REPORT

Traffic Assessment -Technical Study Report

DURHAM YORK
RESIDUAL WASTE EA STUDY

REPORT NO. 1009497

July 22, 2009
Our File No. *33016045*

Stantec (formerly Jacques Whitford Limited)
3430 South Service Road, Unit 203
Burlington, Ontario L7N 3T9

Attention: Mr. David Payne

Dear Mr. Payne:

Re: Traffic Assessment Technical Study Report
Durham/York Thermal Treatment Facility
Municipality of Clarington

URS Canada Inc. is pleased to submit our *Traffic Assessment Technical Study Report* for the Proposed Durham/York Thermal Treatment Facility. This Report documents the transportation impacts and needs for the Site, located southeast of the Highway 401/Courtice Road interchange in the Municipality of Clarington. The study incorporates scenarios with and without traffic associated with the future Clarington Energy Business Park.

If you have any questions regarding the study, please feel free to contact the undersigned at 905-882-4401 Ext. 182.

Yours very truly,

URS CANADA INC.

Ilya Sher, C.E.T.

Senior Transportation Technologist

Traffic Engineering and Systems Planning Group

EXECUTIVE SUMMARY

URS Canada Inc. was retained to undertake a transportation assessment of potential traffic effects associated with Durham and York Regions Proposed Thermal Treatment Facility (the Facility). The Facility will be located south of Highway 401, between Courtice Road and Osborne Road in the Municipality of Clarington.

The purpose of this Report is to assess the traffic effects of the Project on the adjacent road network, identify any road and/or traffic control improvements required as a result of the development both during construction and operations, and forecast future traffic demands based on proposed development in the area including the build-out of the Clarington Energy Business Park (CEBP).

The Facility is expected to be operational by 2013, with construction starting in 2010. Access to and from the Site during construction and operations is expected to be along Courtice Road, South Service Road and Osborne Road. The CEBP traffic is expected to utilize both the Courtice Road/Highway 401 interchange and the Holt Road/Highway 401 interchange, with majority of Site traffic utilizing the former.

Both ramp terminal intersections (Courtice Road/Highway 401) were found to operate acceptably under existing traffic conditions, lane configurations and traffic control. Traffic signals are not warranted at either ramp terminal intersection, and are not expected to be warranted at the time of construction.

Construction of the Facility is expected to generate 44 two-way peak hour trips in the first year, 94 two-way peak hour trips in the second year and up to 122 two-way peak hour trips in the third year. The existing Courtice Road/Highway 401 interchange will accommodate additional traffic associated with construction works. The eastbound left turn at the south ramp terminal intersection is expected to operate at Level of Service (LOS) “E” in the p.m. peak hour. The lower LOS is due to growth in background traffic.

Road/pavement improvements may be required to South Service Road and Osborne Road to accommodate future trucks associated with the construction of the Facility, as well as site-generated trucks once the Facility is operational. Pavement testing along the haul route will be completed by the Region of Durham if the Project is approved to confirm if road reconstruction/pavement improvements are required.

During operations, the Project is expected to generate up to 34 trucks per day in the Base Case scenario with an initial design capacity of 140,000 tonnes per year (tpy) (Base Case), 51 daily truck trips in Alternative Case 1 (250,000 tpy) and 77 daily truck trips in the maximum design capacity of 400,000 tpy (Alternative Case 2). The Facility is expected to generate 18 trucks (inbound and outbound) and 22 cars during the peak hour operating at 140,000 tpy. At 250,000 tpy peak hour traffic is anticipated to be 26 trucks and 22 cars, and at 400,000 tpy peak hour traffic is anticipated to be 40 trucks and 22 cars. No traffic control measures are required on the adjacent road network to accommodate traffic during operations of the Facility.

Partial and full build-out of the future CEBP was used in the analysis under 2013 and 2023 traffic conditions. The future CEBP (excluding traffic generated by the Project) is estimated to generate a total

of 2,100 two-way trips during both a.m. and p.m. peak hours once fully built-out. Traffic associated with a partial build-out of the subject lands (Courtice Road to Osborne Road by 2013) was calculated to be in the 800 to 900 vehicles per hour range, or slightly less than 50% of total traffic under the full build-out scenario (2023 horizon year). The proposed Facility would add 40, 48, and 62 two-way trips during both the a.m. and p.m. peak hour under the 140,000, 250,000 and 400,000 tpy scenarios respectively. This would account for 2%-3% of the total trips generated in the fully built-out CEBP.

Both ramp terminal intersections could require traffic signals by the ultimate 2023 horizon year with the full build-out of the CEBP. With the partial development of the subject lands assumed for the 2013 horizon year, only the south ramp terminal intersection is expected to require traffic signals. Traffic on the westbound approach (off-ramp) at the north ramp terminal intersection is expected to experience delays of up to one minute during the p.m. peak hour with a stop control.

The south ramp terminal is expected to have critical movements in the 2023 horizon year due to traffic associated with the CEBP. Specifically, eastbound left turning traffic and northbound through traffic could experience LOS “F” operations in the p.m. peak hour under the traffic signal control. Widening of Courtice Road to four lanes through the interchange could alleviate the problem, resulting in shorter delays and traffic queues on eastbound and northbound approaches at this intersection.

The northbound left turn lane at the north ramp terminal intersection is expected to carry over 900 vehicles per hour during the p.m. peak hour. The 95th percentile queue on the northbound approach at the north ramp terminal intersection is expected to extend to the south ramp terminal intersection in the p.m. peak hour (2023 horizon year). A loop ramp to accommodate traffic origination from the south and destined to the west (S-W) at this location would alleviate the queuing problem.

