APPENDIX E

Capacity Analysis Outputs – Future Conditions (Without Build-Out of CEBP)

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: No Energy Park Scenario (140,000 tpy)
East/West Street: Hwy 401 on-off ramps
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	33	138		237	342	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	33	138		237	342	
Percent Heavy Vehicles	25	--	--	--	--	
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1		1	0	
Configuration	LT				TR	
Upstream Signal?		No		No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	35		228			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	35		228			
Percent Heavy Vehicles	15		7			
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			Yes /2			/
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	33			263				
C(m) (vph)	891			1035				
v/c	0.04			0.25				
95% queue length	0.12			1.02				
Control Delay	9.2			10.9				
LOS	A			B				
Approach Delay				10.9				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
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TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: No Energy Park Scenario (140,000 tpy)
East/West Street: Hwy 401 on-off ramps
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	33	138			237	342
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	8	34			59	86
Hourly Flow Rate, HFR	33	138			237	342
Percent Heavy Vehicles	25	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	35		228			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	9		57			
Hourly Flow Rate, HFR	35		228			
Percent Heavy Vehicles	15		7			
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			Yes /2			/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	138	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	25		15		7			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.3		6.5		6.3			
2-stage								

Follow-Up Time Calculations Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	25		15		7			
t(f)	2.4		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	579		612		138			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s	1500							
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	138	
Potential Capacity	897	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	897	
Probability of Queue free St.	0.75	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		579
Potential Capacity		891
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		891
Probability of Queue free St.	1.00	0.96
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96

Movement Capacity			
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Conflicting Flows	612		
Potential Capacity	436		
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor			0.96
Maj. L, Min T Adj. Imp Factor.			0.97
Cap. Adj. factor due to Impeding mvmnt	0.96		0.72
Movement Capacity	420		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8		11
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Probability of Queue free St.			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor	1.00		1.00
Cap. Adj. factor due to Impeding mvmnt	0.96		0.96
Movement Capacity			
Result for 2 stage process:			
a			
y			
C t			
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	612		
Potential Capacity	436		
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor			0.96
Maj. L, Min T Adj. Imp Factor.			0.97
Cap. Adj. factor due to Impeding mvmnt	0.96		0.72
Movement Capacity	420		
Results for Two-stage process:			
a			
y			
C t	420		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	35		228			
Movement Capacity (vph)	420		897			
Shared Lane Capacity (vph)		779				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	420		897			
Volume	35		228			
Delay	14.4		10.4			
Q sep	0.14		0.66			
Q sep +1	1.14		1.66			
round (Qsep +1)	1		2			
n max		2				
C sh		779				
SUM C sep		1035				
n		2				
C act		1035				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	33			263				
C(m) (vph)	891			1035				
v/c	0.04			0.25				
95% queue length	0.12			1.02				
Control Delay	9.2			10.9				
LOS	A			B				
Approach Delay				10.9				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.96	1.00
v(il), Volume for stream 2 or 5	138	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	9.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

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TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: Without Energy Park (140,000 tpy)
East/West Street: Hwy 401 E-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	63	691		220	149	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	63	691		220	149	
Percent Heavy Vehicles	25	--	--	--	--	
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1		1	0	
Configuration	LT				TR	
Upstream Signal?		No		No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	17		232			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	17		232			
Percent Heavy Vehicles	42		4			
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			Yes	/2		/
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	63			249				
C(m) (vph)	1074			473				
v/c	0.06			0.53				
95% queue length	0.19			3.24				
Control Delay	8.6			22.4				
LOS	A			C				
Approach Delay				22.4				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.2

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TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: Without Energy Park (140,000 tpy)
East/West Street: Hwy 401 E-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	63	691			220	149
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	16	173			55	37
Hourly Flow Rate, HFR	63	691			220	149
Percent Heavy Vehicles	25	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	17		232			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		58			
Hourly Flow Rate, HFR	17		232			
Percent Heavy Vehicles	42		4			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			Yes	/2		/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	691	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	25		42		4			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.3		6.8		6.2			
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	25		42		4			
t(f)	2.4		3.9		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	369		1111		691			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s	1500							
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	691	
Potential Capacity	441	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	441	
Probability of Queue free St.	0.47	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		369
Potential Capacity		1074
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1074
Probability of Queue free St.	1.00	0.94
Maj L-Shared Prob Q free St.		0.90

