



## MEMO

**TO:** Nelson Cadete, City of Brampton  
**FROM:** Ismet Medic, Brittany Chung (WSP)  
**CC:** Dave McLaughlin, John Zunic (WSP)  
**SUBJECT:** **Brampton East-West Cycling Corridor – Synchro Future Conditions (Sensitivity Analysis for Howden Boulevard)**  
**DATE:** **June 11, 2020**

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The City of Brampton’s 2019 Active Transportation Master plan identified the implementation of protected bike lanes or cycle tracks along Vodden Street East and Howden Boulevard, and a bike lane along Hanover Street. A traffic operations assessment of the existing and proposed future traffic conditions was completed by WSP and is documented in the “Brampton Vodden Cycling Facilities Design Feasibility – Traffic Operations Review” report, dated June 11, 2020. The future traffic conditions assessment which simulated the future road-diet scenario identified several intersection movements are expected to operate at over 90% capacity.

In this memo, an additional sensitivity analysis was undertaken in Synchro to assess the critical movements in the future road-diet scenario along Howden Boulevard. The purpose of this assessment is to determine the percentage of trips needed to be diverted from these critical intersections such that all movements operate within 90% capacity.

## FUTURE TRAFFIC CONDITIONS – CRITICAL MOVEMENTS

As per the Synchro future conditions results in the Traffic Operations Report, it was found that several intersection movements are expected to operate at critical capacity when the road-diet is place. The critical movements are summarized in Table 1.



Table 1: Weekday Future Intersection Operations – Critical Movements

Intersection	Weekday A.M. Peak Hour		Weekday P.M. Peak Hour	
	Overall LOS [Delay in Seconds] (v/c Ratio)	Critical Movement (v/c Ratio)	Overall LOS [Delay in Seconds] (v/c Ratio)	Critical Movement (v/c Ratio)
Dixie Road & Howden Blvd	D [51] (0.98)	EBT (0.99) SBT (1.00)	C [33] (0.90)	WBT (0.91)
Howden Blvd/N Park Drive & Williams Parkway			D [49] (0.99)	EBL (0.94) NBL (0.98)
Vodden Street East & Howden Blvd			D [47] (0.99)	EBT (0.90) WBL (0.97) NBL (0.95)

Note: Critical v/c ratios are only listed for values over 0.90.

## SENSITIVITY ANALYSIS

Additional Synchro analysis was conducted to determine the traffic volumes that would need to be diverted away from the Howden Boulevard intersections in order for the critical movements to operate within 90% capacity in the road-diet scenario.

### TRAFFIC REDISTRIBUTION AND SIGNAL TIMING OPTIMIZATION

To determine the traffic redistribution required at the critical intersections, traffic volumes were iteratively removed, and signal timings splits were adjusted until all movements operate at a v/c of 0.90 or less.

Note that only the critical intersections were assessed, and any removal of traffic volumes were not carried through to the upstream and downstream intersections.

The A.M. and P.M. peak hour traffic volumes and the required redistributions are shown in Figure 1 and Figure 2.

