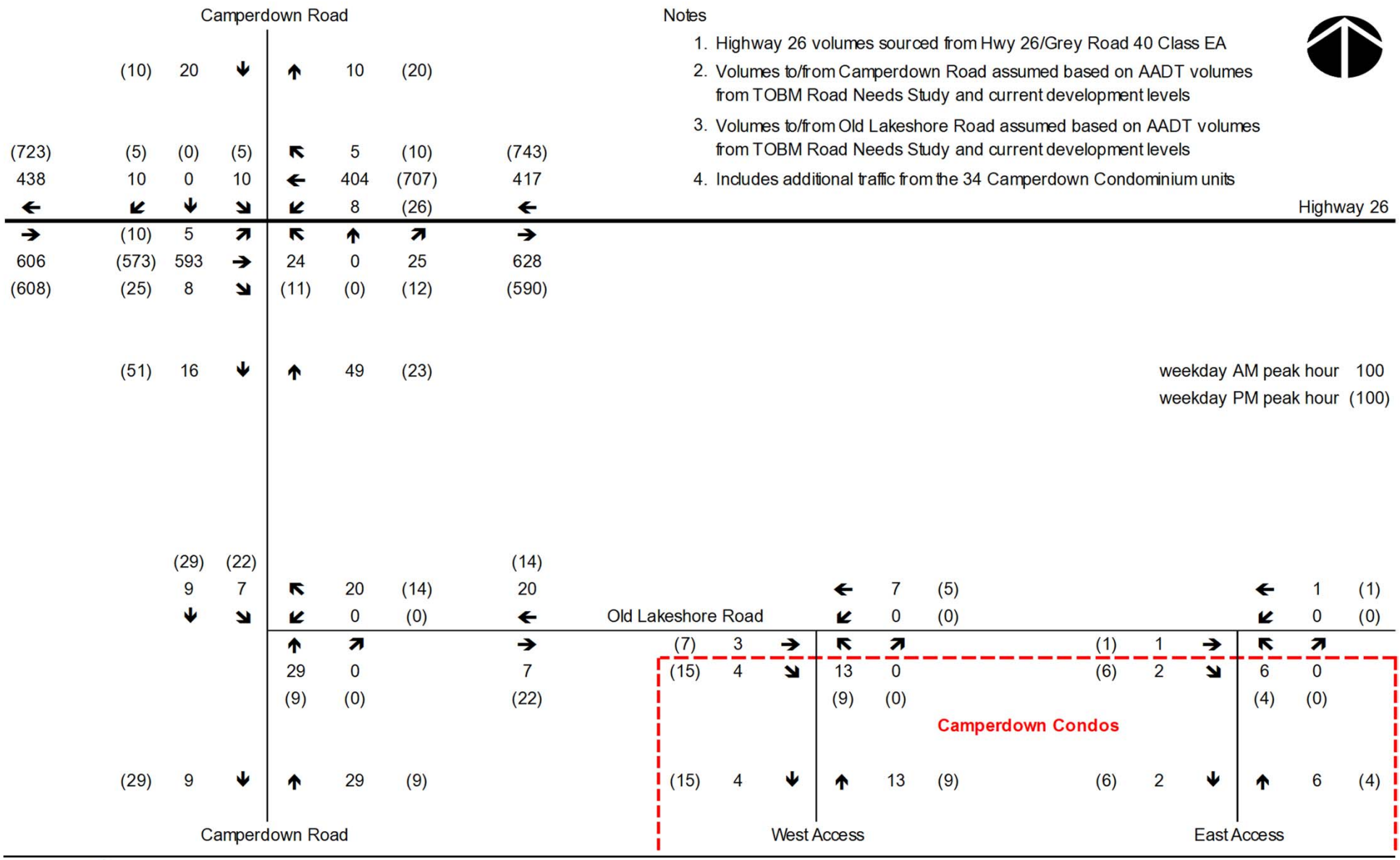
weekday AM peak hour 100
weekday PM peak hour (100)

C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

2023 Background Traffic Volumes

Figure 9



C.C. Tatham & Associates Ltd.
Consulting Engineers

Camperdown Condominiums Transportation Brief

2023 Total Traffic Volumes

Figure

10

Table 4: Intersection Operations - 2023 Background Conditions

Intersection and Movement		Control	Weekday AM Peak Hour			Weekday PM Peak Hour		
			delay	LOS	v/c	delay	LOS	v/c
Highway 26 & Camperdown Road	NB	stop	21	C	0.13	28	D	0.07
	SB	stop	20	C	0.09	29	D	0.07
Camperdown Road & Old Lakeshore Road	WB	stop	9	A	0.00	9	A	0.00