In addition, CEBP traffic destined to Highway 401 west will have the flexibility in accessing Highway 401 by diverting to the Holt Road interchange at the east end; however, resulting in minor out-of-way travel (back-tracking). This could result in further reduction of left turning traffic volumes on the northbound approach at the north ramp terminal intersection at Courtice Road. Specifically, approximately 270 northbound left turning vehicles at the north ramp terminal intersection at Courtice Road could potentially be reassigned to the Holt Road interchange, as these trips are generated by the CEBP land uses located east of Osborne Road.

All other study area intersections were found to operate at good Levels of Service under 2013 and 2023 traffic conditions.

At the time of preparation of this report, the Ministry of Transportation developed a conceptual design of the Highway 401/Courtice Road interchange as part of their Highway 407 East Preliminary Design project. The proposed interchange eliminates the N/S-E loop ramp, and replaces it with a directional ramp forming a full Diamond interchange. This conceptual reconfiguration of the interchange along with the proposed realignment of South Service Road may preclude certain roadways from being constructed within the CEBP as identified in the Municipality of Clarington Official Plan. The analysis undertaken as part of this study, assumed the future road network that was provided in the Municipality of Clarington Official Plan. A supplementary analysis may be required to incorporate potential changes

to the road network due to Highway 401 widening and improvements to the Courtice Road/Highway 401 interchange once designs are finalized.

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GLOSSARY AND ABBREVIATIONS

** An asterisk (*) beside a defined term indicates that the term is defined in the Environmental Assessment Act.*

Alternatives:	Both alternative methods and alternatives to a proposed undertaking.
Alternative Methods:	Alternative methods of carrying out the proposed undertaking are different ways of doing the same activity. Alternative methods could include consideration of one or more of the following: alternative technologies; alternative methods of applying specific technologies; alternative sites for a proposed undertaking; alternative design methods; and, alternative methods of operating any facilities associated with a proposed undertaking.
Alternatives To:	Alternatives to the proposed undertaking are functionally different ways of approaching and dealing with a problem or opportunity.
Durham:	The Regional Municipality of Durham or its geographic area, as the context requires.
Durham/York Residual Waste Study:	The Durham/York Residual Waste Study is a joint initiative between the Region of Durham and York Region to work together to find a way to manage solid waste remaining after at-source diversion.
Energy-from-Waste (EFW):	The recovery of energy in the form of heat and/or power from the thermal treatment of waste. Generally applied to incineration, pyrolysis, gasification but can also include the combustion of landfill gas and gas produced from anaerobic digestion of organic materials.
Environment*:	The environment is broadly defined under the Environmental Assessment Act as follows: (a) Air, land or water; (b) Plant and animal life, including human life; (c) The social, economic and cultural conditions that influence the life of humans or a community; (d) Any building, structure, machine or other device or thing made by humans; (e) Any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities; or, (f) Any part or combination of the foregoing and the interrelationships between any two or more of them.

Environmental Assessment:	Environmental assessment is a study, which assesses the potential environmental effects (positive or negative) of a proposal. Key components of an environmental assessment include consultation with government agencies and the public; consideration and evaluation of alternatives; and, the management of potential environmental effects. Conducting an environmental assessment promotes good environmental planning before decisions are made about proceeding with a proposal.
Environmental Assessment Act:	The *Environmental Assessment Act* (and amendments and regulations thereto) is a provincial statute that sets out a planning and decision-making process to evaluate the potential environmental effects of a proposed undertaking. Proponents wishing to proceed with an undertaking must document their planning and decision-making process and submit the results from their environmental assessment to the Minister for approval.
Individual Environmental Assessment:	An Individual Environmental Assessment requires the following steps to fully address the requirements of the EAA: Preparation of the Proposed EA Terms of Reference; Submission of the EA Terms of Reference to the Minister of the Environment for Approval; Completion of the EA Study in accordance with approved EA Terms of Reference, and; Submission of the EA Study to the Minister of the Environment for Approval.
Project:	Encompasses the design, construction (including construction financing) and operation of the Proposed Thermal Treatment Facility, and includes, the EA Study, the supply of municipal waste, and the sale of energy.
Regions:	Durham and York collectively.
Residual:	Amount of a pollutant remaining in the environment after a natural or technological process has taken place; e.g., the sludge remaining after initial wastewater treatment, or particulates remaining in air after it passes through a scrubbing or other process.
Stakeholder:	Any organization, governmental entity, or individual that has a stake in or may be impacted by a given approach to environmental regulation, pollution prevention, energy conservation, etc.
Terms of Reference:	A document prepared by the proponent and submitted to the Ministry of the Environment for approval. The terms of reference sets out the framework for the planning and decision-making process to be followed by the proponent during the preparation of an environmental assessment. In other words, it is the proponent's work plan for what is going to be studied. If approved, the environmental assessment must be prepared according to the terms of reference.

Thermal Treatment:	Use of elevated temperatures to treat wastes (e.g., combustion or gasification).
Undertaking*:	An enterprise, activity or a proposal, plan, or program that a proponent initiates or proposes to initiate.
York:	The Regional Municipality of York or its geographic area, as context requires.

List of Abbreviations

CEBP	Clarington Energy Business Park
Tpy	Tonnes per year
LOS	Level of Service
v/c	Volume-to-Capacity ratio

UNITS OF MEASUREMENT

Area

km	kilometre
m	metre

REPORT

1.0 INTRODUCTION

Durham and York Regions (the Regions) have partnered to undertake a joint Residual Waste Planning Environmental Assessment (EA) Study. Both municipalities are in need of a solution to manage the residual solid waste that remains after diversion. The Regions are working together to address the social, economic, and environmental concerns through an Environmental Assessment (EA) Study process to examine potential long-term residual waste management alternatives.