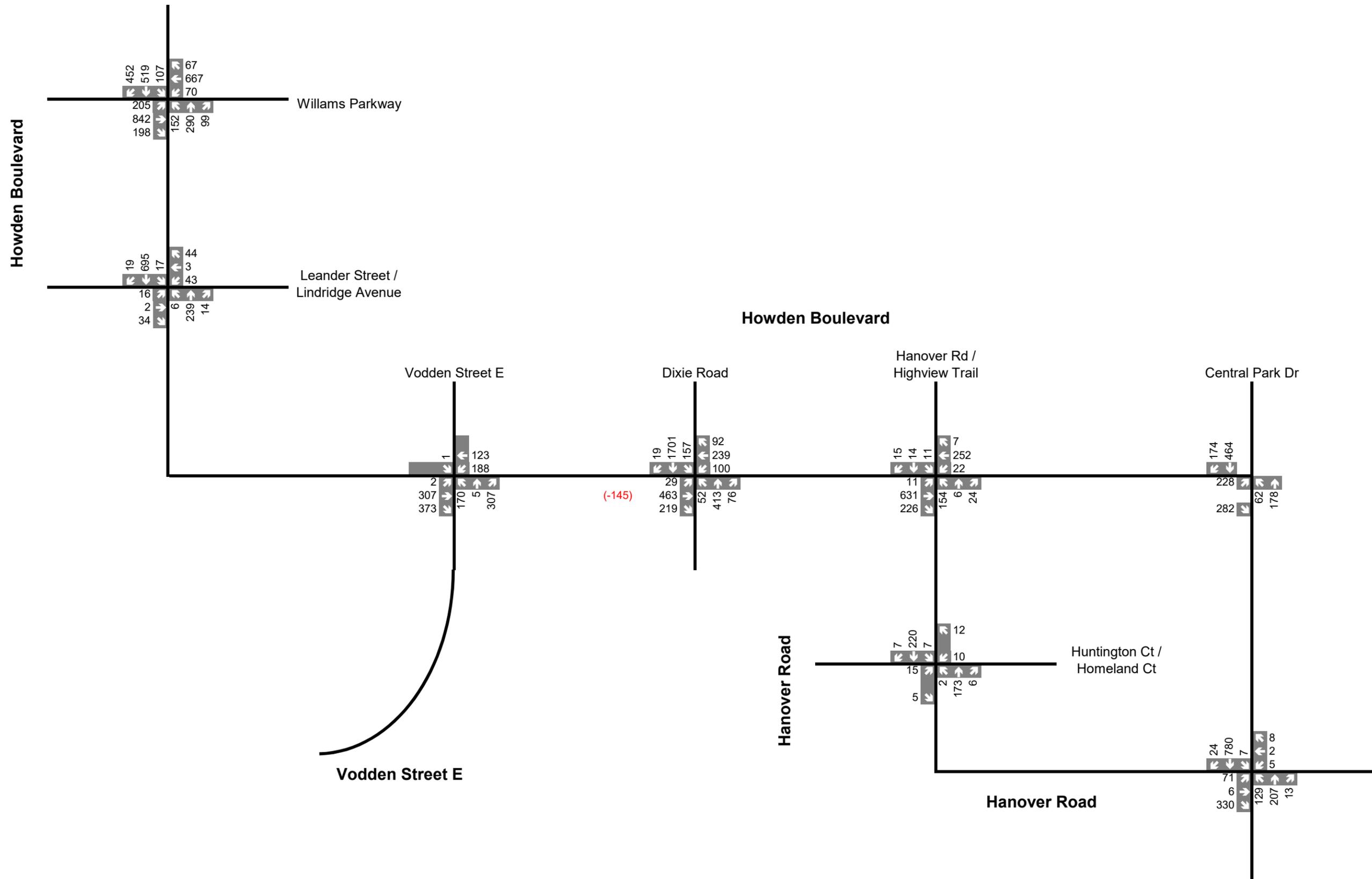


Figure 1  
Sensitivity Analysis - Redistribution of AM Peak Hour Traffic Volumes (Howden Blvd / Hanover Rd)

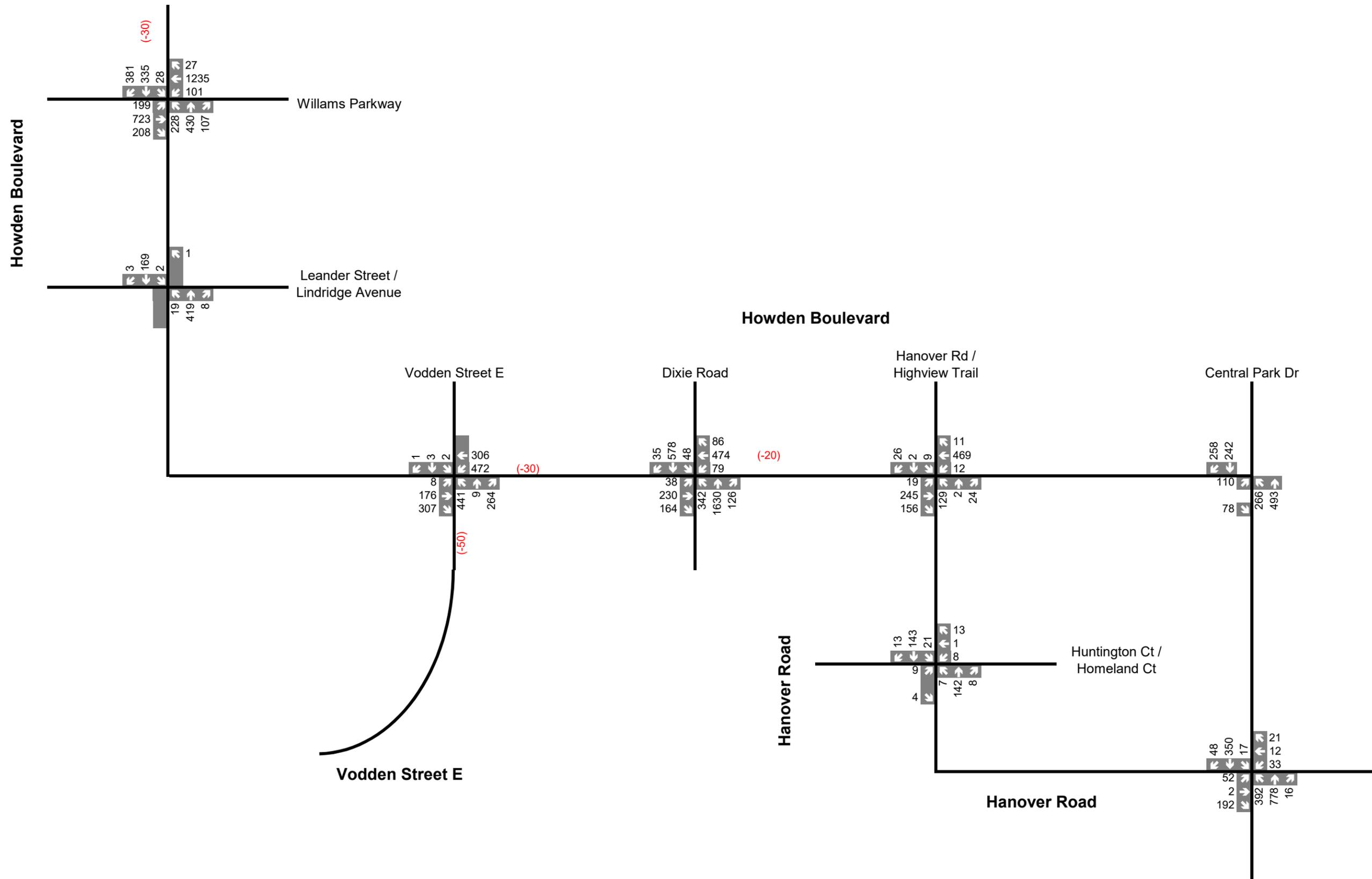


Figure 2  
Sensitivity Analysis - Redistribution of PM Peak Hour Traffic Volumes  
(Howden Blvd / Hanover Rd)



The percentage of redistributed volumes to the original volumes are also summarized in Table 2.