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90

Movement Capacity			
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Conflicting Flows	1111		
Potential Capacity	194		
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor			0.90
Maj. L, Min T Adj. Imp Factor.			0.92
Cap. Adj. factor due to Impeding mvmnt	0.94		0.44
Movement Capacity	183		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8		11
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Probability of Queue free St.			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor	1.00		1.00
Cap. Adj. factor due to Impeding mvmnt	0.90		0.90
Movement Capacity			
Result for 2 stage process:			
a			
y			
C t			
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1111		
Potential Capacity	194		
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor			0.90
Maj. L, Min T Adj. Imp Factor.			0.92
Cap. Adj. factor due to Impeding mvmnt	0.94		0.44
Movement Capacity	183		
Results for Two-stage process:			
a			
y			
C t	183		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	17		232			
Movement Capacity (vph)	183		441			
Shared Lane Capacity (vph)		402				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	183		441			
Volume	17		232			
Delay	26.7		22.1			
Q sep	0.13		1.43			
Q sep +1	1.13		2.43			
round (Qsep +1)	1		2			
n max		2				
C sh		402				
SUM C sep		473				
n		2				
C act		473				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	63			249				
C(m) (vph)	1074			473				
v/c	0.06			0.53				
95% queue length	0.19			3.24				
Control Delay	8.6			22.4				
LOS	A			C				
Approach Delay				22.4				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.94	1.00
v(il), Volume for stream 2 or 5	691	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.90	
d(M,LT), Delay for stream 1 or 4	8.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.8	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	01/05/2009
Analysis Time Period:	AM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	2013
Project ID:	No Energy Park Scenario (140,000 tpy)
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	3	11	3	87	15	172
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	3	11	3	87	15	172
Percent Heavy Vehicles	0	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	3	27	133	97	12
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	4	3	27	133	97	12
Percent Heavy Vehicles	17	5	25	8	10	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes	0	1	1	0	2	0
Configuration	LT	R		LT		TR

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	LT		TR
v (vph)	3	87	7		27	181		60
C(m) (vph)	1399	1467	495		1005	666		688
v/c	0.00	0.06	0.01		0.03	0.27		0.09
95% queue length	0.01	0.19	0.04		0.08	1.11		0.29
Control Delay	7.6	7.6	12.4		8.7	12.4		10.7
LOS	A	A	B		A	B		B
Approach Delay				9.4			12.0	
Approach LOS				A			B	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	01/05/2009
Analysis Time Period:	AM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	2013
Project ID:	No Energy Park Scenario (140,000 tpy)
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	3	11	3	87	15	172
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	1	3	1	22	4	43
Hourly Flow Rate, HFR	3	11	3	87	15	172
Percent Heavy Vehicles	0	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	3	27	133	97	12
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	1	1	7	33	24	3
Hourly Flow Rate, HFR	4	3	27	133	97	12
Percent Heavy Vehicles	17	5	25	8	10	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized			Yes			
Lanes	0	1	1	0	2	0
Configuration	LT		R	LT		TR

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (m)	3.6	3.6	3.6	3.6
Walking Speed (m/sec)	1.2	1.2	1.2	1.2
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed kph	Distance to Signal meters
S2	Left-Turn						
	Through						
S5	Left-Turn						
	Through						

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	11	15
Shared ln volume, major rt vehicles:	3	0
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1700	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0	25	17	5	25	8	10	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.3	7.3	6.6	6.4	7.2	6.6	6.2
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	25	17	5	25	8	10	0
t(f)	2.2	2.4	3.7	4.0	3.5	3.6	4.1	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	187	14	348	379	12	209	209	15
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	12	15
Potential Capacity	1005	1070
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1005	1070
Probability of Queue free St.	0.97	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	14	187
Potential Capacity	1467	1399
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1467	1399
Probability of Queue free St.	0.94	1.00
Maj L-Shared Prob Q free St.	0.94	1.00