Table 5: Intersection Operations - 2023 Total Conditions

Intersection and Movement		Control	Weekday AM Peak Hour			Weekday PM Peak Hour		
			delay	LOS	v/c	delay	LOS	v/c
Highway 26 & Camperdown Road	NB	stop	23	C	0.21	31	D	0.15
	SB	stop	20	C	0.09	31	D	0.07
Camperdown Road & Old Lakeshore Road	WB	stop	9	A	0.02	9	A	0.02

Site Access Operations

The site access operations were not specifically addressed. Notwithstanding, given the limited traffic volumes to/from the site and the minimal traffic volumes on Old Lakeshore Road, excellent operations will result.

Road Section Operations

The road section operations considering the 2023 background and 2023 total traffic volumes are provided in Table 6 and Table 7 respectively. Despite the increase in both background and site volumes, the road sections will continue to operate below capacity and thus the provision of 1 lane per direction is appropriate.

Table 6: Link Operations - 2023 Background Conditions

Road	Capacity vphpl	Weekday AM Peak Hour		Weekday PM Peak Hour	
		volume	v/c	volume	v/c
Highway 26	900	618	0.69	732	0.81
Camperdown Road	400	30	0.08	30	0.08
Old Lakeshore Road	400	1	0.00	1	0.00

Table 7: Link Operations - 2023 Total Conditions

Road	Capacity vphpl	Weekday AM Peak Hour		Weekday PM Peak Hour	
		volume	v/c	volume	v/c
Highway 26	900	628	0.70	743	0.83
Camperdown Road	400	49	0.12	51	0.13
Old Lakeshore Road	400	20	0.05	14	0.03

Need for Improvements

Both intersection and link operations remain acceptable and thus the existing road system is considered sufficient to accommodate the future travel demands, including those of the Camperdown Condominiums development. As such, no additional improvements are required for a traffic operations perspective.

4.3 Sight Line Analysis

Sight Distance Requirements

Stopping sight distance refers to the minimum distance required for a vehicle travelling at the design speed to stop before reaching an object in the road. Should a vehicle slow or stop on Old Lakeshore Road to enter the subject site, approaching vehicles must have sufficient sightlines to ensure that they are able to come to a complete stop (if required) without impacting a turning vehicle. Similarly, upon exit from the development, approaching vehicles must have sufficient sight lines.

The minimum recommended stopping sight distance was determined from the MTO *Geometric Design Standards for Ontario Highways* guidelines. For a design speed of 60 km/h, the requirement is 85 metres.

Available Sight Distances

The available sight distances along Old Lakeshore Road are illustrated in Figure 11. While there are several slight horizontal curves along the road, they do not otherwise restrict sight lines. In all cases, the available sight lines exceed the 85 metre requirement and thus are considered appropriate.

↑ Looking west on Old Lakeshore Road from proposed West Access

↓ Looking east on Old Lakeshore Road from proposed West Access

↑ Looking west on Old Lakeshore Road from proposed East Access

↓ Looking east on Old Lakeshore Road from proposed East Access

Sight Lines at Site Access Points

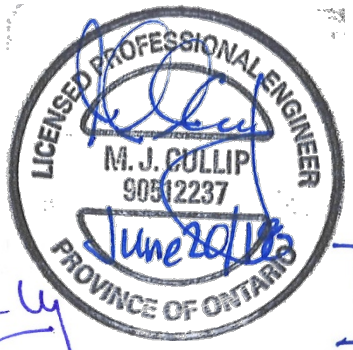
5 Summary

This traffic brief has addressed the transportation impacts associated with the proposed 34 unit Camperdown Condominium development in the Town of The Blue Mountains. The proposed residential development will generate 25 trips in the AM peak hour and 34 trips in the PM peak hour.

Traffic volumes were established for the area road system for the 2018 and 2023 horizon years, with consideration for the proposed development in the 2023 scenario. In all cases, the key intersections (those of Camperdown Road with Highway 26 and Old Lakeshore Road) will continue to provide acceptable operations. While the proposed development will increase traffic volumes through the area, such is not considered significant and thus the impacts to the traffic operations are not problematic (increase in delays of 2 to 3 seconds). With respect to link volumes and operations, the future traffic volumes are within the assumed planning capacity levels and thus the existing road system is considered sufficient.