*Table 2: Sensitivity Analysis – Traffic Volume Redistribution*

Intersection	Movement	Weekday A.M. Peak Hour			Weekday P.M. Peak Hour		
		Volume	Redistributed Volumes		Volume	Redistributed Volumes	
		(veh)	(veh)	(%)	(veh)	(veh)	(%)
Dixie Road & Howden Blvd	EBT	463	-145	-31%	474	-20	-4%
	WBT				474	-20	-4%
Howden Blvd/N Park Drive & Williams Parkway	SBT				335	-30	-9%
Vodden Street East & Howden Blvd	NBL				472	-30	-6%
	WBL				441	-50	-11%

As shown in Table 2, the majority of traffic redistribution required is within approximately 10% of the original volumes, except at the intersection of Dixie Road & Howden Blvd.

The greatest percentage of redistributed traffic required is the eastbound through movement at the intersection of Dixie Road and Howden Boulevard in the A.M. peak hour. Approximately 31% of the vehicles travelling eastbound on Howden Blvd may need to be diverted to other parallel roadways such as Williams Parkway to the north or Queen Street East to the south.

### INTERSECTION CAPACITY RESULTS

The results of the intersection capacity analysis with the redistributed traffic volumes are summarized in Table 3 and Table 4. For comparison purposes, the v/c ratios of the critical intersections without the traffic volume redistributions are provided in Table 4 as well. Detailed Synchro reports are appended to this memo.

*Table 3: Weekday Future Intersection Operations – Sensitivity Analysis of Critical Movements, AM Peak Hour*

Intersection	Future Road-diet Scenario (with existing traffic counts)	Future Road-diet Scenario (with redistributed volumes)
	V/C ratio	V/C ratio
<b>Dixie Road &amp; Howden Blvd</b>	<b>0.98</b>	<b>0.88</b>
Eastbound Left	0.10	0.14
Eastbound Through	0.99	0.90
Eastbound Right	0.43	0.53
Westbound Left	0.93	0.72
Westbound Through	0.44	0.53
Westbound Right	0.06	0.06
Northbound Left	0.54	0.54
Northbound Through+Right	0.28	0.25
Southbound Left	0.39	0.35
Southbound Through+Right	1.00	0.90



Table 4: Weekday Future Intersection Operations – Sensitivity Analysis of Critical Movements, PM Peak Hour

Intersection	Future Road-diet Scenario (with existing traffic counts)	Future Road-diet Scenario (with redistributed volumes)
	V/C ratio	V/C ratio
<b>Dixie Road &amp; Howden Blvd</b>	<b>0.90</b>	<b>0.89</b>
Eastbound Left	0.57	0.50
Eastbound Through	0.58	0.60
Eastbound Right	0.11	0.11
Westbound Left	0.32	0.33
Westbound Through	0.91	0.89
Westbound Right	0.12	0.12
Northbound Left	0.68	0.68
Northbound Through+Right	0.83	0.83
Southbound Left	0.88	0.83
Southbound Through+Right	0.38	0.38
<b>Howden Blvd/N Park Drive &amp; Williams Pkwy</b>	<b>0.99</b>	<b>0.93</b>
Eastbound Left	0.94	0.90
Eastbound Through	0.39	0.39
Eastbound Right	0.20	0.20
Westbound Left	0.37	0.37
Westbound Through+Right	0.84	0.86
Northbound Left	0.98	0.89
Northbound Through	0.70	0.70
Northbound Right	0.13	0.13
Southbound Left	0.20	0.20
Southbound Through	0.81	0.76
Southbound Right	0.85	0.84
<b>Vodden Street East &amp; Howden Blvd</b>	<b>0.99</b>	<b>0.92</b>
Eastbound Left	0.03	0.02
Eastbound Through+Right	0.90	0.80
Westbound Left	0.97	0.89
Westbound Through+Right	0.30	0.29
Northbound Left	0.95	0.89
Northbound Through+Right	0.18	0.18
Southbound Left	0.01	0.01
Southbound Through+Right	0.01	0.01

The sensitivity analysis results show all the critical movements previously identified now operate at a v/c of 0.90 or less with the redistributed traffic. As mentioned, some signal timing splits were adjusted at the intersections to improve operations because of the redistributed traffic volumes.

At intersections where only a relatively small percentage of traffic volumes were rediverted (i.e. 10% or less), the overall intersection operations were marginally improved.

At the intersection of Dixie Road and Howden Boulevard in the A.M. peak hour, the overall intersection v/c improved from 0.98 to 0.88 by removing approximately 31% of the eastbound through traffic. Note that the eastbound left (v/c = 0.14) and eastbound right (v/c = 0.53) movements have capacity to carry some of the eastbound through diverted traffic to other parallel roadways such as Williams Parkway to the north or Queen Street East to the south.



## CONCLUSION

Based on the analysis contained in this memo, the following traffic redistributions would have to occur as a minimum in the future road-diet scenario in order for all intersection movements to operate with a v/c ratio of less than 0.90. The maximum intersection capacity identified in this Memo does not account for any future growth and is based solely on existing volumes collected by the City of Brampton. These conditions represent an at-capacity situation and would result in some queueing and congestion during weekday peak periods.