URS Canada Inc. was retained to undertake a Traffic Assessment with respect to the proposed Durham/York Thermal Treatment Facility (the Facility) in the Municipality of Clarington.

1.1 The Environmental Assessment Process

The purpose of the undertaking (i.e., what the outcome of this EA Study is intended to do) as described in the Approved EA Terms of Reference is:

> *"To process - physically, biologically and/or thermally - the waste that remains after the application of both Regions' at-source waste diversion programs in order to recover resources - both material and energy - and to minimize the amount of material requiring landfill disposal. In proceeding with this undertaking only those approaches that will meet or exceed all regulatory requirements will be considered."*

The EA Study follows a planning approach where environmental constraints or opportunities are considered in the context of the broadly defined environment under the *Environmental Assessment Act* (EAA) (i.e., the natural environment as well as the social, economic and heritage and other "environments" relevant to the undertaking) and potential effects are understood and addressed before development occurs. In accordance with the Approved EA Terms of Reference and EAA, the EA process evaluates: alternatives considering potential effects on the environment; the availability of mitigation measures that address, in whole or in part, the potential effects; and, the comparison of the advantages and disadvantages of the remaining or "net" effects. The result of this process provides the planning rationale and support for a preferred approach and method to implement the undertaking.

It is understood and contemplated that environmental management measures recommended as part of the EA process and this Technical Study Report will in many cases be refined, updated, modified and/or superceded as a result of subsequent approval processes.

The EA Study document has been prepared and conducted in accordance with the EAA, including in accordance with the Approved Terms of Reference approved by Ontario's Minister of the Environment on March 31, 2006. There are currently no federal environmental assessment process triggers identified and, therefore, this project does not require approval under the *Canadian Environmental Assessment Act* (CEAA).

This EA process essentially consists of three parts taking place in stages including:

- the Development and Approval of an EA Terms of Reference;
- the evaluation of "Alternatives to" the undertaking; and
- the evaluation of "Alternative methods" of implementing the undertaking.

The Environmental Assessment Report to which this Technical Report is appended provides a detailed description of the EA process undertaken as part of the Durham/York Residual Waste EA Study.

1.2 Purpose of the Report

This Report entitled the *Traffic Assessment - Technical Study Report* has been prepared for the Proposed Thermal Treatment Facility Site (the Site), Clarington 01.

The purpose of the Report was to:

- Assess existing traffic conditions at the study area intersections;
- Forecast future traffic demands expected to be generated by the Project;
- Forecast future planned roadway network improvements and background travel demands, specifically generated by the future CEBP; and,
- Identify operational concerns and recommend required mitigation measures to address the identified deficiencies, as well as to meet the future traffic demand generated by the Project.

This Report will form part of the supporting documentation and materials for the "Description of the Undertaking", completed as part of the EA Study.

1.3 Overview of Report Contents

This Report describes the existing traffic conditions related to the preferred "Alternative method", Clarington Site 01 (the Site), followed by an effects analysis including net effects of the Project on the adjacent road network. The key components of the Report are as follows:

- An explanation of the study methodology and assumptions is located in Section 2.0;
- A description of existing traffic volumes on the road network adjacent to the Site is included in Section 3.0;
- The results of the analyses, including the effect of construction and operations on the existing road network is located in Section 4.0 and 5.0;
- The results of future planned roadway network improvements and background travel demands, specifically generated by the future CEBP is included in Section 6.0; and,
- A discussion of the study conclusions is included in Section 7.0.

The information contained in this Report has been used to complete the EA.

2.0 STUDY METHODOLOGY

This Report identifies and addresses potential traffic effects that could result from the implementation of the Project. The Facility will be located south of Highway 401, between Courtice Road and Osborne Road in the Municipality of Clarington. The Facility is expected to be operational by 2013.

Figure 2-1 illustrates the preferred location for the Facility.

Figure 2-1 Preferred Location (Clarington 01)

2.1 Study Approach and Key Assumptions

The initial design capacity of the Facility is 140,000 tonnes per year (tpy) (Base Case) at the beginning of the planning period, which is expected to be 2013, to a maximum design capacity of 400,000 tpy (Alternative Case 2) of waste during the planned 35-year operating period.

Three scenarios for the Facility's annual tonnage were reviewed and analyzed in terms of traffic operations and effects on adjacent roads: 140,000, 250,000, and 400,000 tpy of waste.

The Facility is expected to have approximately 33 employees at the Site. Although the Facility is expected to operate 24-hours a day, 7 days a week, refuse trucks are expected to enter and leave the Site during regular working hours, Monday through Saturday[1]. Site-generated trips are discussed in detail in Section 5.2.

The traffic assessment was based on the a.m. and p.m. road peak hours on a weekday, as this is generally the simultaneous peak for both commuter and Site traffic. Traffic effects were based on the observed and forecast traffic volumes for both the weekday a.m. and p.m. peak hours. A traffic

[1] Design, Build, Operate and Maintain Proposal submission, submitted by Covanta Energy Corporation, 2009.

assessment study of this nature is usually based on the forecasted traffic effects associated with the usual or typical traffic conditions that are to be experienced on a day-to-day basis at the Site during the a.m. and p.m. peak hours.

Trip generation for the Site during the operational period was based on the Alternative Case scenarios of 140,000, 250,000 and 400,000 tpy of waste processing capacity for the Facility. Trip generation for the remaining uses within the CEBP was based on ITE trip generation rates obtained from the ITE Trip Generation Manual, 8th Edition for corresponding land uses and their sizes.

For the purpose of this traffic assessment, a ten-year horizon period was selected to assess future traffic conditions. The Facility is expected to be operational by 2013, thus a 2023 horizon year reflects an appropriate assessment horizon (10 years from beginning of operations).

