APPENDIX H – Traffic Impact Study

Memorandum

To: Shannon Noonan
Copy: Ken Hodges
From: Nick Palomba

Date: October 21, 2009
Project: EM3528 TWD01

Re: Boxwood Industrial Park: Region Of Waterloo Versus City Of Cambridge Saturation Flow Rates

Delcan completed a Draft Transportation Impact Study (TIS) for the Boxwood Industrial Park; the traffic analysis in that report was conducted using saturation flow rates provided by the Region of Waterloo. City of Cambridge staff has requested that analysis of traffic operating conditions be also conducted using City of Cambridge saturation flow rates for the area intersections.

According to the Highway Capacity Manual 2000, saturation flow rate is defined as: *'the equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced'*. Typically the more urbanized an area, the higher the saturation flow rate since drivers would tend to be more aggressive resulting in lower headway between vehicles.

Table 1 provides a comparison of saturation flow rates for various movements as provided by the Region and the City. Since the City does not have saturation flow rates for all movements, Delcan has derived recommended saturation flow rates for these movements in consultation with City Staff. The values have been used in the enclosed traffic analysis.

TABLE 1
Comparison of Regional versus City of Cambridge Signalized Intersection Saturation Flow Rates

Movement	Regional Saturation Flow Rate	City of Cambridge Saturation Flow Rate	Recommended Saturation Flow Rate for City Use
Dual Left Turn Lanes	1775	1750 (Advanced Left)	
Left Turn Lane	1775	1750 (if has Advanced Left)	
Through Lane	1900	1800	
Right Turn Lane	1750	1550	
Through & Through/Right (2 lane approach)	1775	Not Provided	((1800+1800)*.9)/2=1620
Through & Through/Left (2 lane approach)	1775	Not Provided	((1800+1800)*.9)/2=1620
Through/Left Lane	1650	Not Provided	((1750+1800)*.9)/2=1600
Through/Right Lane	1650	Not Provided	((1550+1800)*.9)/2=1510
Left/Through/Right Lane	1550	Not Provided	((1750+1800+1550)*.9)/3=1530
Left/Right Lane	1765	Not Provided	((1750+1550)*.9)/2 = 1485
Left/Through & Through/Right	1650	Not Provided	((1800+1800+1550+1750)*.9)/4=1555

This memo has been structured by extracting operational analysis summary tables from the draft TIS (which used Regional saturation flow rates) and using the same numbering system adding a "R" for Regional Saturation flows and a "C" for City saturation flows. The table numbering has been maintained for ease of reference. Each table from the TIS showing individual intersection operational performance is presented below; Regional saturation flow rates results are presented first, followed by operational performance obtained using Cambridge saturation flow rates.

Table 2.1R – Signalized Operational Performance-Existing Traffic (Regional Saturation Flow Rates)

Signalized Intersection*	AM PEAK HOUR				PM PEAK HOUR			
	LOS	Delay/ Veh (sec.)	V/C	Critical V/C (>=0.85)	LOS	Delay/ veh (sec.)	V/C	Critical V/C (>=0.85)
Eagle St & Speedsville Rd	B	15.9	0.43	-	E	62.4	1.09	EBL=0.88 WBTR=1.21 NBL=0.93 SBTR=1.04
Maple Grove Rd & Fountain St	C	21.3	0.46	-	C	32.5	0.74	-
Toyota South Entrance & Fountain St	A	4.6	0.13	-	C	29.4	0.72	-
Toyota North Entrance & Fountain St	A	3.6	0.18	-	B	13.9	0.62	-
Maple Grove Rd & Speedsville Rd	B	11.8	0.59	-	D	46.3	0.98	EBT=0.90 NBLTR=1.17
Cherry Blossom Rd & Fountain St	B	12.0	0.32	-	C	28.2	0.67	EBLTR=0.92
Maple Grove Rd & Vondrau Dr	A	7.1	0.25	-	B	10.0	0.40	-
Maple Grove Rd & Beaverdale Rd	A	6.6	0.36	-	A	7.3	0.44	-
Maple Grove Rd & Hespeler Rd	B	16.5	0.63	-	C	23.2	0.78	-

*LOS, V/C and delay for overall intersection (with exception of specific critical V/C movements as noted)

Table 2.1C – Signalized Operational Performance-Existing Traffic (City of Cambridge Saturation Flow Rates)