While detailed operational reviews were not conducted for the site access points, excellent operations will be provided given the limited site volumes coupled with the minimal volumes on Old Lakeshore Road. Sight lines and sight distances were also reviewed at the site access points and deemed sufficient as they are in accordance with applicable MTO stopping sight distance requirements.

Overall, the development will not result in any operational issues; the road system can accommodate the additional volumes without concern.



Authored by: Michael Cullip, B.Eng. & Mgmt, P.Eng.
Director, Manager - Municipal &
Transportation Engineer

Reviewed by: David Perks, M.Sc. PTP
Transportation Planner

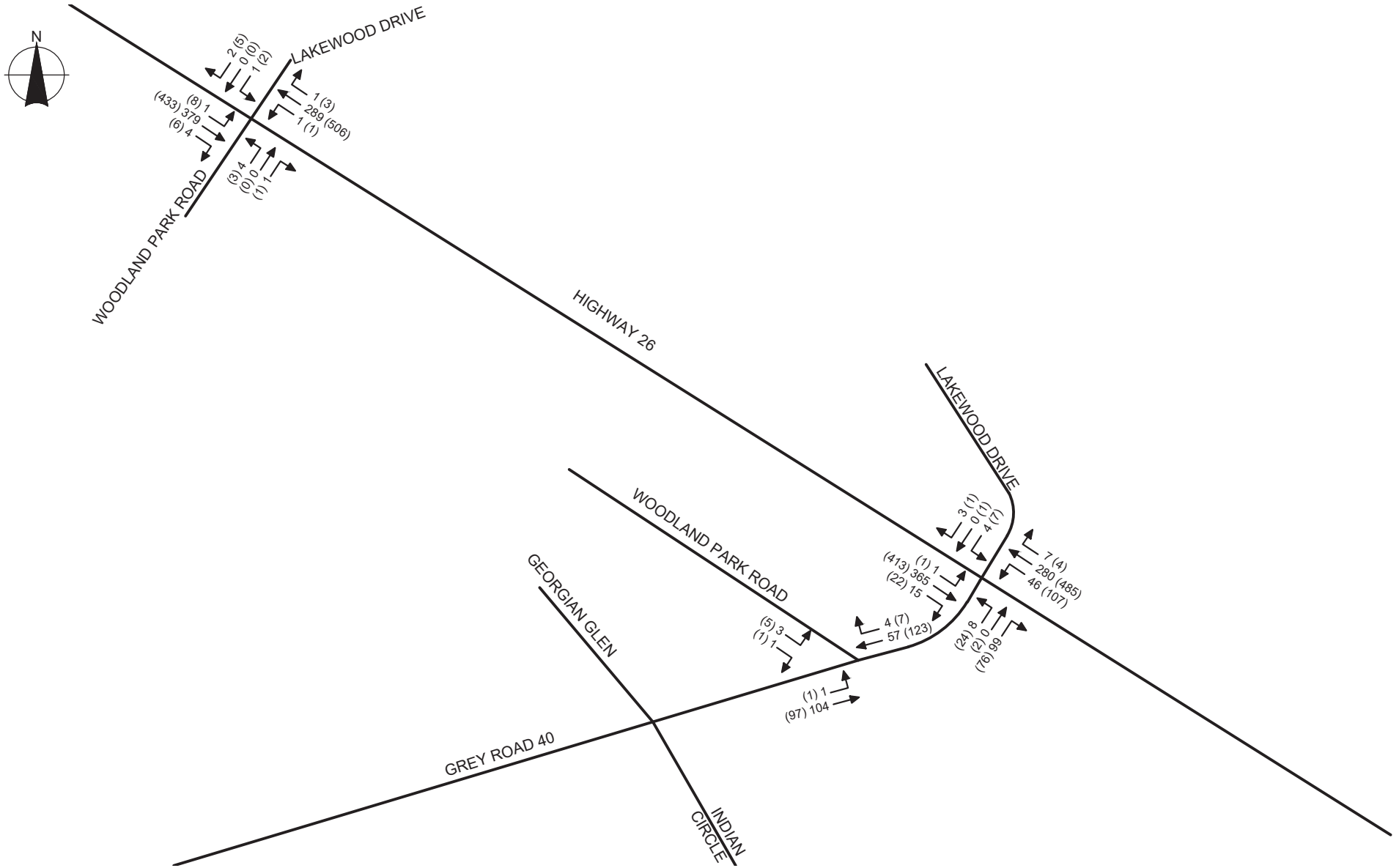
APPENDIX A:
HIGHWAY 26/GREY ROAD 40 CLASS EA EXCERPTS

Highway 26 / Grey Road 40 Intersection Improvements Municipal Class Environmental Assessment Schedule B Project File Report (PFR)