In the event that the 400,000 tpy scenario is reached before 2023, the traffic assessment will be updated to assess the traffic effects of the Project on the adjacent road network, and to identify any road and/or traffic control improvements required.

3.0 EXISTING TRAFFIC CONDITIONS

The Clarington 01 Site is located in the southeast quadrant of the Courtice Road/Highway 401 interchange with access/egress to/from South Service Road and Osborne Road. The Site is located in close proximity to Highway 401 and the Courtice Road interchange. Both ramp terminal intersections with Highway 401 are stop-controlled on the minor approaches (Highway 401 off-ramps).

3.1 Existing Traffic Volumes

Existing traffic volumes at the study area intersections were derived from a series of 2007 traffic surveys undertaken by URS during a.m. and p.m. peak periods at the following locations:

- Courtice Road / Highway 401 E-N/S ramp; and,
- Courtice Road / Highway 401 W-N/S ramp.

Additional traffic information was obtained from the Municipality of Clarington. This information included 24-hour automated traffic recorders (ATR) for the following locations:

- Courtice Road south of Bloor Street (March 2006 – ATR);
- Darlington Park Road west of Courtice Road (1994 – ATR);
- Courtice Road north of Darlington Park Road (2002 estimate); and,
- Courtice Road south of Darlington Park Road (2002 estimate).

All traffic data was adjusted to one common base year of 2009 using a historical growth rate for traffic on Courtice Road.

Existing lane configurations at the study area intersections are illustrated in Figure 3-1 and existing a.m. and p.m. peak hour volumes are illustrated in Figures 3-2 and 3-3.

Figure 3-1 Existing Lane Configurations

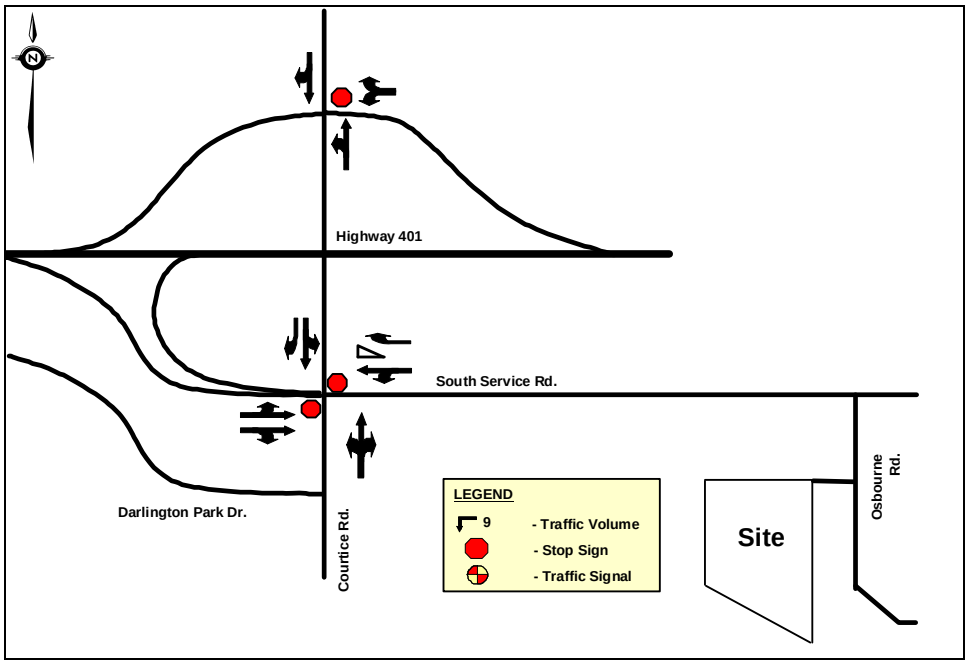


Figure 3-2 Existing AM Peak Hour Volumes (2009 adjusted)

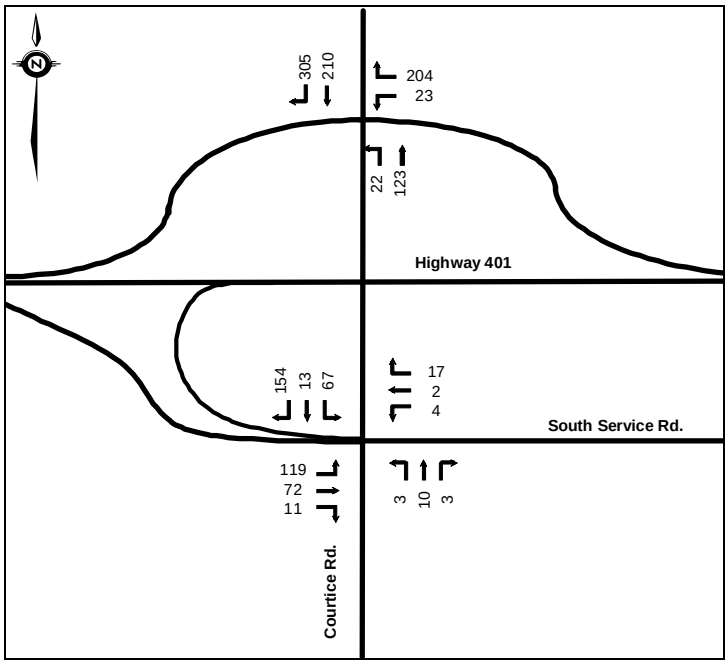
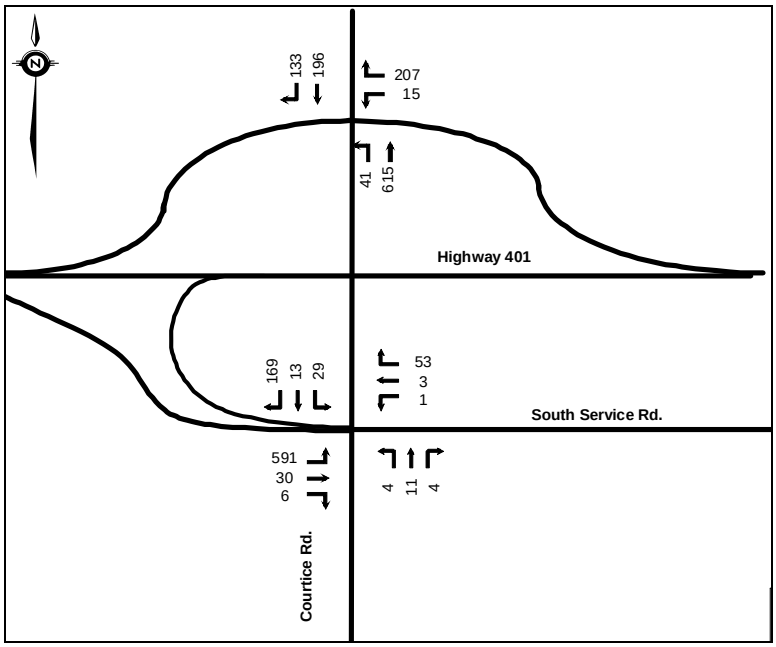