Signalized Intersection*	AM PEAK HOUR				PM PEAK HOUR			
	LOS	Delay/ Veh (sec.)	V/C	Critical V/C (>=0.85)	LOS	Delay/ veh (sec.)	V/C	Critical V/C (>=0.85)
Eagle St & Speedsville Rd	B	16.3	0.46	-	F	81.7	1.19	EBL=0.90 WBTR=1.33 NBL=0.94 SBTR=1.14
Maple Grove Rd & Fountain St	C	21.9	0.47	-	C	33.6	0.77	-
Toyota South Entrance & Fountain St	A	4.7	0.14	-	C	32.0	0.74	NB LTR=0.89
Toyota North Entrance & Fountain St	A	3.6	0.19	-	B	14.1	0.62	-
Maple Grove Rd & Speedsville Rd	B	12.6	0.63	-	D	52.4	1.02	EBT=0.93 NBLTR=1.22
Cherry Blossom Rd & Fountain St	B	12.1	0.33	-	C	28.8	0.68	EBLTR=0.92
Maple Grove Rd & Vondrau Dr	A	7.1	0.27	-	B	10.2	0.42	-
Maple Grove Rd & Beaverdale Rd	A	6.7	0.37	-	A	7.4	0.45	-
Maple Grove Rd & Hespeler Rd	B	17.2	0.65	-	C	25.0	0.81	NBL=0.95

A review of the existing traffic scenario (Table 2.1c) indicates that most of the traffic movements that where identified as critical under Regional saturation flow rate (SFR) conditions have become slightly worse under Cambridge SFR conditions during the PM peak hour. As highlighted in yellow, in Table 2.1c, the use of Cambridge SFRs will result in the following two new critical movements:

- Northbound left/through/right movement at intersection of Toyota South Entrance and Fountain Street
- Northbound left movement at intersection of Maple Grove Road and Hespeler Road

The following two tables summarize the signalized intersection performance under the 2014 background traffic demands for the Regional and City saturation flows.

Table 3.1R – Signalized Operational Performance:
AM/PM Peak Hour 2014 Background Traffic
(Regional Saturation Flow Rates)

Signalized Intersection*	AM PEAK HOUR				PM PEAK HOUR			
	LOS	Delay/ Veh (sec.)	V/C	Critical V/C (>=0.85)	LOS	Delay/ veh (sec.)	V/C	Critical V/C (>=0.85)
Eagle St & Speedsville Rd	B	15.1	0.35	-	D	45.5	0.97	EBL=0.99 WBTR=0.87 NBL=0.97 SBTR=0.96
Maple Grove Rd & Fountain St	C	22.1	0.48	-	D	36.7	0.77	-
Toyota South Entrance & Fountain St	A	4.6	0.14	-	C	23.2	0.73	-
Toyota North Entrance & Fountain St	A	3.5	0.18	-	C	21.7	0.64	-
Maple Grove Rd & Speedsville Rd	B	10.2	0.54	-	C	31.8	0.77	EBT=0.92
Cherry Blossom Rd & Fountain St	B	11.8	0.32	-	B	17.7	0.69	-
Maple Grove Rd & Vondrau Dr	A	7.1	0.27	-	B	10.1	0.42	-
Maple Grove Rd & Beaverdale Rd	A	6.5	0.36	-	A	7.1	0.44	-
Maple Grove Rd & Hespeler Rd	B	17.3	0.67	-	C	26.4	0.77	NBL=0.86

**Table 3.1C – Signalized Operational Performance:
AM/PM Peak Hour 2014 Background Traffic
(Cambridge Saturation Flow Rates)**

Signalized Intersection*	AM PEAK HOUR				PM PEAK HOUR			
	LOS	Delay/ Veh (sec.)	V/C	Critical V/C (>=0.85)	LOS	Delay/ veh (sec.)	V/C	Critical V/C (>=0.85)
Eagle St & Speedsville Rd	B	15.4	0.39	-	D	54.0	1.03	EBL=1.00 WBT=0.92 NBL=0.99 SBTR=1.05
Maple Grove Rd & Fountain St	C	22.8	0.50	-	D	38.1	0.79	-
Toyota South Entrance & Fountain St	A	4.6	0.14	-	C	24.2	0.76	-
Toyota North Entrance & Fountain St	A	3.5	0.20	-	C	22.9	0.67	-
Maple Grove Rd & Speedsville Rd	B	11.1	0.58	-	C	31.6	0.81	EBT=0.92
Cherry Blossom Rd & Fountain St	B	12.8	0.37	-	B	18.3	0.69	-
Maple Grove Rd & Vondrau Dr	A	7.1	0.28	-	B	10.5	0.43	-
Maple Grove Rd & Beaverdale Rd	A	6.4	0.35	-	A	7.5	0.47	-
Maple Grove Rd & Hespeler Rd	B	18.3	0.69	-	C	28.4	0.80	NBL=0.87

As shown above, the use of Cambridge SFRs resulted in increased delay in increased v/c ratios for most critical movements. Of note is the operation of the intersection of Eagle Street and Speedsville Road. At this intersection the eastbound left and southbound through/right lanes reach theoretical capacity levels under Cambridge SFR conditions (highlighted in yellow).