- Minor traffic redistribution (approximately 10% or less) would need to be diverted at the intersections of Dixie Road & Howden Blvd, Howden Blvd/N Park Drive & Williams Parkway, and Vodden Street East & Howden Blvd in the P.M. peak hour.
- Approximately 31% (145 vehicles) of the eastbound through traffic at the intersection of Dixie Road and Howden Boulevard in the A.M. peak hour would need to be diverted to other parallel roadways to operate at a v/c ratio of under 0.9, which is technically an at-capacity condition.

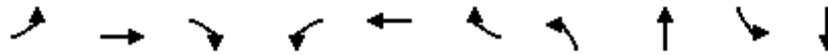
While it is possible that some diversion of traffic would occur over time as a result of the removal of a vehicle travel lane in each direction, the widening of Dixie Road to 6 lanes will likely result in induced vehicular demand. Therefore, it is reasonable to expect more motorists to travel along Dixie Road, as well as Howden Boulevard, Williams Parkway, and other surrounding streets. In addition to addressing this induced demand, the City should recognize that there will be future growth in traffic on Howden Boulevard and surrounding roadways, as the City grows over time. Howden Boulevard provides a direct route for individuals looking to travel between Williams Parkway and Queen Street, without needing to travel through the intersection of Williams Parkway / Dixie Road, including those who are destined to Highway 410.

Based on the additional sensitivity analysis, WSP remains of the opinion that the implementation of an IBMUP along Howden Boulevard is the preferred AT facility solution. We recommend proceeding with the detailed design of the IBMUP between Williams Parkway and Hanover Road.

Timings  
12: Dixie Road & Howden Blvd

<Future - Redistributed Volumes>AM

06-09-2020

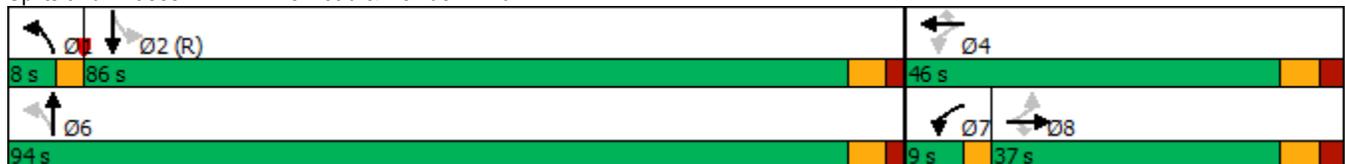


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↑	↗	↖	↑	↗	↖	↑↔	↖	↑↔
Traffic Volume (vph)	29	318	219	100	239	92	52	413	157	1701
Future Volume (vph)	29	318	219	100	239	92	52	413	157	1701
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	NA
Protected Phases		8		7	4		1	6		2
Permitted Phases	8		8	4		4	6		2	
Detector Phase	8	8	8	7	4	4	1	6	2	2
Switch Phase										
Minimum Initial (s)	8.0	8.0	8.0	5.0	8.0	8.0	5.0	8.0	8.0	8.0
Minimum Split (s)	36.8	36.8	36.8	8.0	36.8	36.8	8.0	40.1	40.1	40.1
Total Split (s)	37.0	37.0	37.0	9.0	46.0	46.0	8.0	94.0	86.0	86.0
Total Split (%)	26.4%	26.4%	26.4%	6.4%	32.9%	32.9%	5.7%	67.1%	61.4%	61.4%
Yellow Time (s)	4.0	4.0	4.0	3.0	4.0	4.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.8	2.8	2.8	0.0	2.8	2.8	0.0	2.1	2.1	2.1
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.8	6.8	6.8	3.0	6.8	6.8	3.0	6.1	6.1	6.1
Lead/Lag	Lag	Lag	Lag	Lead			Lead		Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes			Yes		Yes	Yes
Recall Mode	None	Max	C-Max	C-Max						
Act Effct Green (s)	29.3	29.3	29.3	42.1	38.3	38.3	91.9	88.8	82.4	82.4
Actuated g/C Ratio	0.21	0.21	0.21	0.30	0.27	0.27	0.66	0.63	0.59	0.59
v/c Ratio	0.14	0.90	0.62	0.68	0.53	0.20	0.47	0.26	0.35	0.89
Control Delay	46.3	79.7	38.7	60.1	47.8	7.8	25.7	11.0	18.3	32.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	46.3	79.7	38.7	60.1	47.8	7.8	25.7	11.0	18.3	32.7
LOS	D	E	D	E	D	A	C	B	B	C
Approach Delay		62.2			42.1			12.4		31.5
Approach LOS		E			D			B		C

Intersection Summary

Cycle Length: 140  
 Actuated Cycle Length: 140  
 Offset: 107 (76%), Referenced to phase 2:SBTL, Start of Green  
 Natural Cycle: 125  
 Control Type: Actuated-Coordinated  
 Maximum v/c Ratio: 0.90  
 Intersection Signal Delay: 34.9  
 Intersection Capacity Utilization 95.5%  
 Analysis Period (min) 15  
 Intersection LOS: C  
 ICU Level of Service F