The Town of The Blue Mountains

R.J. Burnside & Associates Limited
3 Ronell Crescent
Collingwood ON L9Y 4J6 CANADA

May 2016
300032093.0000



LEGEND

100 - AM PEAK HOUR (vph)

(100) - PM PEAK HOUR (vph)

BURNSIDE

Figure Title

CLASS EA - HIGHWAY 26 / GREY RD 40

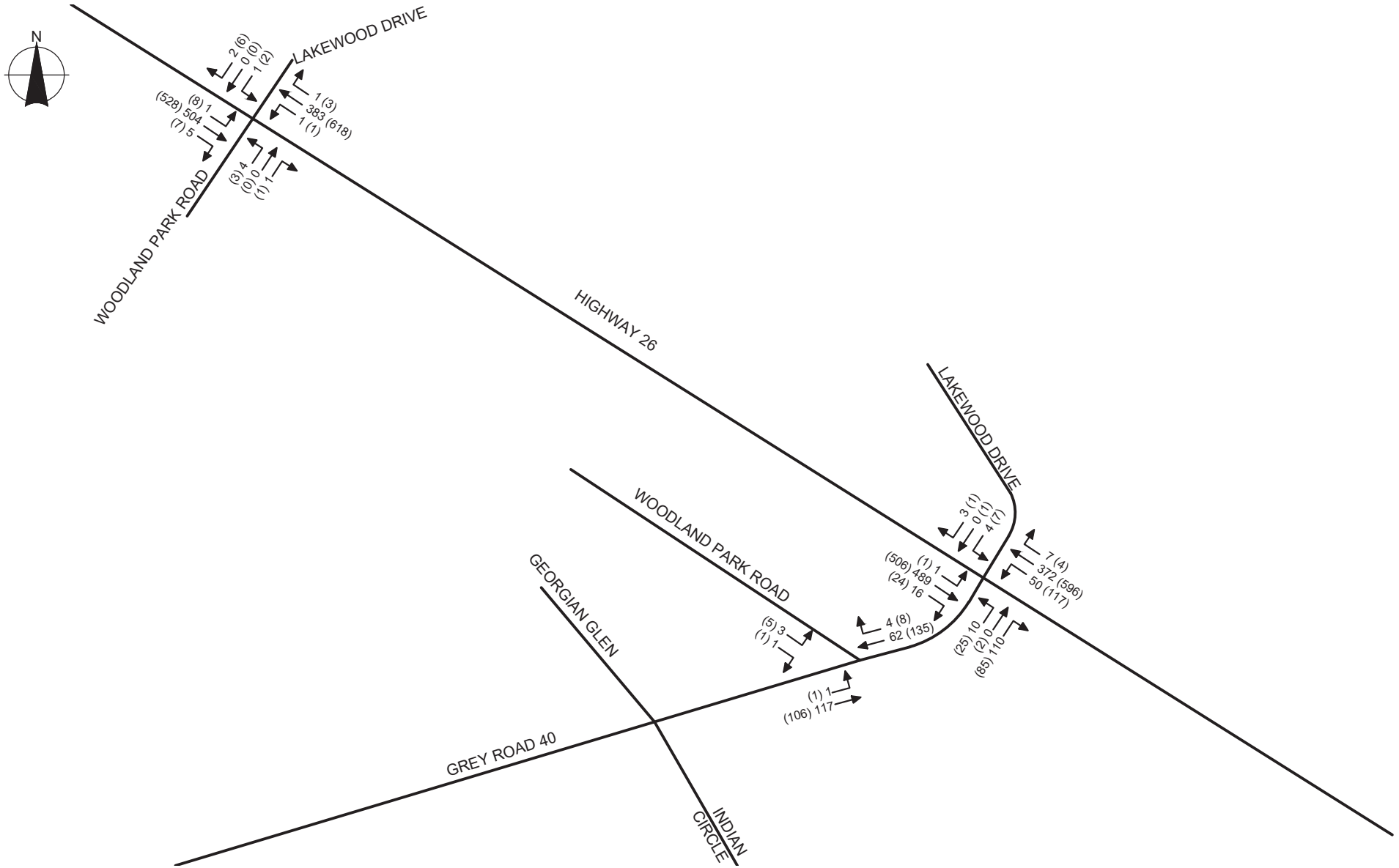
TRAFFIC FORECAST - YEAR 2018

Client

TOWN OF THE BLUE MOUNTAINS

Drawn	Checked	Date	Figure No.
JBL	HC	13/03/19	**TR3**
Scale		Project No.	
NTS		300032093	