The following two tables summarize the signalized intersection performance during the AM Peak hour under the 2014 Total traffic demands for the Regional and City saturation flows.

**Table 3.4R – Signalized Operational Performance:
AM Peak Hour 2014 Total Traffic
(Regional Saturation Flow Rates)**

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85
Eagle St & Speedsville Rd	B	15.8	0.41	_	B	15.8	0.41	_	B	15.8	0.41	_
Maple Grove Rd & Fountain St	C	23.2	0.57	_	C	23.2	0.57	_	C	23.2	0.57	_

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85
Toyota South Entrance & Fountain St	A	4.6	0.14	_	A	4.6	0.14	_	A	4.6	0.14	_
Toyota North Entrance & Fountain St	A	3.5	0.18	_	A	3.5	0.18	_	A	3.5	0.18	_
Maple Grove Rd & Speedsville Rd	B	12.8	0.67	_	B	11.0	0.57	_	B	12.7	0.67	_
Cherry Blossom Rd & Fountain St	B	12.6	0.38	_	B	12.6	0.38	_	B	12.6	0.38	_
Maple Grove Rd & Vondrau Dr	A	7.0	0.28	_	A	7.0	0.28	_	A	7.0	0.28	_
Maple Grove Rd & Beaverdale Rd	A	6.7	0.44	_	A	6.7	0.44	_	A	6.7	0.44	_
Maple Grove Rd & Hespeler Rd	C	25.8	0.76	_	C	25.8	0.76	_	C	25.8	0.76	_

Table 3.4C – Signalized Operational Performance: AM Peak Hour 2014 Total Traffic (Cambridge Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Eagle St & Speedsville Rd	B	16.2	0.44	_	B	16.2	0.44	_	B	16.2	0.44	_
Maple Grove Rd & Fountain St	C	24.0	0.59	_	C	24.0	0.59	_	C	24.0	0.59	_
Toyota South Entrance & Fountain St	A	4.6	0.14	_	A	4.6	0.14	_	A	4.6	0.14	_
Toyota North Entrance & Fountain St	A	3.5	0.18	_	A	3.5	0.18	_	A	3.5	0.18	_
Maple Grove Rd & Speedsville Rd	B	14.9	0.72	_	B	12.0	0.61	_	B	17.9	0.79	_
Cherry Blossom Rd & Fountain St	B	12.8	0.40	_	B	12.8	0.40	_	B	12.8	0.40	_
Maple Grove Rd & Vondrau Dr	A	7.1	0.30	_	A	7.1	0.30	_	A	7.1	0.30	_
Maple Grove Rd & Beaverdale Rd	A	7.0	0.48	_	A	7.0	0.48	_	A	7.0	0.48	_
Maple Grove Rd & Hespeler Rd	C	27.7	0.78	_	C	27.7	0.78	_	C	27.7	0.78	_

As shown in Tables 3.4 R and 3.4C, during the AM peak hour the operation of the majority of the intersections will become slightly worse using Cambridge SFRs, however, the impact of using Cambridge SFRs during the AM peak hour will be minimal.

The following two tables summarize the signalized intersection performance during the PM Peak hour under the 2014 Total traffic demands for the Regional and City saturation flows.

Table 3.5R – Signalized Operational Performance:
PM Peak Hour 2014 Total Traffic
(Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Eagle St & Speedsville Rd	E	61.2	1.09	EBL=1.07 WBT=0.87 NBL=1.14 SBTR=1.10	E	61.2	1.09	EBL=1.07 WBT=0.87 NBL=1.14 SBTR=1.10	E	61.2	1.09	EBL=1.07 WBT=0.87 NBL=1.14 SBTR=1.10
Maple Grove Rd & Fountain St	D	45.0	0.83	EBL=0.87 WBT=0.89 SBL=0.86	D	45.0	0.83	EBL=0.87 WBT=0.89 SBL=0.86	D	45.0	0.83	EBL=0.87 WBT=0.89 SBL=0.86
Toyota South Entrance & Fountain St	C	26.6	0.69	_	C	26.6	0.69	_	C	26.6	0.69	_
Toyota North Entrance & Fountain St	B	16.0	0.64	_	B	16.0	0.64	_	B	16.0	0.64	_
Maple Grove Rd & Speedsville Rd	C	27.9	0.81	EBT=0.89	C	30.3	0.86	EBT=0.90	C	33.9	1.11	EBT=0.96_
Cherry Blossom Rd & Fountain St	C	20.8	0.78	_	C	20.8	0.78	_	C	20.8	0.78	_
Maple Grove Rd & Vondrau Dr	B	10.4	0.41	_	B	10.4	0.41	_	B	10.4	0.41	_
Maple Grove Rd & Beaverdale Rd	A	7.4	0.50	_	A	7.4	0.50	_	A	7.4	0.50	_
Maple Grove Rd & Hespeler Rd	C	29.2	0.80	NBL=0.88	C	29.2	0.80	NBL=0.88	C	29.2	0.80	NBL=0.88