Figure 3-3 Existing PM Peak Hour Volumes (2009 adjusted)



3.2 Existing Traffic Operations Assessment

The operations of the boundary road intersections were analyzed on the basis of the above noted traffic volumes in Figures 3-2 and 3-3. This analysis reflects the existing lane configurations. The assessment for unsignalized intersection operations was based on the results of the Highway Capacity Software (HCS+), which is based on the methodology in the Highway Capacity Manual, 2000. The Highway Capacity Manual is produced by the Transportation Research Board.

The following table summarizes the overall Level of Service (LOS), vehicular delay (i.e., the delay induced by a traffic signal, stop sign etc.), and volume-to-capacity ratio (v/c) for each of the subject intersections.

Level of Service definitions related to intersection operations are contained in **Appendix A** – Level of Service Definitions. LOS is a qualifying measure of traffic operations at an intersection, relating the control delay per vehicle for a 15-minute analysis period. LOS is summarized on a grading system, 'A' being the best service condition and 'F' being the worst. For example, LOS 'C' means that vehicles experience a delay at an intersection of greater than 20 seconds but less than 35 seconds and individual traffic cycles start to see break down defined by a v/c ratio. The v/c ratio is a measure of the proportion of the calculated intersection capacity that is utilized by the modeled traffic volumes.

Table 3-1 Existing Traffic Operations

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 11.1 s, 0.22	C, 20.8 s, 0.75
		Critical Movements	-	-
Courtice Road / EB 401	Unsignalized	Intersection	B, 10.5 s, 0.24	C, 19.5 s, 0.46
		Critical Movements	-	-

The study area intersections were found to operate at LOS "C" or better during existing a.m. and p.m. peak hours. Neither ramp terminal intersection warrants traffic signals under existing traffic conditions. Capacity analysis outputs are provided in **Appendix C** to this Report.

4.0 CONSTRUCTION ASSESSMENT

Construction of the Facility is expected to begin in 2010 with the following proposed break-down of construction activities[2]:

2010 April - December (principal activities may include earthwork and foundations)

- Types of traffic on Site is expected to include dump trucks, scrapers, bulldozers, excavators, concrete trucks, cranes, and pick-up trucks.
- Peak labour is anticipated to be approximately 50 full time staff.
- A day shift is expected to be utilized.
- Staff are anticipated to work Monday – Thursday from 7am – 6pm (with occasional work on Friday and Saturday).

2011 January - December (principle activities may include structural steel erection and major equipment delivery)

- Types of traffic on Site is expected to include cranes, forklifts, and pick-up trucks.
- Peak labour is anticipated to be approximately 150 full time staff.
- A day shift is expected to be utilized (A second shift may be used periodically and only for short term periods).
- Staff are anticipated to work Monday – Thursday from 7am – 6pm (with occasional work on Friday and Saturday).

2012 – 2013 (principle activities may include process equipment installation, piping, electrical work, startup/testing)

[2] Design, Build, Operate and Maintain Proposal submission, submitted by Covanta Energy Corporation, 2009.

- Types of traffic on Site is expected to include cranes, forklifts, pick-up trucks, and paving equipment.
- Peak labour is anticipated to be approximately 200 full time staff. Average labour is expected to be approximately 125 full time staff.
- A day shift is expected to be utilized (A second shift may be used periodically and only for short term periods).
- Staff are anticipated to work Monday – Thursday from 7am – 6pm (with occasional work on Friday and Saturday).

In order to estimate hourly trips of construction-related trucks and cars, daily traffic volumes were converted to peak hour traffic volumes assuming an even distribution of trucks through the typical working day and shift-days for construction workers. Conservatively, resultant hourly truck volumes were multiplied by two to account for possible spikes in arrival/departure rates at the beginning of the first shift and the end of the last shift. With respect to passenger vehicular traffic (i.e., car traffic), it was assumed that 60% of daily traffic would arrive at the beginning of the first shift (a.m. peak hour). Similarly, 60% of all daily trips were assumed to leave the Site at the end of the last shift (p.m. peak hour). Table below summarizes construction-related vehicular trips.