File Name: 032093_TRAFFIC_Figures.dwg Date Plotted: September 20, 2013 - 4:21 PM



LEGEND

100 - AM PEAK HOUR (vph)

(100) - PM PEAK HOUR (vph)

BURNSIDE

Figure Title

CLASS EA - HIGHWAY 26 / GREY RD 40

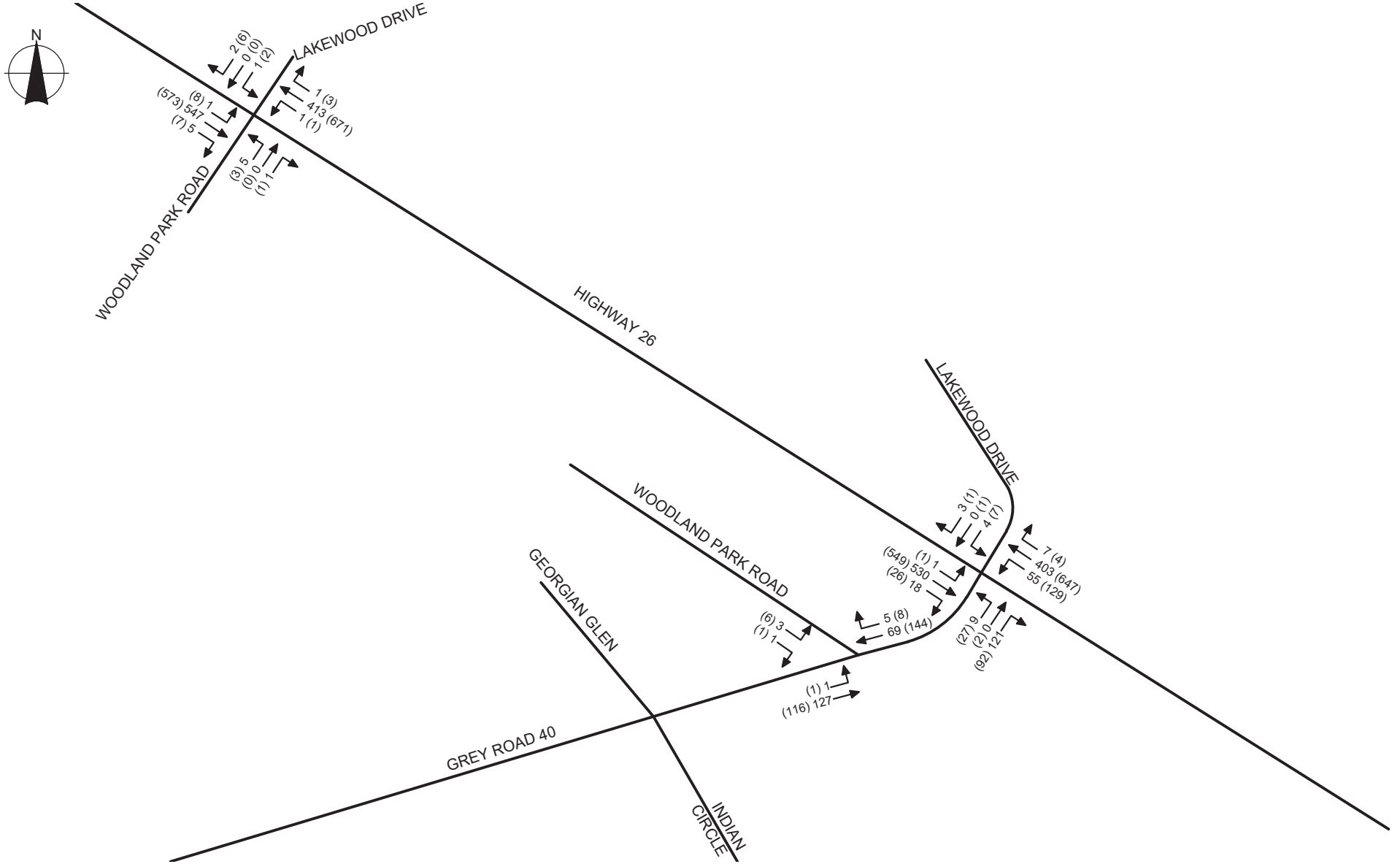
TRAFFIC FORECAST - YEAR 2023

Client

TOWN OF THE BLUE MOUNTAINS

Drawn	Checked	Date	Figure No.
JBL	HC	13/03/19	**TR4**
Scale		Project No.	
NTS		300032093	