Table 3.5C – Signalized Operational Performance: PM Peak Hour 2014 Total Traffic (Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Eagle St & Speedsville Rd	E	74.7	1.15	EBL=1.08 WBT=0.92 NBL=1.16 SBTR=1.20	E	74.7	1.15	EBL=1.08 WBT=0.92 NBL=1.16 SBTR=1.20	E	74.7	1.15	EBL=1.08 WBT=0.92 NBL=1.16 SBTR=1.20
Maple Grove Rd & Fountain St	D	49.3	0.87	EBL=0.88 WBT=0.94 SBL=0.88	D	49.3	0.87	EBL=0.88 WBT=0.94 SBL=0.88	D	49.3	0.87	EBL=0.88 WBT=0.94 SBL=0.88
Toyota South Entrance & Fountain St	C	27.4	0.71	_	C	27.4	0.71	_	C	27.4	0.71	_
Toyota North Entrance & Fountain St	B	16.8	0.67	_	B	16.8	0.67	_	B	16.8	0.67	_
Maple Grove Rd & Speedsville Rd	C	31.8	0.85	EBT=0.92	D	35.3	0.91	EBT=0.94	D	42.0	0.92	EBT=1.02
Cherry Blossom Rd & Fountain St	C	21.7	0.80	_	C	21.7	0.80	_	C	21.7	0.80	_
Maple Grove Rd & Vondrau Dr	B	10.6	0.43	_	B	10.6	0.43	_	B	10.6	0.43	_
Maple Grove Rd & Beaverdale Rd	A	7.8	0.54	_	A	7.8	0.54	_	A	7.8	0.54	_
Maple Grove Rd & Hespeler Rd	C	31.1	0.81	NBL=0.88	C	31.1	0.81	NBL=0.88	C	31.1	0.81	NBL=0.88

In the majority of the intersections the use of Cambridge SFRs reduced the intersection's operational performance. At the intersection of Maple Grove Road and Speedsville Road (as highlighted above in yellow in Table 3.5c), the eastbound through movement, under access Option C, reaches theoretical capacity, increasing from a v/c ratio of 0.96 under regional SFR conditions to a v/c ratio of 1.02 under Cambridge SFR conditions.

A summary of the performance of the three critical intersections with geometric improvements recommended in the TIS is summarized in Tables 3.6R, 3.6C and Tables 3.7R and 3.7C under AM and PM peak hour conditions using Regional and City saturation flow rates, respectively.

Table 3.6R –Signalized Operational Performance AM Peak Hour 2014 Total Traffic With Geometric Improvements (Regional Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Speedsville Rd	A	8.5	0.42	_	A	9.7	0.54	_	A	8.5	0.42	_
Eagle St & Speedsville Rd	B	15.8	0.41	_	B	15.8	0.41	_	B	15.8	0.41	_
Maple Grove Rd & Hespeler Rd	B	14.6	0.50	_	B	14.6	0.50	_	B	14.6	0.50	_

*LOS, V/C and delay for overall intersection (with exception of specific critical movements as noted)

Table 3.6C –Signalized Operational Performance AM Peak Hour 2014 Total Traffic With Geometric Improvements (Cambridge Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Speedsville Rd	A	8.9	0.46	_	A	10.1	0.56	_	A	8.9	0.46	_
Eagle St & Speedsville Rd	B	16.2	0.44	_	B	16.2	0.44	_	B	16.2	0.44	_
Maple Grove Rd & Hespeler Rd	B	14.9	0.51	_	B	14.9	0.51	_	B	14.9	0.51	_

By comparing Table 3.6r with Table 3.6c, it can be seen that Cambridge SFRs will slightly reduce operational performance of individual intersections, however under AM peak hour this reduction will not be significant.