Table 4-1 Construction Traffic – Hourly Trips

	2010 Construction Period			
	A.M. Peak total in	A.M. Peak total out	P.M. Peak total in	P.M. Peak total out
Trucks	7	7	7	7
Cars	30	0	0	30
Total	37	7	7	37
	2011 Construction Period			
	A.M. Peak total in	A.M. Peak total out	P.M. Peak total in	P.M. Peak total out
Trucks	2	2	2	2
Cars	90	0	0	90
Total	92	2	2	92
	2012-2013 Construction Period			
	A.M. Peak total in	A.M. Peak total in	P.M. Peak total in	P.M. Peak total in
Trucks	1	1	1	1
Cars	120	0	0	120
Total	121	1	1	121

The construction of the Facility is expected to generate most traffic in its last year, although with lowest truck volumes. The first year of construction is expected to generate the most truck traffic with up to 14 trucks (both directions) in the peak hour.

Access to the construction Site will be provided via South Service Road and Osborne Road. For analysis purposes, study area intersections were analyzed for the construction year three (2012) assuming no changes to the existing road network/lane configurations at the study area intersections.

Figures 4-1 through 4-4 illustrate construction Site traffic and total traffic volumes during construction for 2012-2013 a.m. and p.m. peak hours. Table 4-2 summarizes traffic operations at the ramp terminal intersections anticipated during construction.