Step 3: TH from Minor St.	8	11
Conflicting Flows	379	209
Potential Capacity	548	674
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94

Movement Capacity	514	632
Probability of Queue free St.	0.99	0.85
Step 4: LT from Minor St.	7	10
Conflicting Flows	348	209
Potential Capacity	579	736
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.79	0.93
Maj. L, Min T Adj. Imp Factor.	0.84	0.95
Cap. Adj. factor due to Impeding mvmnt	0.83	0.92
Movement Capacity	482	679

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	379	209
Potential Capacity	548	674
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	514	632
Result for 2 stage process:		
a		
y		
C t	514	632
Probability of Queue free St.	0.99	0.85
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	348	209
Potential Capacity	579	736
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.79	0.93
Maj. L, Min T Adj. Imp Factor.	0.84	0.95
Cap. Adj. factor due to Impeding mvmnt	0.83	0.92
Movement Capacity	482	679
Results for Two-stage process:		
a		
y		
C t	482	679

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	3	27	133	97	12
Movement Capacity (vph)	482	514	1005	679	632	1070
Shared Lane Capacity (vph)	495			666		688

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	482	514	1005	679	632	1070
Volume	4	3	27	133	97	12
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	495			666		688
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	LT		TR
v (vph)	3	87	7		27	181		60
C(m) (vph)	1399	1467	495		1005	666		688
v/c	0.00	0.06	0.01		0.03	0.27		0.09
95% queue length	0.01	0.19	0.04		0.08	1.11		0.29
Control Delay	7.6	7.6	12.4		8.7	12.4		10.7
LOS	A	A	B		A	B		B
Approach Delay				9.4			12.0	
Approach LOS				A			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.94
v(il), Volume for stream 2 or 5	11	15
v(i2), Volume for stream 3 or 6	3	0
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1700	1800
P*(oj)	1.00	0.94
d(M,LT), Delay for stream 1 or 4	7.6	7.6
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.5

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	06/25/2007
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	2013
Project ID:	No Energy Park Scenario (140,000 tpy)
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	12	4	33	15	189
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	4	12	4	33	15	189
Percent Heavy Vehicles	0	--	--	10	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	13	78	662	42	7
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	1	13	78	662	42	7
Percent Heavy Vehicles	0	25	0	3	25	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes	0	1	1	1	1	0
Configuration	LT	R		L		TR

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	L		TR
v (vph)	4	33	14		78	662		49
C(m) (vph)	1380	1551	575		1072	775		761
v/c	0.00	0.02	0.02		0.07	0.85		0.06
95% queue length	0.01	0.07	0.07		0.24	14.07		0.21
Control Delay	7.6	7.4	11.4		8.6	34.5		10.1
LOS	A	A	B		A	D		B
Approach Delay				9.0			32.8	
Approach LOS				A			D	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	06/25/2007
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	2013
Project ID:	No Energy Park Scenario (140,000 tpy)
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	12	4	33	15	189
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	1	3	1	8	4	47
Hourly Flow Rate, HFR	4	12	4	33	15	189
Percent Heavy Vehicles	0	--	--	10	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	13	78	662	42	7
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	0	3	20	166	10	2
Hourly Flow Rate, HFR	1	13	78	662	42	7
Percent Heavy Vehicles	0	25	0	3	25	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized			Yes			
Lanes	0	1	1	1	1	0
Configuration	LT		R	L		TR

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (m)	3.6	3.6	3.6	3.6
Walking Speed (m/sec)	1.2	1.2	1.2	1.2
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed kph	Distance to Signal meters
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	12	15
Shared ln volume, major rt vehicles:	4	0
Sat flow rate, major th vehicles:	1700	1700
Sat flow rate, major rt vehicles:	1700	1700
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0	10	0	25	0	3	25	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.2	7.1	6.8	6.2	7.1	6.8	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	10	0	25	0	3	25	0
t(f)	2.2	2.3	3.5	4.2	3.3	3.5	4.2	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)

	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	204	16	222	292	14	109	105	15
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	14	15
Potential Capacity	1072	1070
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1072	1070
Probability of Queue free St.	0.93	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	16	204
Potential Capacity	1551	1380
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1551	1380
Probability of Queue free St.	0.98	1.00
Maj L-Shared Prob Q free St.	0.98	1.00