Table 3.7R – Improved Signalized Operational Performance PM Peak Hour 2014 Total Traffic With Geometric Improvements (Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Speedsville Rd	C	20.4	0.64	_	C	21.7	0.70	_	C	21.4	0.67	_
Eagle St & Speedsville Rd	E	61.2	1.09	EBL=1.07 WBT=0.87 NBL=1.14 SBTR=1.10	E	61.2	1.09	EBL=1.07 WBT=0.87 NBL=1.14 SBTR=1.10	E	61.2	1.09	EBL=1.07 WBT=0.87 NBL=1.14 SBTR=1.10
Maple Grove Rd & Hespeler Rd	C	20.3	0.67	_	C	20.3	0.67	_	C	20.3	0.67	_

Table 3.7C – Improved Signalized Operational Performance
PM Peak Hour 2014 Total Traffic With Geometric Improvements
(Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Speedsville Rd	C	22.1	0.69	_	C	24.0	0.75	_	C	23.4	0.71	_
Eagle St & Speedsville Rd	E	74.7	1.15	EBL=1.08 WBT=0.92 NBL=1.16 SBTR=1.20	E	74.7	1.15	EBL=1.08 WBT=0.92 NBL=1.16 SBTR=1.20	E	74.7	1.15	EBL=1.08 WBT=0.92 NBL=1.16 SBTR=1.20
Maple Grove Rd & Hespeler Rd	C	21.5	0.70	_	C	21.5	0.70	_	C	21.5	0.70	_

Overall, the use of Cambridge SFRs results in decreased operational performance of affected signalized intersections. Of note is the intersection of Eagle Street and Speedsville Road; the use of Cambridge SFRs further emphasizes the congestion/bottleneck that will be experienced at this intersection by 2014.

Tables 3.10R and 3.10C present the AM and PM operational analysis for the signalization of Maple Grove Road and Boxwood Road intersection.

Table 3.10R –Signalized Operational Performance
Maple Grove Road and Boxwood Drive
AM & PM Peak Hour 2014 Total Traffic (Regional Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
AM Peak Hour	A	4.9	0.30	_	A	4.8	0.30		A	4.3	0.29	_
PM Peak Hour	A	7.2	0.52	_	B	12.2	0.64	_	A	7.9	0.54	_

Table 3.10C –Signalized Operational Performance
Maple Grove Road and Boxwood Drive
AM & PM Peak Hour 2014 Total Traffic (Cambridge Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
AM Peak Hour	A	5.0	0.32	_	A	4.9	0.33	_	A	4.3	0.31	_
PM Peak Hour	A	7.5	0.56	_	B	13.0	0.67	_	A	8.3	0.57	_

While the use of Cambridge SFRs will reports reduced performance at the signalized intersection, the net reduction is minimal and the intersection will still operate at a very good level of service.

The following two tables are new and represent the signalization of the intersection of Maple Grove Road and Access "C" to the Boxwood development.

Table 3.10(new) R –Signalized Operational Performance
Maple Grove Road and Access 'C'
AM and PM Peak Hour 2014 Total Traffic
(Regional Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
AM Peak Hour	A	3.6	0.31	_	N/A				A	3.5	0.29	_
PM Peak Hour	A	8.8	0.56	_	N/A				A	8.3	0.54	_

Table 3.10(New) C –Signalized Operational Performance
Maple Grove Road and Access 'C'
AM and PM Peak Hour 2014 Total Traffic
(Cambridge Saturation Flow Rates)

Signalized Intersection*	ACCESS OPTION A				ACCESS OPTION B				ACCESS OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
AM Peak Hour	A	3.6	0.31	_	N/A				A	3.6	0.29	_
PM Peak Hour	A	9.1	0.59	_	N/A				A	8.3	0.54	_

While the use of Cambridge SFRs will reduce performance at the signalized intersection of Maple Grove Road and Access 'C', the reduction in performance is minimal; overall performance using either the Regional or Cambridge SFRs will be very good.

The following table will present a comparison of anticipated signalized intersection performance under the 2019 total traffic scenario for the AM and PM peak hours of operation.