Figure 4-1 Construction Traffic Volumes – 2012-2013 AM Peak Hour

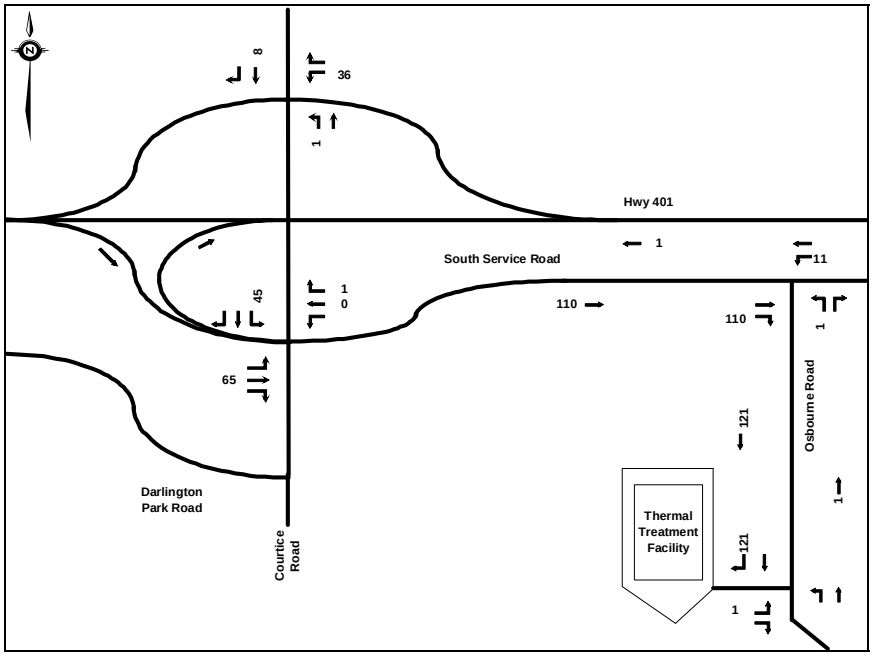


Figure 4-2 Construction Traffic Volumes – 2012-2013 PM Peak Hour

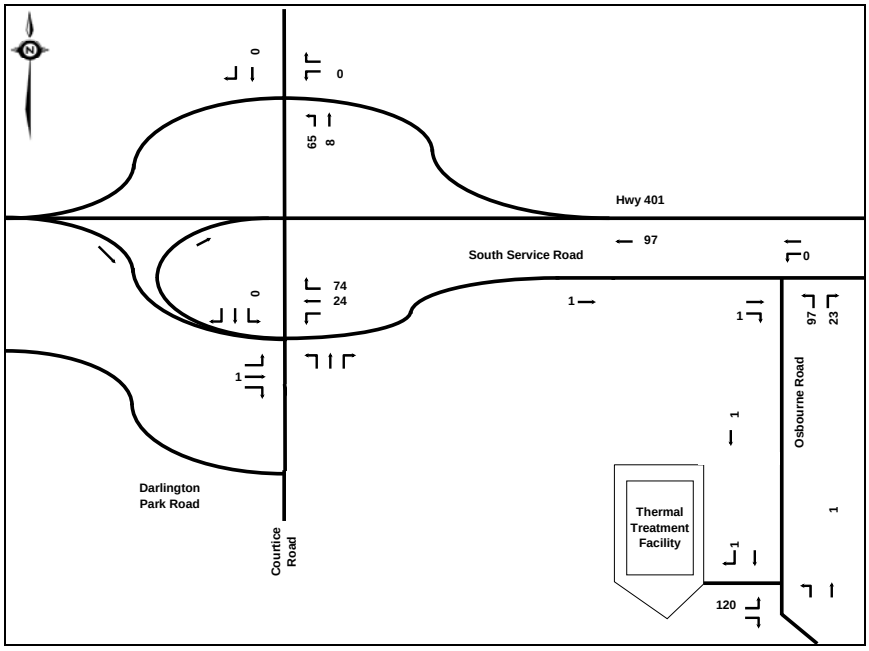


Figure 4-3 Total Traffic Volumes During Construction – 2012-2013 AM Peak Hour

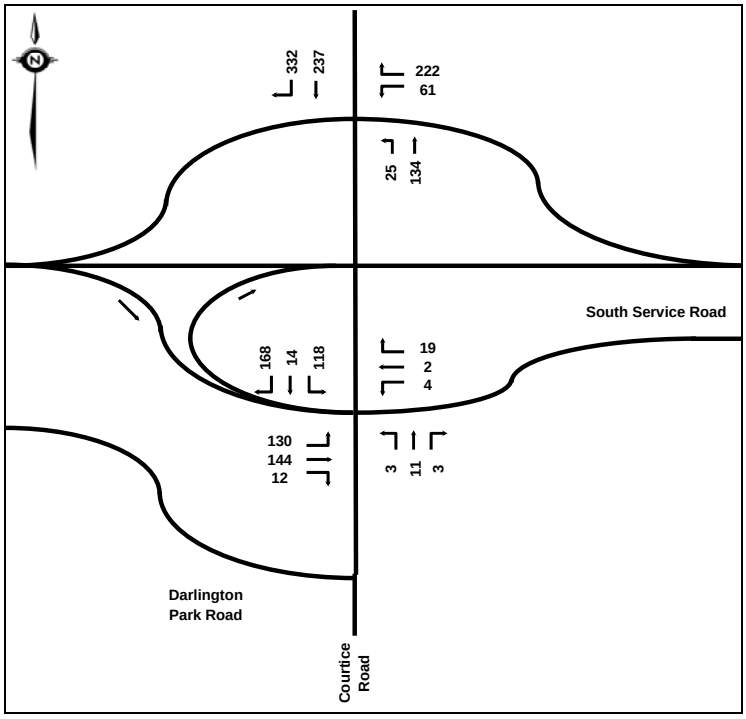


Figure 4-4 Total Traffic Volumes During Construction – 2012-2013 PM Peak Hour

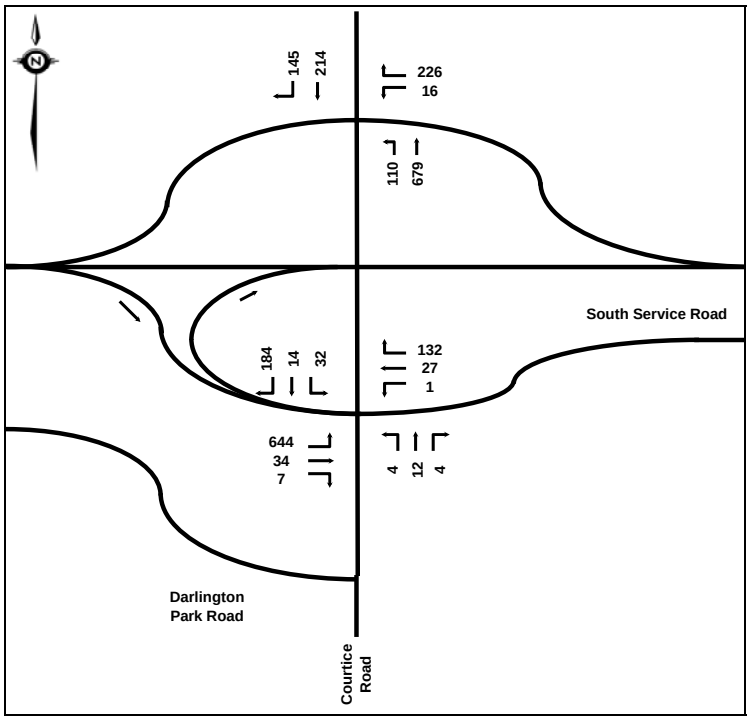


Table 4-2 Intersection Capacity Analysis – 2012 Construction Year

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 11.4 s, 0.26	C, 21.8 s, 0.50
		Critical Movements	-	-
Courtice Road / EB 401	Unsignalized	Intersection	B, 13.7 s, 0.36	E, 45.8 s, 0.96
		Critical Movements	-	EBL: E, 48.0 s, 0.96

Left turning vehicles from the eastbound approach are expected to operate at LOS "E" during the p.m. peak hour. It should be noted that construction vehicles will travel through the intersection from this approach to South Service Road (no left turns to Courtice Road northbound). Traffic volumes at this intersection are not expected to warrant traffic signals by 2012. The 95th percentile queue on the eastbound approach was calculated at approximately 100 metres during the p.m. peak hour.