Step 3: TH from Minor St.	8	11
Conflicting Flows	292	105
Potential Capacity	582	744
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98

Movement Capacity	568	726
Probability of Queue free St.	0.98	0.94
Step 4: LT from Minor St.	7	10
Conflicting Flows	222	109
Potential Capacity	738	867
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.95
Maj. L, Min T Adj. Imp Factor.	0.94	0.96
Cap. Adj. factor due to Impeding mvmnt	0.93	0.89
Movement Capacity	688	775

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	292	105
Potential Capacity	582	744
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	568	726
Result for 2 stage process:		
a		
y		
C t	568	726
Probability of Queue free St.	0.98	0.94
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	222	109
Potential Capacity	738	867
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.95
Maj. L, Min T Adj. Imp Factor.	0.94	0.96
Cap. Adj. factor due to Impeding mvmnt	0.93	0.89
Movement Capacity	688	775
Results for Two-stage process:		
a		
y		
C t	688	775

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	13	78	662	42	7
Movement Capacity (vph)	688	568	1072	775	726	1070
Shared Lane Capacity (vph)	575					761

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	688	568	1072	775	726	1070
Volume	1	13	78	662	42	7
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	575					761
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	L		TR
v (vph)	4	33	14		78	662		49
C(m) (vph)	1380	1551	575		1072	775		761
v/c	0.00	0.02	0.02		0.07	0.85		0.06
95% queue length	0.01	0.07	0.07		0.24	14.07		0.21
Control Delay	7.6	7.4	11.4		8.6	34.5		10.1
LOS	A	A	B		A	D		B
Approach Delay				9.0			32.8	
Approach LOS				A			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5	12	15
v(i2), Volume for stream 3 or 6	4	0
s(il), Saturation flow rate for stream 2 or 5	1700	1700
s(i2), Saturation flow rate for stream 3 or 6	1700	1700
P*(oj)	1.00	0.98
d(M,LT), Delay for stream 1 or 4	7.6	7.4
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.2

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TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: No Energy Park Scenario (250,000 tpy)
East/West Street: Hwy 401 on-off ramps
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	37	138		238	342	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	37	138		238	342	
Percent Heavy Vehicles	25	--	--	--	--	
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1		1	0	
Configuration	LT				TR	
Upstream Signal?		No		No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	36		228			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	36		228			
Percent Heavy Vehicles	15		7			
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			Yes	/2		/
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	37			264				
C(m) (vph)	890			1039				
v/c	0.04			0.25				
95% queue length	0.13			1.02				
Control Delay	9.2			10.9				
LOS	A			B				
Approach Delay				10.9				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: No Energy Park Scenario (250,000 tpy)
East/West Street: Hwy 401 on-off ramps
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	37	138			238	342
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	9	34			60	86
Hourly Flow Rate, HFR	37	138			238	342
Percent Heavy Vehicles	25	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	36		228			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	9		57			
Hourly Flow Rate, HFR	36		228			
Percent Heavy Vehicles	15		7			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			Yes	/2		/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	138	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	25		15		7			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.3		6.5		6.3			
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	25		15		7			
t(f)	2.4		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	580		621		138			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s	1500							
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	138	
Potential Capacity	897	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	897	
Probability of Queue free St.	0.75	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		580
Potential Capacity		890
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		890
Probability of Queue free St.	1.00	0.96
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95