File Name: 032093_TRAFFIC_Figures.dwg Date Plotted: September 20, 2013 - 4:21 PM



LEGEND

100 - AM PEAK HOUR (vph)

(100) - PM PEAK HOUR (vph)

BURNSIDE

Figure Title

CLASS EA - HIGHWAY 26 / GREY RD 40

TRAFFIC FORECAST - YEAR 2028

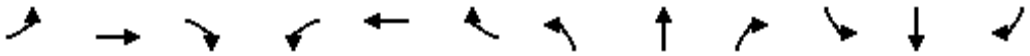
Client

TOWN OF THE BLUE MOUNTAINS

Drawn	Checked	Date	Figure No.
JBL	HC	13/03/19	**TR5**
Scale		Project No.	
NTS		300032093	

File Name: 032093_TRAFFIC_Figures.dwg Date Plotted: September 20, 2013 - 4:21 PM

APPENDIX B:
2018 INTERSECTION OPERATIONS



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	458	5	5	308	5	15	1	15	10	1	10
Future Volume (Veh/h)	5	458	5	5	308	5	15	1	15	10	1	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	498	5	5	335	5	16	1	16	11	1	11
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	340			503			864	858	498	870	858	335
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	340			503			864	858	498	870	858	335
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			94	100	97	96	100	98
cM capacity (veh/h)	1219			1061			267	292	572	262	292	707

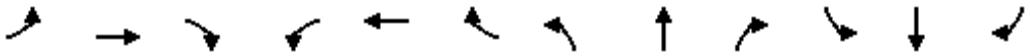
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	5	498	5	5	335	5	33	23
Volume Left	5	0	0	5	0	0	16	11
Volume Right	0	0	5	0	0	5	16	11
cSH	1219	1700	1700	1061	1700	1700	362	377
Volume to Capacity	0.00	0.29	0.00	0.00	0.20	0.00	0.09	0.06
Queue Length 95th (m)	0.1	0.0	0.0	0.1	0.0	0.0	2.3	1.5
Control Delay (s)	8.0	0.0	0.0	8.4	0.0	0.0	15.9	15.2
Lane LOS	A			A			C	C
Approach Delay (s)	0.1			0.1			15.9	15.2
Approach LOS							C	C

Intersection Summary				
Average Delay	1.1			
Intersection Capacity Utilization	34.1%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	1	29	1	1	9
Future Volume (Veh/h)	1	1	29	1	1	9
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	1	32	1	1	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	44	32			33	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	44	32			33	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	965	1041			1579	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	33	11
Volume Left	1	0	1
Volume Right	1	1	0
cSH	1002	1700	1579
Volume to Capacity	0.00	0.02	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	8.6	0.0	0.7
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	0.7
Approach LOS	A		

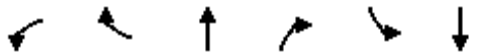
Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	471	15	15	586	10	5	1	5	5	1	5
Future Volume (Veh/h)	10	471	15	15	586	10	5	1	5	5	1	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	512	16	16	637	11	5	1	5	5	1	5
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	648			528			1208	1214	512	1208	1219	637
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	648			528			1208	1214	512	1208	1219	637
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			98			97	99	99	97	99	99
cM capacity (veh/h)	938			1039			154	177	562	154	175	477

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	11	512	16	16	637	11	11	11
Volume Left	11	0	0	16	0	0	5	5
Volume Right	0	0	16	0	0	11	5	5
cSH	938	1700	1700	1039	1700	1700	234	227
Volume to Capacity	0.01	0.30	0.01	0.02	0.37	0.01	0.05	0.05
Queue Length 95th (m)	0.3	0.0	0.0	0.4	0.0	0.0	1.1	1.2
Control Delay (s)	8.9	0.0	0.0	8.5	0.0	0.0	21.1	21.7
Lane LOS	A			A			C	C
Approach Delay (s)	0.2			0.2			21.1	21.7
Approach LOS							C	C