Splits and Phases: 12: Dixie Road & Howden Blvd



HCM Signalized Intersection Capacity Analysis  
12: Dixie Road & Howden Blvd

<Future - Redistributed Volumes>AM  
06-09-2020

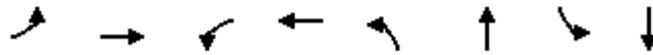
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	318	219	100	239	92	52	413	76	157	1701	19
Future Volume (vph)	29	318	219	100	239	92	52	413	76	157	1701	19
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.7	3.5	3.7	3.7
Total Lost time (s)	6.8	6.8	6.8	3.0	6.8	6.8	3.0	6.1		6.1	6.1	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.96	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98		1.00	1.00	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1785	1828	1504	1765	1760	1551	1785	3214		1715	3514	
Flt Permitted	0.58	1.00	1.00	0.17	1.00	1.00	0.05	1.00		0.46	1.00	
Satd. Flow (perm)	1084	1828	1504	324	1760	1551	89	3214		825	3514	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	31	342	235	108	257	99	56	444	82	169	1829	20
RTOR Reduction (vph)	0	0	68	0	0	72	0	11	0	0	0	0
Lane Group Flow (vph)	31	342	167	108	257	27	56	515	0	169	1849	0
Confl. Peds. (#/hr)			20	20			14		1	1		14
Heavy Vehicles (%)	0%	3%	2%	1%	7%	3%	0%	9%	6%	4%	2%	0%
Bus Blockages (#/hr)	0	5	0	0	5	0	0	9	0	0	8	0
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		Perm	NA	
Protected Phases		8		7	4		1	6			2	
Permitted Phases	8		8	4		4	6			2		
Actuated Green, G (s)	29.3	29.3	29.3	38.3	38.3	38.3	88.8	88.8		81.8	81.8	
Effective Green, g (s)	29.3	29.3	29.3	38.3	38.3	38.3	88.8	88.8		81.8	81.8	
Actuated g/C Ratio	0.21	0.21	0.21	0.27	0.27	0.27	0.63	0.63		0.58	0.58	
Clearance Time (s)	6.8	6.8	6.8	3.0	6.8	6.8	3.0	6.1		6.1	6.1	
Vehicle Extension (s)	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	226	382	314	150	481	424	104	2038		482	2053	
v/s Ratio Prot		c0.19		c0.03	0.15		c0.02	0.16			c0.53	
v/s Ratio Perm	0.03		0.11	0.17		0.02	0.32			0.20		
v/c Ratio	0.14	0.90	0.53	0.72	0.53	0.06	0.54	0.25		0.35	0.90	
Uniform Delay, d1	45.1	53.9	49.2	43.0	43.3	37.6	27.5	11.2		15.2	25.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.6	23.8	3.1	15.2	2.1	0.1	5.3	0.3		2.0	6.9	
Delay (s)	45.6	77.6	52.4	58.3	45.3	37.7	32.8	11.4		17.2	32.4	
Level of Service	D	E	D	E	D	D	C	B		B	C	
Approach Delay (s)		66.2			46.7			13.5			31.1	
Approach LOS		E			D			B			C	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			36.1								HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio			0.88									
Actuated Cycle Length (s)			140.0								Sum of lost time (s)	18.9
Intersection Capacity Utilization			95.5%								ICU Level of Service	F
Analysis Period (min)			15									

c Critical Lane Group

Timings  
10: Vodden Street East & Howden Blvd

<Future - Redistributed Volumes>PM

06-11-2020

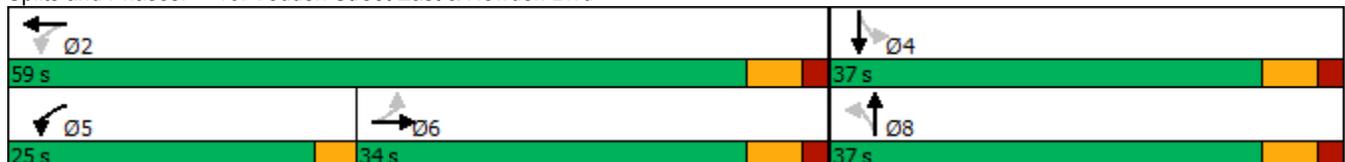


Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↗	↖	↗
Traffic Volume (vph)	8	176	442	306	391	9	2	3
Future Volume (vph)	8	176	442	306	391	9	2	3
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		6	5	2		8		4
Permitted Phases	6		2		8		4	
Detector Phase	6	6	5	2	8	8	4	4
Switch Phase								
Minimum Initial (s)	8.0	8.0	6.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	24.0	24.0	9.0	24.0	27.0	27.0	27.0	27.0
Total Split (s)	34.0	34.0	25.0	59.0	37.0	37.0	37.0	37.0
Total Split (%)	35.4%	35.4%	26.0%	61.5%	38.5%	38.5%	38.5%	38.5%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	Max	Max	None	Max	None	None	None	None
Act Effct Green (s)	29.7	29.7	56.1	53.1	29.5	29.5	29.5	29.5
Actuated g/C Ratio	0.31	0.31	0.59	0.56	0.31	0.31	0.31	0.31
v/c Ratio	0.02	0.82	0.88	0.29	0.89	0.40	0.01	0.01
Control Delay	24.8	38.9	38.0	12.2	55.8	5.5	22.5	20.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.8	38.9	38.0	12.2	55.8	5.5	22.5	20.2
LOS	C	D	D	B	E	A	C	C
Approach Delay		38.7		27.5		35.1		21.0
Approach LOS		D		C		D		C

Intersection Summary

Cycle Length: 96	
Actuated Cycle Length: 94.6	
Natural Cycle: 90	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.89	
Intersection Signal Delay: 33.0	Intersection LOS: C
Intersection Capacity Utilization 94.4%	ICU Level of Service F
Analysis Period (min) 15	

Splits and Phases: 10: Vodden Street East & Howden Blvd



HCM Signalized Intersection Capacity Analysis  
10: Vodden Street East & Howden Blvd