Movement Capacity			
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Conflicting Flows	621		
Potential Capacity	431		
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor			0.95
Maj. L, Min T Adj. Imp Factor.			0.97
Cap. Adj. factor due to Impeding mvmnt	0.96		0.72
Movement Capacity	413		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8		11
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Probability of Queue free St.			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor	1.00		1.00
Cap. Adj. factor due to Impeding mvmnt	0.95		0.95
Movement Capacity			
Result for 2 stage process:			
a			
y			
C t			
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	621		
Potential Capacity	431		
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor			0.95
Maj. L, Min T Adj. Imp Factor.			0.97
Cap. Adj. factor due to Impeding mvmnt	0.96		0.72
Movement Capacity	413		
Results for Two-stage process:			
a			
y			
C t	413		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	36		228			
Movement Capacity (vph)	413		897			
Shared Lane Capacity (vph)		773				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	413		897			
Volume	36		228			
Delay	14.5		10.4			
Q sep	0.15		0.66			
Q sep +1	1.15		1.66			
round (Qsep +1)	1		2			
n max		2				
C sh		773				
SUM C sep		1039				
n		2				
C act		1039				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	37			264				
C(m) (vph)	890			1039				
v/c	0.04			0.25				
95% queue length	0.13			1.02				
Control Delay	9.2			10.9				
LOS	A			B				
Approach Delay				10.9				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.96	1.00
v(il), Volume for stream 2 or 5	138	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	9.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: Without Energy Park (250,000 tpy)
East/West Street: Hwy 401 E-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	66	691		220	149	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	66	691		220	149	
Percent Heavy Vehicles	25	--	--	--	--	
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1		1	0	
Configuration	LT				TR	
Upstream Signal?		No		No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	17		232			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	17		232			
Percent Heavy Vehicles	42		4			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			Yes	/2		/
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	66			249				
C(m) (vph)	1074			473				
v/c	0.06			0.53				
95% queue length	0.20			3.24				
Control Delay	8.6			22.5				
LOS	A			C				
Approach Delay				22.5				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 01/05/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2013
Project ID: Without Energy Park (250,000 tpy)
East/West Street: Hwy 401 E-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	66	691			220	149
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	16	173			55	37
Hourly Flow Rate, HFR	66	691			220	149
Percent Heavy Vehicles	25	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	17		232			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		58			
Hourly Flow Rate, HFR	17		232			
Percent Heavy Vehicles	42		4			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			Yes	/2		/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	691	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	25		42		4			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.3		6.8		6.2			
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	25		42		4			
t(f)	2.4		3.9		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	369		1117		691			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s	1500							
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	691	
Potential Capacity	441	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	441	
Probability of Queue free St.	0.47	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		369
Potential Capacity		1074
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1074
Probability of Queue free St.	1.00	0.94
Maj L-Shared Prob Q free St.		0.90

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	1117	
Potential Capacity	192	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.94	0.44
Movement Capacity	180	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1117	
Potential Capacity	192	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.94	0.44
Movement Capacity	180	
Results for Two-stage process:		
a		
y		
C t	180	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	17		232			
Movement Capacity (vph)	180		441			
Shared Lane Capacity (vph)		401				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	180		441			
Volume	17		232			
Delay	27.1		22.1			
Q sep	0.13		1.43			
Q sep +1	1.13		2.43			
round (Qsep +1)	1		2			
n max		2				
C sh		401				
SUM C sep		473				
n		2				
C act		473				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	66			249				
C(m) (vph)	1074			473				
v/c	0.06			0.53				
95% queue length	0.20			3.24				
Control Delay	8.6			22.5				
LOS	A			C				
Approach Delay				22.5				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.94	1.00
v(il), Volume for stream 2 or 5	691	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.90	
d(M,LT), Delay for stream 1 or 4	8.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.9	

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TWO-WAY STOP CONTROL SUMMARY

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	01/05/2009
Analysis Time Period:	AM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	2013
Project ID:	No Energy Park Scenario (250,000 tpy)
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation: NS	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	3	11	3	88	15	172
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	3	11	3	88	15	172
Percent Heavy Vehicles	0	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	3	31	133	100	12
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	4	3	31	133	100	12
Percent Heavy Vehicles	17	5	25	8	10	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes	0	1	1	0	2	0
Configuration	LT	R		LT		TR

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	LT		TR
v (vph)	3	88	7		31	183		62
C(m) (vph)	1399	1467	492		1005	661		684
v/c	0.00	0.06	0.01		0.03	0.28		0.09
95% queue length	0.01	0.19	0.04		0.10	1.14		0.30
Control Delay	7.6	7.6	12.4		8.7	12.5		10.8
LOS	A	A	B		A	B		B
Approach Delay			9.4			12.1		
Approach LOS			A			B		