Table 3.11R – Signalized Operational Performance: AM Peak Hour 2019 Total Traffic (Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85
Eagle St & Speedsville Rd	C	24.6	0.63	_	C	24.6	0.63	_	C	24.6	0.63	_
Maple Grove Rd & Access 'C'	A	4.1	0.39	_	N/A				A	4.0	0.37	_
Maple Grove Rd & Fountain St	D	51.4	0.96	EBL=1.03 SBL=1.06	D	51.4	0.96	EBL=1.03 SBL=1.06	D	51.4	0.96	EBL=1.03 SBL=1.06
Toyota South Entrance & Fountain St	A	4.8	0.25	_	A	4.8	0.25	_	A	4.8	0.25	_
Toyota North Entrance & Fountain St	A	3.5	0.21	_	A	3.5	0.21	_	A	3.5	0.21	_
Maple Grove Rd & Speedsville Rd	B	18.8	0.77	_	C	20.0	0.82	_	B	18.7	0.77	_
Cherry Blossom Rd & Fountain St	B	12.3	0.49	_	B	12.3	0.49	_	B	12.3	0.49	_
Maple Grove Rd & Vondrau Dr	A	7.2	0.39	_	A	7.2	0.39	_	A	7.2	0.39	_
Maple Grove Rd & Beaverdale Rd	A	9.2	0.66	_	A	9.2	0.66	_	A	9.2	0.66	_
Maple Grove Rd & Hespeler Rd	B	19.2	0.72	_	B	19.2	0.72	_	B	19.2	0.72	_
Maple Grove Rd & Boxwood Dr	A	4.8	0.37	_	A	4.9	0.38	_	A	4.2	0.36	_

Table 3.11C – Signalized Operational Performance: AM Peak Hour 2019 Total Traffic (Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85
Eagle St & Speedsville Rd	C	25.8	0.67	_	C	25.8	0.67	_	C	25.8	0.67	_
Maple Grove Rd & Access 'C'	A	4.2	0.40	_	N/A				A	4.3	0.39	_
Maple Grove Rd & Fountain St	E	56.4	0.98	EBL=1.07 SBL=1.07 WBT=0.91	E	56.4	0.98	EBL=1.07 SBL=1.07 WBT=0.91	E	56.4	0.98	EBL=1.07 SBL=1.07 WBT=0.91
Toyota South Entrance & Fountain St	A	4.9	0.26	_	A	4.9	0.26	_	A	4.9	0.26	_
Toyota North Entrance & Fountain St	A	3.6	0.23	_	A	3.6	0.23	_	A	3.6	0.23	_

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85	LOS	Delay (s)	V/C	Critical V/C>= 0.85
Maple Grove Rd & Speedsville Rd	C	23.1	0.84	_	C	22.3	0.80	_	C	26.4	0.83	_
Cherry Blossom Rd & Fountain St	B	12.6	0.52	_	B	12.6	0.52	_	B	12.6	0.52	_
Maple Grove Rd & Vondrau Dr	A	7.3	0.41	_	A	7.3	0.41	_	A	7.3	0.41	_
Maple Grove Rd & Beaverdale Rd	B	11.2	0.72	_	B	11.2	0.72	_	B	11.2	0.72	_
Maple Grove Rd & Hespeler Rd	C	21.3	0.70	_	C	21.3	0.70	_	C	21.3	0.70	_
Maple Grove Rd & Boxwood Dr	A	4.9	0.40	_	A	5.0	0.41	_	A	4.3	0.39	_

While the use of Cambridge SFRs generally results in reduced intersection performance values, no significant change will result during the AM peak hour with the exception of the westbound through movement at the intersection of Maple Grove Road and Fountain Street. Using either the Cambridge or Regional SFRs will result in both the eastbound and southbound left-turn movements reaching theoretical capacity. The use of Cambridge SFRs will result in an additional movement (westbound left) reaching a critical level (v/c ratio over 0.85: highlighted above in yellow) by this timeframe.

Table 3.12R – Signalized Operational Performance:
PM Peak Hour 2019 Total Traffic (Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Eagle St & Speedsville Rd	F	86.6	1.24	EBL = 1.21 WBT = 0.89 NBL=1.24 SBTR = 1.26	F	86.6	1.24	EBL = 1.21 WBT = 0.89 NBL=1.24 SBTR = 1.26	F	86.6	1.24	EBL = 1.21 WBT = 0.89 NBL=1.24 SBTR = 1.26
Maple Grove Rd & Access 'C'	B	11.0	0.59	_	N/A				A	9.1	0.60	_
Maple Grove Rd & Fountain St	E	60.9	0.96	EBL=0.97 WBT/TR=0.91 NBL=1.08 NBT/TR=0.93 SBLT1.05	E	60.9	0.96	EBL=0.97 WBT/TR=0.91 NBL=1.08 NBT/TR=0.93 SBLT1.05	E	60.9	0.96	EBL=0.97 WBT/TR=0.91 NBL=1.08 NBT/TR=0.93 SBLT1.05
Toyota South Entrance & Fountain St	C	20.7	0.63	_	C	20.7	0.63	_	C	20.7	0.63	_
Toyota North Entrance & Fountain St	B	13.0	0.58	_	B	13.0	0.58	_	B	13.0	0.58	_
Maple Grove Rd & Speedsville Rd	D	38.0	0.86	EBT=0.86 SBL=0.86 SBT=0.90	D	49.5	0.94	EBT=0.86 WBL=0.86 NBL=0.87 NBT=1.01 SBL=1.07 SBT=0.87	D	40.4	0.89	EBT=0.91 NBL=0.86 SBL=0.85 SBT=0.91