<Future - Redistributed Volumes>PM  
06-11-2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗		↖	↗		↖	↗	
Traffic Volume (vph)	8	176	307	442	306	0	391	9	264	2	3	1
Future Volume (vph)	8	176	307	442	306	0	391	9	264	2	3	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.7	3.5	3.7	3.7	3.5	3.7	3.7	3.5	3.7	3.7
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frbp, ped/bikes	1.00	0.98		1.00	1.00		1.00	0.97		1.00	0.99	
Flpb, ped/bikes	0.99	1.00		1.00	1.00		0.99	1.00		1.00	1.00	
Frt	1.00	0.90		1.00	1.00		1.00	0.85		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1767	1665		1767	1861		1765	1585		1778	1835	
Flt Permitted	0.57	1.00		0.18	1.00		0.76	1.00		0.48	1.00	
Satd. Flow (perm)	1067	1665		330	1861		1403	1585		895	1835	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	8	176	307	442	306	0	391	9	264	2	3	1
RTOR Reduction (vph)	0	63	0	0	0	0	0	182	0	0	1	0
Lane Group Flow (vph)	8	420	0	442	306	0	391	91	0	2	3	0
Confl. Peds. (#/hr)	6		2	2		6	5		3	3		5
Heavy Vehicles (%)	0%	4%	0%	1%	2%	2%	0%	0%	1%	0%	0%	0%
Bus Blockages (#/hr)	0	3	0	0	3	0	0	0	0	0	0	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		6		5	2			8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	29.7	29.7		53.1	53.1		29.5	29.5		29.5	29.5	
Effective Green, g (s)	29.7	29.7		53.1	53.1		29.5	29.5		29.5	29.5	
Actuated g/C Ratio	0.31	0.31		0.56	0.56		0.31	0.31		0.31	0.31	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	5.0	5.0		3.0	5.0		5.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	334	522		495	1044		437	494		279	572	
v/s Ratio Prot		0.25		c0.19	0.16			0.06			0.00	
v/s Ratio Perm	0.01			c0.31			c0.28			0.00		
v/c Ratio	0.02	0.80		0.89	0.29		0.89	0.18		0.01	0.01	
Uniform Delay, d1	22.4	29.8		21.2	10.9		31.1	23.8		22.4	22.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	12.4		18.2	0.7		21.4	0.4		0.0	0.0	
Delay (s)	22.6	42.2		39.4	11.6		52.5	24.1		22.5	22.4	
Level of Service	C	D		D	B		D	C		C	C	
Approach Delay (s)		41.9			28.0			40.8			22.5	
Approach LOS		D			C			D			C	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			36.0				HCM 2000 Level of Service			D		
HCM 2000 Volume to Capacity ratio			0.92									
Actuated Cycle Length (s)			94.6				Sum of lost time (s)		15.0			
Intersection Capacity Utilization			94.4%				ICU Level of Service		F			
Analysis Period (min)			15									

c Critical Lane Group

Timings  
11: Howden Blvd/N Park Drive & Willams Parkway

<Future - Redistributed Volumes>PM

06-11-2020

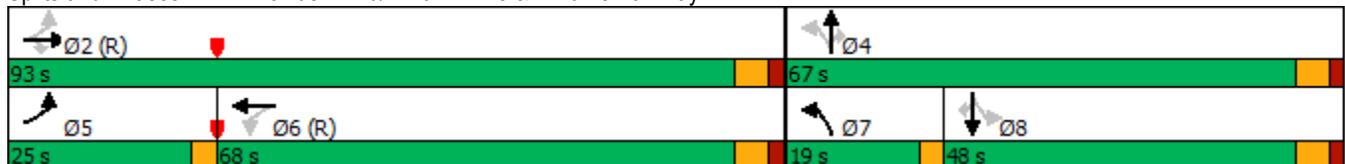
Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Traffic Volume (vph)	199	723	208	101	1235	228	430	107	28	305	381
Future Volume (vph)	199	723	208	101	1235	228	430	107	28	305	381
Turn Type	pm+pt	NA	Perm	Perm	NA	pm+pt	NA	Perm	Perm	NA	Perm
Protected Phases	5	2			6	7	4			8	
Permitted Phases	2		2	6		4		4	8		8
Detector Phase	5	2	2	6	6	7	4	4	8	8	8
Switch Phase											
Minimum Initial (s)	6.0	8.0	8.0	8.0	8.0	6.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	9.0	43.0	43.0	43.0	43.0	9.0	48.0	48.0	48.0	48.0	48.0
Total Split (s)	25.0	93.0	93.0	68.0	68.0	19.0	67.0	67.0	48.0	48.0	48.0
Total Split (%)	15.6%	58.1%	58.1%	42.5%	42.5%	11.9%	41.9%	41.9%	30.0%	30.0%	30.0%
Yellow Time (s)	3.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	0.0	2.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lead			Lag	Lag	Lead			Lag	Lag	Lag
Lead-Lag Optimize?											
Recall Mode	None	C-Max	C-Max	C-Max	C-Max	None	None	None	None	None	None
Act Effct Green (s)	94.8	91.8	91.8	71.2	71.2	59.2	56.2	56.2	37.2	37.2	37.2
Actuated g/C Ratio	0.59	0.57	0.57	0.44	0.44	0.37	0.35	0.35	0.23	0.23	0.23
v/c Ratio	0.89	0.39	0.23	0.37	0.85	0.86	0.70	0.19	0.20	0.76	0.88
Control Delay	79.9	20.0	10.5	37.5	47.2	65.3	50.4	14.6	50.7	68.5	58.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	79.9	20.0	10.5	37.5	47.2	65.3	50.4	14.6	50.7	68.5	58.0
LOS	E	C	B	D	D	E	D	B	D	E	E
Approach Delay		28.8			46.5		49.8			62.2	
Approach LOS		C			D		D			E	