Intersection Summary				
Average Delay	0.6			
Intersection Capacity Utilization	40.8%	ICU Level of Service		A
Analysis Period (min)	15			

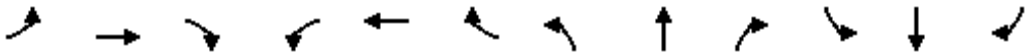


Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	1	9	1	1	29
Future Volume (Veh/h)	1	1	9	1	1	29
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	1	10	1	1	32
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	44	10			11	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	44	10			11	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	965	1071			1608	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	11	33
Volume Left	1	0	1
Volume Right	1	1	0
cSH	1015	1700	1608
Volume to Capacity	0.00	0.01	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	8.6	0.0	0.2
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	0.2
Approach LOS	A		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX C:
2023 FUTURE BACKGROUND INTERSECTION OPERATIONS



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	593	5	5	404	5	15	1	15	10	1	10
Future Volume (Veh/h)	5	593	5	5	404	5	15	1	15	10	1	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	645	5	5	439	5	16	1	16	11	1	11
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	444			650			1116	1109	645	1120	1109	439
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	444			650			1116	1109	645	1120	1109	439
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			91	100	97	94	100	98
cM capacity (veh/h)	1116			936			180	208	472	175	208	618

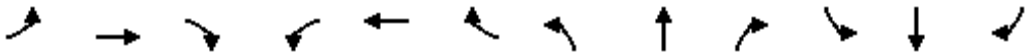
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	5	645	5	5	439	5	33	23
Volume Left	5	0	0	5	0	0	16	11
Volume Right	0	0	5	0	0	5	16	11
cSH	1116	1700	1700	936	1700	1700	258	270
Volume to Capacity	0.00	0.38	0.00	0.01	0.26	0.00	0.13	0.09
Queue Length 95th (m)	0.1	0.0	0.0	0.1	0.0	0.0	3.3	2.1
Control Delay (s)	8.2	0.0	0.0	8.9	0.0	0.0	21.0	19.6
Lane LOS	A			A			C	C
Approach Delay (s)	0.1			0.1			21.0	19.6
Approach LOS							C	C

Intersection Summary				
Average Delay	1.1			
Intersection Capacity Utilization	41.2%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	1	29	1	1	9
Future Volume (Veh/h)	1	1	29	1	1	9
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	1	32	1	1	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	44	32			33	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	44	32			33	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	965	1041			1579	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	33	11
Volume Left	1	0	1
Volume Right	1	1	0
cSH	1002	1700	1579
Volume to Capacity	0.00	0.02	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	8.6	0.0	0.7
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	0.7
Approach LOS	A		

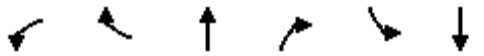
Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	573	15	15	707	10	5	1	5	5	1	5
Future Volume (Veh/h)	10	573	15	15	707	10	5	1	5	5	1	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	623	16	16	768	11	5	1	5	5	1	5
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	779			639			1450	1456	623	1450	1461	768
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	779			639			1450	1456	623	1450	1461	768
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			98			95	99	99	95	99	99
cM capacity (veh/h)	838			945			104	126	486	104	125	402

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	11	623	16	16	768	11	11	11
Volume Left	11	0	0	16	0	0	5	5
Volume Right	0	0	16	0	0	11	5	5
cSH	838	1700	1700	945	1700	1700	166	161
Volume to Capacity	0.01	0.37	0.01	0.02	0.45	0.01	0.07	0.07
Queue Length 95th (m)	0.3	0.0	0.0	0.4	0.0	0.0	1.6	1.7
Control Delay (s)	9.4	0.0	0.0	8.9	0.0	0.0	28.2	29.0
Lane LOS	A			A			D	D
Approach Delay (s)	0.2			0.2			28.2	29.0
Approach LOS							D	D

Intersection Summary				
Average Delay	0.6			
Intersection Capacity Utilization	47.2%	ICU Level of Service		A
Analysis Period (min)	15			

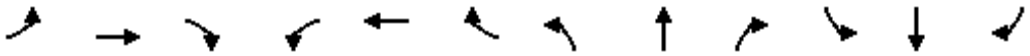


Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	1	9	1	1	29
Future Volume (Veh/h)	1	1	9	1	1	29
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	1	10	1	1	32
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	44	10			11	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	44	10			11	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	965	1071			1608	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	11	33
Volume Left	1	0	1
Volume Right	1	1	0
cSH	1015	1700	1608
Volume to Capacity	0.00	0.01	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	8.6	0.0	0.2
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	0.2
Approach LOS	A		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