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	01/05/2009
Analysis Time Period:	AM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	2013
Project ID:	No Energy Park Scenario (250,000 tpy)
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation: NS	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	3	11	3	88	15	172
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	1	3	1	22	4	43
Hourly Flow Rate, HFR	3	11	3	88	15	172
Percent Heavy Vehicles	0	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	3	31	133	100	12
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	1	1	8	33	25	3
Hourly Flow Rate, HFR	4	3	31	133	100	12
Percent Heavy Vehicles	17	5	25	8	10	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized			Yes			
Lanes	0	1	1	0	2	0
Configuration	LT		R	LT		TR

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (m)	3.6	3.6	3.6	3.6
Walking Speed (m/sec)	1.2	1.2	1.2	1.2
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed kph	Distance to Signal meters
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	11	15
Shared ln volume, major rt vehicles:	3	0
Sat flow rate, major th vehicles:	1700	1700
Sat flow rate, major rt vehicles:	1700	1700
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0	25	17	5	25	8	10	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.3	7.3	6.6	6.4	7.2	6.6	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	25	17	5	25	8	10	0
t(f)	2.2	2.4	3.7	4.0	3.5	3.6	4.1	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)

	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	187	14	351	381	12	211	211	15
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	12	15
Potential Capacity	1005	1070
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1005	1070
Probability of Queue free St.	0.97	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	14	187
Potential Capacity	1467	1399
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1467	1399
Probability of Queue free St.	0.94	1.00
Maj L-Shared Prob Q free St.	0.94	1.00

Step 3: TH from Minor St.	8	11
Conflicting Flows	381	211
Potential Capacity	547	672
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94

Movement Capacity	513	630
Probability of Queue free St.	0.99	0.84
Step 4: LT from Minor St.	7	10
Conflicting Flows	351	211
Potential Capacity	577	733
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.79	0.93
Maj. L, Min T Adj. Imp Factor.	0.84	0.95
Cap. Adj. factor due to Impeding mvmnt	0.83	0.92
Movement Capacity	478	673

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	381	211
Potential Capacity	547	672
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	513	630
Result for 2 stage process:		
a		
y		
C t	513	630
Probability of Queue free St.	0.99	0.84
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	351	211
Potential Capacity	577	733
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.79	0.93
Maj. L, Min T Adj. Imp Factor.	0.84	0.95
Cap. Adj. factor due to Impeding mvmnt	0.83	0.92
Movement Capacity	478	673
Results for Two-stage process:		
a		
y		
C t	478	673

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	3	31	133	100	12
Movement Capacity (vph)	478	513	1005	673	630	1070
Shared Lane Capacity (vph)	492			661		684

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	478	513	1005	673	630	1070
Volume	4	3	31	133	100	12
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	492			661		684
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	LT		TR
v (vph)	3	88	7		31	183		62
C(m) (vph)	1399	1467	492		1005	661		684
v/c	0.00	0.06	0.01		0.03	0.28		0.09
95% queue length	0.01	0.19	0.04		0.10	1.14		0.30
Control Delay	7.6	7.6	12.4		8.7	12.5		10.8
LOS	A	A	B		A	B		B
Approach Delay				9.4			12.1	
Approach LOS				A			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.94
v(il), Volume for stream 2 or 5	11	15
v(i2), Volume for stream 3 or 6	3	0
s(il), Saturation flow rate for stream 2 or 5	1700	1700
s(i2), Saturation flow rate for stream 3 or 6	1700	1700
P*(oj)	1.00	0.94
d(M,LT), Delay for stream 1 or 4	7.6	7.6
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.5

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 06/25/2007
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:
Units: U. S. Metric
Analysis Year: 2013
Project ID: No Energy Park Scenario (250,000 tpy)
East/West Street: Hwy 401 W-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	12	4	33	15	189
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	4	12	4	33	15	189
Percent Heavy Vehicles	0	--	--	10	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	15	83	662	46	7
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	1	15	83	662	46	7
Percent Heavy Vehicles	0	25	0	3	25	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes	0	1	1	1	1	0
Configuration	LT	R		L		TR