Cherry Blossom Rd & Fountain St	C	27.7	0.67	_	C	27.7	0.67	_	C	27.7	0.67	_
Maple Grove Rd & Vondrau Dr	B	10.3	0.47	_	B	10.3	0.47	_	B	10.3	0.47	_
Maple Grove Rd & Beaverdale Rd	A	8.0	0.61	_	A	8.0	0.61	_	A	8.0	0.61	_
Maple Grove Rd & Hespeler Rd	C	22.7	0.71	_	C	22.7	0.71	_	C	22.7	0.71	_
Maple Grove Rd & Boxwood Dr	A	7.2	0.55	_	B	13.2	0.69	_	A	8.0	0.59	_

Table 3.12C – Signalized Operational Performance: PM Peak Hour 2019 Total Traffic (Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Eagle St & Speedsville Rd	F	105.7	1.32	EBL = 1.23 WBT = 0.94 NBL=1.26 SBTR = 1.38	F	105.7	1.32	EBL = 1.23 WBT = 0.94 NBL=1.26 SBTR = 1.38	F	105.7	1.32	EBL = 1.23 WBT = 0.94 NBL=1.26 SBTR = 1.38
Maple Grove Rd & Access 'C'	B	10.6	0.67	_	N/A				A	9.7	0.64	_
Maple Grove Rd & Fountain St	E	70.8	1.00	EBL=0.99 WBT/TR=0.98 NBL=1.12 NBT/TR=1.02 SBL=1.08 SBT/TR=0.85	E	70.8	1.00	EBL=0.99 WBT/TR=0.98 NBL=1.12 NBT/TR=1.02 SBL=1.08 SBT/TR=0.85	E	70.8	1.00	EBL=0.99 WBT/TR=0.98 NBL=1.12 NBT/TR=1.02 SBL=1.08 SBT/TR=0.85
Toyota South Entrance & Fountain St	C	21.2	0.65	_	C	21.2	0.65	_	C	21.2	0.65	_
Toyota North Entrance & Fountain St	B	13.8	0.62	_	B	13.8	0.62	_	B	13.8	0.62	_
Maple Grove Rd & Speedsville Rd	D	44.8	0.91	NBL=0.85 NBT=0.88 EBT=0.94 SBL=0.86 SBT=0.94	E	60.0	1.01	EBT=0.93 WBL=0.86 NBL=0.92 NBT=1.13 SBL=1.05 SBT=0.93	D	51.0	0.96	EBT=0.99 NBL=0.88 SBL=0.86 SBT=0.99
Cherry Blossom Rd & Fountain St	C	25.7	0.68	_	C	25.7	0.68	_	C	25.7	0.68	_
Maple Grove Rd & Vondrau Dr	B	10.6	0.49	_	B	10.6	0.49	_	B	10.6	0.49	_
Maple Grove Rd & Beaverdale Rd	A	9.0	0.66	_	A	9.0	0.66	_	A	9.0	0.66	_
Maple Grove Rd & Hespeler Rd	C	24.5	0.76	_	C	24.5	0.76	_	C	24.5	0.76	_
Maple Grove Rd & Boxwood Dr	A	7.3	0.59	_	B	13.9	0.72	_	A	8.1	0.62	_

As is shown above in Table 3.12c, most of the traffic movements that will reach critical levels, under Regional saturation flow rate (SFR) conditions, will worsen under City SFR conditions during the PM peak hour. As highlighted in yellow in Table 3.12c the use of Cambridge SFR will result in the following significant anticipated operational changes:

- Maple Grove Road and Fountain Street Intersection: Northbound through/right movement will reach theoretical capacity; Southbound through/right movement will have critical v/c ratio of 0.85

- Maple Grove Road and Speedsville Road: Northbound through and left movements will have critical v/c ratio levels (0.85 or greater).

As detailed in the TIS the operational analysis of these two intersections under improved geometric conditions is summarized in Tables 3.13R and 3.13C for AM peak hour and Tables 3.14R and 3.14C for PM peak hour, respectively.