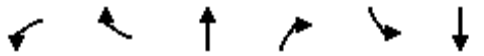
APPENDIX D:
2023 FUTURE TOTAL INTERSECTION OPERATIONS



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	593	8	8	404	5	25	1	25	10	1	10
Future Volume (Veh/h)	5	593	8	8	404	5	25	1	25	10	1	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	645	9	9	439	5	27	1	27	11	1	11
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	444			654			1124	1117	645	1140	1121	439
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	444			654			1124	1117	645	1140	1121	439
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			85	100	94	93	100	98
cM capacity (veh/h)	1116			933			177	204	472	166	203	618

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	5	645	9	9	439	5	55	23
Volume Left	5	0	0	9	0	0	27	11
Volume Right	0	0	9	0	0	5	27	11
cSH	1116	1700	1700	933	1700	1700	256	258
Volume to Capacity	0.00	0.38	0.01	0.01	0.26	0.00	0.21	0.09
Queue Length 95th (m)	0.1	0.0	0.0	0.2	0.0	0.0	6.0	2.2
Control Delay (s)	8.2	0.0	0.0	8.9	0.0	0.0	22.9	20.3
Lane LOS	A			A			C	C
Approach Delay (s)	0.1			0.2			22.9	20.3
Approach LOS							C	C

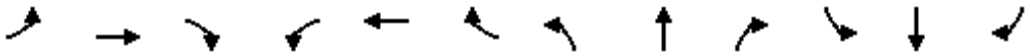
Intersection Summary				
Average Delay	1.6			
Intersection Capacity Utilization	41.7%	ICU Level of Service		A
Analysis Period (min)	15			



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	20	29	1	7	9
Future Volume (Veh/h)	1	20	29	1	7	9
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	22	32	1	8	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	58	32			33	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	58	32			33	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	98			99	
cM capacity (veh/h)	944	1041			1579	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	23	33	18
Volume Left	1	0	8
Volume Right	22	1	0
cSH	1037	1700	1579
Volume to Capacity	0.02	0.02	0.01
Queue Length 95th (m)	0.5	0.0	0.1
Control Delay (s)	8.6	0.0	3.3
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	3.3
Approach LOS	A		

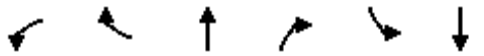
Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	16.7%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	573	26	26	707	10	11	1	11	5	1	5
Future Volume (Veh/h)	10	573	26	26	707	10	11	1	11	5	1	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	623	28	28	768	11	12	1	12	5	1	5
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	779			651			1474	1480	623	1482	1497	768
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	779			651			1474	1480	623	1482	1497	768
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			97			88	99	98	95	99	99
cM capacity (veh/h)	838			935			99	120	486	97	117	402

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	11	623	28	28	768	11	25	11
Volume Left	11	0	0	28	0	0	12	5
Volume Right	0	0	28	0	0	11	12	5
cSH	838	1700	1700	935	1700	1700	162	152
Volume to Capacity	0.01	0.37	0.02	0.03	0.45	0.01	0.15	0.07
Queue Length 95th (m)	0.3	0.0	0.0	0.7	0.0	0.0	4.0	1.8
Control Delay (s)	9.4	0.0	0.0	9.0	0.0	0.0	31.2	30.6
Lane LOS	A			A			D	D
Approach Delay (s)	0.2			0.3			31.2	30.6
Approach LOS							D	D

Intersection Summary				
Average Delay	1.0			
Intersection Capacity Utilization	47.2%	ICU Level of Service		A
Analysis Period (min)	15			



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	14	9	1	22	29
Future Volume (Veh/h)	1	14	9	1	22	29
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	15	10	1	24	32
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	90	10			11	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	90	10			11	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			99	
cM capacity (veh/h)	896	1071			1608	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	11	56
Volume Left	1	0	24
Volume Right	15	1	0
cSH	1058	1700	1608
Volume to Capacity	0.02	0.01	0.01
Queue Length 95th (m)	0.4	0.0	0.3
Control Delay (s)	8.5	0.0	3.2
Lane LOS	A		A
Approach Delay (s)	8.5	0.0	3.2
Approach LOS	A		

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	19.4%	ICU Level of Service	A
Analysis Period (min)	15		