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	L		TR
v (vph)	4	33	16		83	662		53
C(m) (vph)	1380	1551	574		1072	767		758
v/c	0.00	0.02	0.03		0.08	0.86		0.07
95% queue length	0.01	0.07	0.09		0.25	14.76		0.23
Control Delay	7.6	7.4	11.5		8.6	36.4		10.1
LOS	A	A	B		A	E		B
Approach Delay			9.1			34.4		
Approach LOS			A			D		

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 06/25/2007
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:
Units: U. S. Metric
Analysis Year: 2013
Project ID: No Energy Park Scenario (250,000 tpy)
East/West Street: Hwy 401 W-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	12	4	33	15	189
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	1	3	1	8	4	47
Hourly Flow Rate, HFR	4	12	4	33	15	189
Percent Heavy Vehicles	0	--	--	10	--	--
Median Type/Storage	Undivided		/			
RT Channelized?					No	
Lanes	0	1	0	0	1	1
Configuration	LTR			LT	R	
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	15	83	662	46	7
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	0	4	21	166	12	2
Hourly Flow Rate, HFR	1	15	83	662	46	7
Percent Heavy Vehicles	0	25	0	3	25	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
RT Channelized			Yes			
Lanes	0	1	1	1	1	0
Configuration	LT		R	L		TR

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (m)	3.6	3.6	3.6	3.6
Walking Speed (m/sec)	1.2	1.2	1.2	1.2
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed kph	Distance to Signal meters
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	12	15
Shared ln volume, major rt vehicles:	4	0
Sat flow rate, major th vehicles:	1900	1900
Sat flow rate, major rt vehicles:	1900	1700
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0	10	0	25	0	3	25	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.2	7.1	6.8	6.2	7.1	6.8	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	10	0	25	0	3	25	0
t(f)	2.2	2.3	3.5	4.2	3.3	3.5	4.2	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)

	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	204	16	224	292	14	111	105	15
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	14	15
Potential Capacity	1072	1070
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1072	1070
Probability of Queue free St.	0.92	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	16	204
Potential Capacity	1551	1380
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1551	1380
Probability of Queue free St.	0.98	1.00
Maj L-Shared Prob Q free St.	0.98	1.00

Step 3: TH from Minor St.	8	11
Conflicting Flows	292	105
Potential Capacity	582	744
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98

Movement Capacity	568	726
Probability of Queue free St.	0.97	0.94
Step 4: LT from Minor St.	7	10
Conflicting Flows	224	111
Potential Capacity	736	865
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.91	0.95
Maj. L, Min T Adj. Imp Factor.	0.93	0.96
Cap. Adj. factor due to Impeding mvmnt	0.93	0.89
Movement Capacity	683	767

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	292	105
Potential Capacity	582	744
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	568	726
Result for 2 stage process:		
a		
y		
C t	568	726
Probability of Queue free St.	0.97	0.94
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	224	111
Potential Capacity	736	865
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.91	0.95
Maj. L, Min T Adj. Imp Factor.	0.93	0.96
Cap. Adj. factor due to Impeding mvmnt	0.93	0.89
Movement Capacity	683	767
Results for Two-stage process:		
a		
y		
C t	683	767

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	15	83	662	46	7
Movement Capacity (vph)	683	568	1072	767	726	1070
Shared Lane Capacity (vph)	574					758

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	683	568	1072	767	726	1070
Volume	1	15	83	662	46	7
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	574					758
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LT	LT		R	L		TR
v (vph)	4	33	16		83	662		53
C(m) (vph)	1380	1551	574		1072	767		758
v/c	0.00	0.02	0.03		0.08	0.86		0.07
95% queue length	0.01	0.07	0.09		0.25	14.76		0.23
Control Delay	7.6	7.4	11.5		8.6	36.4		10.1
LOS	A	A	B		A	E		B
Approach Delay				9.1			34.4	
Approach LOS				A			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5	12	15
v(i2), Volume for stream 3 or 6	4	0
s(il), Saturation flow rate for stream 2 or 5	1900	1900
s(i2), Saturation flow rate for stream 3 or 6	1900	1700
P*(oj)	1.00	0.98
d(M,LT), Delay for stream 1 or 4	7.6	7.4
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.2