Intersection Summary

Cycle Length: 160  
 Actuated Cycle Length: 160  
 Offset: 7 (4%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green  
 Natural Cycle: 110  
 Control Type: Actuated-Coordinated  
 Maximum v/c Ratio: 0.89  
 Intersection Signal Delay: 44.9  
 Intersection Capacity Utilization 93.7%  
 Analysis Period (min) 15

Intersection LOS: D  
 ICU Level of Service F

Splits and Phases: 11: Howden Blvd/N Park Drive & Willams Parkway



HCM Signalized Intersection Capacity Analysis  
 11: Howden Blvd/N Park Drive & Willams Parkway

<Future - Redistributed Volumes>PM  
 06-11-2020

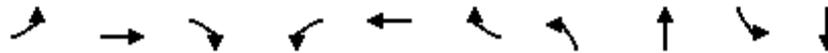
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	199	723	208	101	1235	27	228	430	107	28	305	381
Future Volume (vph)	199	723	208	101	1235	27	228	430	107	28	305	381
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.7	3.5	3.7	3.7	3.5	3.7	3.5	3.5	3.7	3.5
Total Lost time (s)	3.0	6.0	6.0	6.0	6.0		3.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1767	3550	1633	1785	3601		1784	1902	1581	1785	1883	1542
Flt Permitted	0.05	1.00	1.00	0.35	1.00		0.22	1.00	1.00	0.34	1.00	1.00
Satd. Flow (perm)	100	3550	1633	666	3601		404	1902	1581	646	1883	1542
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	216	786	226	110	1342	29	248	467	116	30	332	414
RTOR Reduction (vph)	0	0	42	0	1	0	0	0	46	0	0	112
Lane Group Flow (vph)	216	786	184	110	1370	0	248	467	70	30	332	302
Confl. Peds. (#/hr)	4					4	3					3
Heavy Vehicles (%)	1%	2%	0%	0%	1%	0%	0%	1%	1%	0%	2%	2%
Bus Blockages (#/hr)	0	4	0	0	0	0	0	0	0	0	0	0
Turn Type	pm+pt	NA	Perm	Perm	NA		pm+pt	NA	Perm	Perm	NA	Perm
Protected Phases	5	2			6		7	4			8	
Permitted Phases	2		2	6			4		4	8		8
Actuated Green, G (s)	91.8	91.8	91.8	71.2	71.2		56.2	56.2	56.2	37.2	37.2	37.2
Effective Green, g (s)	91.8	91.8	91.8	71.2	71.2		56.2	56.2	56.2	37.2	37.2	37.2
Actuated g/C Ratio	0.57	0.57	0.57	0.45	0.45		0.35	0.35	0.35	0.23	0.23	0.23
Clearance Time (s)	3.0	6.0	6.0	6.0	6.0		3.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	5.0	5.0	5.0	5.0		3.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	240	2036	936	296	1602		279	668	555	150	437	358
v/s Ratio Prot	c0.10	0.22			0.38		c0.09	0.25			0.18	
v/s Ratio Perm	c0.41		0.11	0.17			c0.22		0.04	0.05		0.20
v/c Ratio	0.90	0.39	0.20	0.37	0.86		0.89	0.70	0.13	0.20	0.76	0.84
Uniform Delay, d1	51.8	18.7	16.4	29.5	39.8		42.6	44.6	35.2	49.4	57.2	58.6
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	32.8	0.6	0.5	3.6	6.1		27.1	4.1	0.2	1.4	8.8	17.9
Delay (s)	84.6	19.2	16.9	33.1	45.8		69.6	48.7	35.4	50.8	66.0	76.5
Level of Service	F	B	B	C	D		E	D	D	D	E	E
Approach Delay (s)		30.3			44.9			53.1			71.0	
Approach LOS		C			D			D			E	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			47.0			HCM 2000 Level of Service				D		
HCM 2000 Volume to Capacity ratio			0.93									
Actuated Cycle Length (s)			160.0			Sum of lost time (s)			18.0			
Intersection Capacity Utilization			93.7%			ICU Level of Service			F			
Analysis Period (min)			15									