Table 3.13R – Signalized Operational Performance
AM Peak Hour 2019 Total Traffic With Geometric Improvements
(Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Fountain St	C	29.4	0.64	_	C	29.4	0.64	_	C	29.4	0.64	_
Maple Grove Rd & Speedsville Rd	B	15.3	0.68	_	B	14.8	0.66	_	B	15.3	0.68	_

Table 3.13C – Signalized Operational Performance
AM Peak Hour 2019 Total Traffic With Geometric Improvements
(Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Fountain St	C	31.3	0.68	_	C	31.3	0.68	_	C	31.3	0.68	_
Maple Grove Rd & Speedsville Rd	B	17.0	0.73	_	B	15.6	0.68	_	B	16.9	0.73	_

As can been seen through comparison of Table 3.13r and 3.13c, the use of Cambridge SFRs will result in no significant change in operational performance during the AM peak hour; each affected signalized intersection continues to operate at a good level of service.

Table 3.14R – Signalized Operational Performance
PM Peak Hour 2019 Total Traffic With Geometric Improvements
(Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Fountain St	D	41.1	0.86	SBT = 0.89	D	41.1	0.86	SBT = 0.89	D	41.1	0.86	SBT = 0.89
Maple Grove Rd & Speedsville Rd	C	27.2	0.75	_	C	24.8	0.71	_	C	24.7	0.71	_

Table 3.14C – Signalized Operational Performance
PM Peak Hour 2019 Total Traffic With Geometric Improvements
(Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Fountain St	D	45.4	0.93	WBTR=0.91 SBT = 0.92 NBL=0.88	D	45.4	0.93	WBTR=0.91 SBT = 0.92 NBL=0.88	D	45.4	0.93	WBTR=0.91 SBT = 0.92 NBL=0.88
Maple Grove Rd & Speedsville Rd	C	28.2	0.81	_	C	30.9	0.77	_	C	31.6	0.82	_

At this stage, the TIS report recommends adding east and southbound double left turn lanes at the intersection of Maple Grove Road and Fountain Street based on Regional SFRs. Even with the addition of these lanes, operational performance at the intersection is anticipated to be unacceptable using Cambridge SFRs. To improve performance, an additional northbound double left turn lane is recommended under City SFRs scenario. This will provide satisfactory operation as summarized below:

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
Maple Grove Rd & Fountain St	D	38.6	0.78	-	D	38.6	0.78	-	D	38.6	0.78	-

Under the 2019 total traffic demands the intersections of Speedsville Road and Briardean Road and Speedsville Road and Royal Oak Road are recommended to be signalized. A comparison of the performance of these intersections under the various SFRs is summarized in Tables 3.17R and 3.17C.

Table 3.17R –New Signalized Intersection Performance AM and PM Peak Hour 2019 Total Traffic (Regional Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
AM PEAK HOUR												
Speedsville Rd & Briardean Rd.	Unsignalized				A	6.4	0.44	_	Unsignalized			
Speedsville Rd & Royal Oak Rd.	A	7.8	0.46	_	A	7.0	0.43	_	A	6.9	0.42	_
PM PEAK HOUR												
Speedsville Rd & Briardean Rd	Unsignalized				A	9.9	0.57	_	Unsignalized			
Speedsville Rd & Royal Oak Rd.	C	24.3	0.70	_	C	22.4	0.66	_	C	22.3	0.66	_

Table 3.17C –New Signalized Intersection Performance AM and PM Peak Hour 2019 Total Traffic (Cambridge Saturation Flow Rates)

Signalized Intersection*	OPTION A				OPTION B				OPTION C			
	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85	LOS	Delay (s)	V/C	Critical V/C>=0.85
AM PEAK HOUR												
Speedsville Rd & Briardean Rd.	Unsignalized				A	6.5	0.44	_	Unsignalized			
Speedsville Rd & Royal Oak Rd.	A	8.2	0.52	_	A	7.2	0.48	_	A	7.1	0.47	_
PM PEAK HOUR												
Speedsville Rd & Briardean Rd	Unsignalized				B	10.4	0.61	_	Unsignalized			
Speedsville Rd & Royal Oak Rd.	C	25.8	0.80	SBTR=0.85	C	22.8	0.76	_	C	22.7	0.76	_

The use of Cambridge SFRs results in no significant change in operational performance during the AM and PM peak hours. The only notable impact is that the SBTR movement at the intersection of Speedsville Road and Royal Oak Road will reach a v/c ratio of 0.85.

SUMMARY

Although the use of Cambridge saturation flow rates (SFR) result in reduced operational performance for all intersections and individual lane groups, their use does not accelerate the timeframe for any of the recommended geometric or intersection traffic control improvements document in the draft TIS report. The only new requirement resulting from the use of the City SFRs scenario is the need for a northbound double left turn movement at the intersection of Maple Grove Road and Fountain Street under the 2019 total traffic demands.