c Critical Lane Group

Timings  
12: Dixie Road & Howden Blvd

<Future - Redistributed Volumes>PM

06-11-2020



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↖	↗	↖	↖	↕	↖	↕
Traffic Volume (vph)	38	230	164	79	454	86	342	1630	48	578
Future Volume (vph)	38	230	164	79	454	86	342	1630	48	578
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	NA
Protected Phases		8		7	4		1	6		2
Permitted Phases	8		8	4		4	6		2	
Detector Phase	8	8	8	7	4	4	1	6	2	2
Switch Phase										
Minimum Initial (s)	8.0	8.0	8.0	5.0	8.0	8.0	5.0	8.0	8.0	8.0
Minimum Split (s)	36.8	36.8	36.8	8.0	36.8	36.8	8.0	40.1	40.1	40.1
Total Split (s)	38.0	38.0	38.0	9.0	47.0	47.0	20.0	88.0	68.0	68.0
Total Split (%)	28.1%	28.1%	28.1%	6.7%	34.8%	34.8%	14.8%	65.2%	50.4%	50.4%
Yellow Time (s)	4.0	4.0	4.0	3.0	4.0	4.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.8	2.8	2.8	0.0	2.8	2.8	0.0	2.1	2.1	2.1
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.8	6.8	6.8	3.0	6.8	6.8	3.0	6.1	6.1	6.1
Lead/Lag	Lag	Lag	Lag	Lead			Lead		Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes			Yes		Yes	Yes
Recall Mode	None	Max	C-Max	C-Max						
Act Effct Green (s)	29.1	29.1	29.1	41.9	38.1	38.1	87.1	84.0	65.5	65.5
Actuated g/C Ratio	0.22	0.22	0.22	0.31	0.28	0.28	0.65	0.62	0.49	0.49
v/c Ratio	0.51	0.60	0.36	0.31	0.89	0.19	0.66	0.83	0.84	0.38
Control Delay	69.5	54.2	8.3	36.2	66.5	18.2	17.5	24.5	116.4	23.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	69.5	54.2	8.3	36.2	66.5	18.2	17.5	24.5	116.4	23.3
LOS	E	D	A	D	E	B	B	C	F	C
Approach Delay		38.1			55.9			23.4		30.0
Approach LOS		D			E			C		C

Intersection Summary

Cycle Length: 135

Actuated Cycle Length: 135

Offset: 32 (24%), Referenced to phase 2:SBTL, Start of Green

Natural Cycle: 105

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.89

Intersection Signal Delay: 31.5

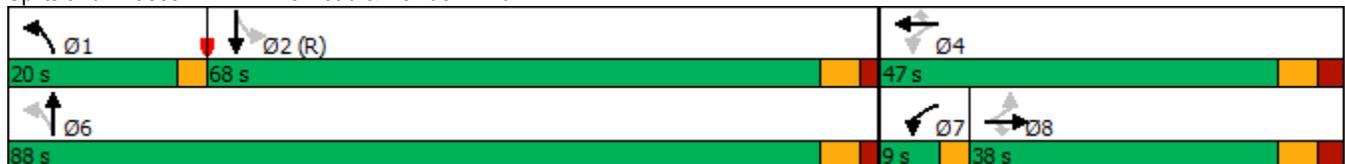
Intersection LOS: C

Intersection Capacity Utilization 108.1%

ICU Level of Service G

Analysis Period (min) 15

Splits and Phases: 12: Dixie Road & Howden Blvd



HCM Signalized Intersection Capacity Analysis  
12: Dixie Road & Howden Blvd

<Future - Redistributed Volumes>PM

06-11-2020

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	38	230	164	79	454	86	342	1630	126	48	578	35
Future Volume (vph)	38	230	164	79	454	86	342	1630	126	48	578	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.7	3.5	3.7	3.7
Total Lost time (s)	6.8	6.8	6.8	3.0	6.8	6.8	3.0	6.1		6.1	6.1	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1777	1828	1548	1747	1846	1559	1746	3475		1732	3416	
Flt Permitted	0.19	1.00	1.00	0.38	1.00	1.00	0.34	1.00		0.07	1.00	
Satd. Flow (perm)	362	1828	1548	701	1846	1559	623	3475		122	3416	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	39	235	167	81	463	88	349	1663	129	49	590	36
RTOR Reduction (vph)	0	0	131	0	0	35	0	4	0	0	3	0
Lane Group Flow (vph)	39	235	36	81	463	53	349	1788	0	49	623	0
Confl. Peds. (#/hr)	9		7	7		9	11		7	7		11
Heavy Vehicles (%)	0%	3%	1%	2%	2%	0%	2%	2%	2%	3%	4%	0%
Bus Blockages (#/hr)	0	5	0	0	5	0	0	8	0	0	9	0
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		Perm	NA	
Protected Phases		8		7	4		1	6			2	
Permitted Phases	8		8	4		4	6			2		
Actuated Green, G (s)	29.1	29.1	29.1	38.1	38.1	38.1	84.0	84.0		65.4	65.4	
Effective Green, g (s)	29.1	29.1	29.1	38.1	38.1	38.1	84.0	84.0		65.4	65.4	
Actuated g/C Ratio	0.22	0.22	0.22	0.28	0.28	0.28	0.62	0.62		0.48	0.48	
Clearance Time (s)	6.8	6.8	6.8	3.0	6.8	6.8	3.0	6.1		6.1	6.1	
Vehicle Extension (s)	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	78	394	333	244	520	439	517	2162		59	1654	
v/s Ratio Prot		0.13		0.01	c0.25		0.08	c0.51			0.18	
v/s Ratio Perm	0.11		0.02	0.08		0.03	0.34			0.40		
v/c Ratio	0.50	0.60	0.11	0.33	0.89	0.12	0.68	0.83		0.83	0.38	
Uniform Delay, d1	46.6	47.7	42.5	37.1	46.4	36.0	13.1	19.8		30.0	21.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	10.2	3.6	0.3	0.8	18.2	0.3	3.5	3.8		75.2	0.7	
Delay (s)	56.7	51.3	42.8	37.9	64.7	36.3	16.6	23.6		105.3	22.6	
Level of Service	E	D	D	D	E	D	B	C		F	C	
Approach Delay (s)		48.6			57.3			22.5			28.6	
Approach LOS		D			E			C			C	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			32.2	HCM 2000 Level of Service						C		
HCM 2000 Volume to Capacity ratio			0.89									
Actuated Cycle Length (s)			135.0	Sum of lost time (s)						18.9		
Intersection Capacity Utilization			108.1%	ICU Level of Service						G		
Analysis Period (min)			15									

c Critical Lane Group