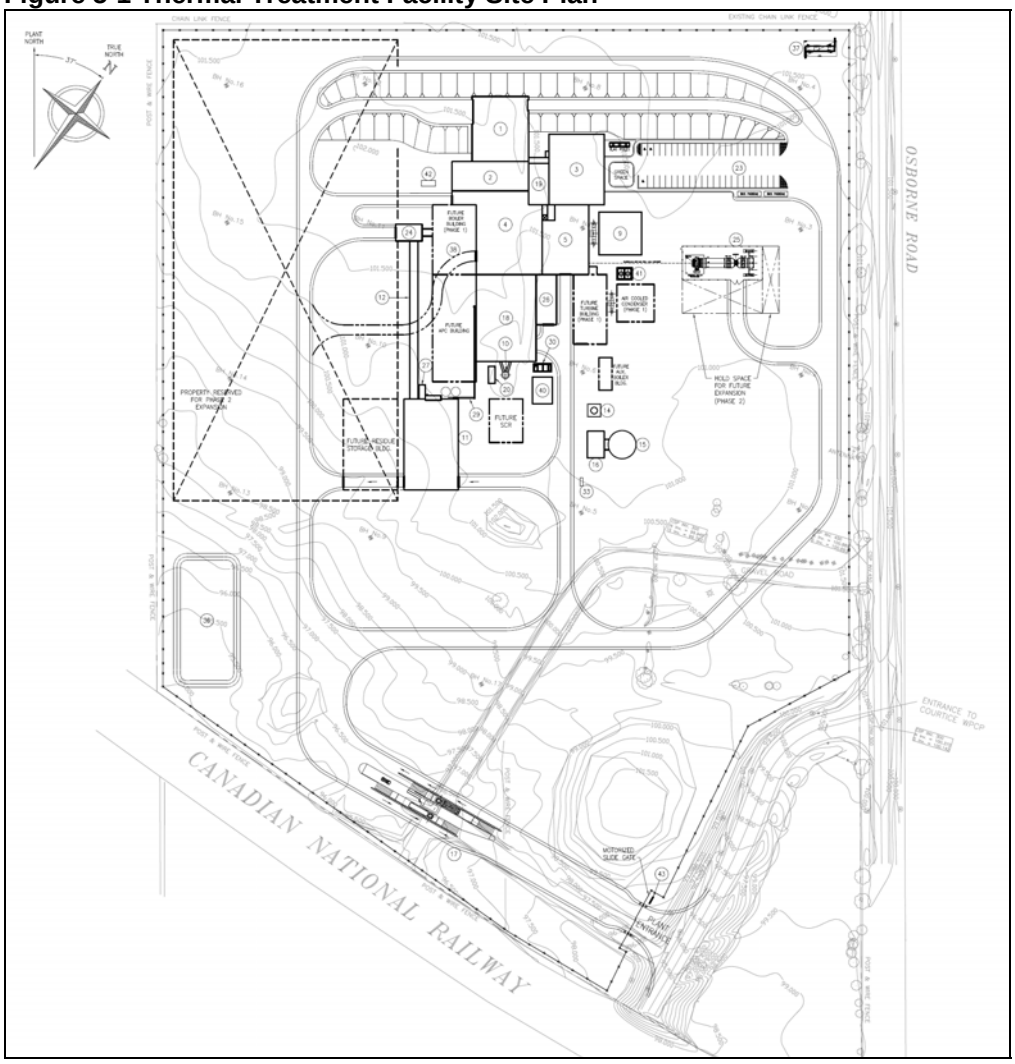
Construction generated traffic is not expected to have adverse traffic effects at the ramp terminal intersections and other study area intersections. Neither ramp terminal intersection warrant traffic signals during construction of the Facility. Road reconstruction/pavement improvements may be required for the section of South Service Road between the interchange and Osborne Road, as well as the section of Osborne Road between South Service Road and the future Site access. The road improvements may be required to accommodate construction trucks and Site-generated trucks, once the Site is built and operational. Pavement testing along the haul route will be completed by the Region of Durham if the Project is approved to confirm if road reconstruction/pavement improvements are required. Capacity analysis outputs (construction assessment) are provided in **Appendix D** to this Report.

5.0 OPERATIONS ASSESSMENT (2013 HORIZON)

5.1 Thermal Treatment Facility

The Facility will be located south of Highway 401, between Courtice Road and Osborne Road in the Municipality of Clarington. Figure 5-1 illustrates the proposed Site plan for the Facility.

Figure 5-1 Thermal Treatment Facility Site Plan



5.2 Site Traffic

5.2.1 Trip Generation

Trip generation for the Site was obtained from the Technical Memorandum titled “Estimate Number of Vehicles During Operations” prepared by Stantec (formerly Jacques Whitford Limited). The Technical Memorandum (Refer to **Appendix B**) provided truck estimates based on various thermal treatment facility sizes or capacities in terms of processed tonnage per year (tpy). The Base Case scenario assumes an initial design capacity for the Facility of 140,000 tonnes of waste per year. In Alternative Case 1, the annual tonnage is increased to 250,000 tpy, and Alternative Case 2 estimates the maximum design capacity at 400,000 tpy. For the purpose of this analysis, Alternative Case 2 (400,000 tpy) was used to assessed the ultimate horizon year of 2023. The opening day scenario (2013 horizon

year) was assessed using the Base Case (140,000 tpy) and Alternative Case 1 (250,000 tpy) capacity of the Facility.

In general, trip generation was based on an estimated number of tractor-trailers, as well as packers and other trucks from and to the Site on an annual basis considering capacity of the Facility, as well as trucks capacity (tonnes). Daily truck trips were derived by dividing the annual trips by 250 days (operating days). The daily trips were then converted to peak hour volumes assuming that both a.m. and p.m. peak hours will comprise 25% of daily trips (conservative assumption). Table 5-1 summarizes daily trips for each of the three scenarios. Table 5-2 summarizes inbound and outbound hourly vehicular and truck trips.

Table 5-1 Daily Truck Trips (Source: Technical Memorandum[3])

Type/Use	Total Number of Trucks per Day		
	Base Case Quantity 140,000 (tpy)	Alternative Case 1 250,000 (tpy)	Alternative Case 2 400,000 (tpy)
Waste Supply	25	38	59
Additional Trucks	9	13	18
TOTAL	**34**	**51**	**77**

Table 5-2 Peak Hour Site Traffic Volumes (Trucks and Cars)

Trip Type	Daily Trips	A.M. Peak Hour		P.M. Peak Hour	
		Inbound	Outbound	Inbound	Outbound
		140,000 tpy			
Trucks	34	9	9	9	9
Staff (cars)	21	21	0	0	21
Visitors (cars)	1	1	0	0	1
Total	56	31	9	9	31
		250,000 tpy			
Trucks	51	13	13	13	13
Staff (cars)	21	21	0	0	21
Visitors (cars)	1	1	0	0	1
Total	73	35	13	13	35
		400,000 tpy			
Trucks	77	20	20	20	20
Staff (cars)	21	21	0	0	21
Visitors (cars)	1	1	0	0	1
Total	99	42	20	20	42

The Facility is expected to generate 18 trucks (inbound and outbound) and 22 cars during the peak hour in the Base Case scenario (140,000 tpy). Alternative Cases 1 and 2 (250,000 tpy and 400,000 tpy) are expected to generate 26 trucks/22 cars and 40 trucks/22 cars, respectively.

5.2.2 Trip Distribution

The distribution of traffic related to the proposed uses was based on a review of the boundary road network, truck trip origins (transfer station locations), and surrounding land uses.

Highway 401 in the immediate area will attract truck traffic, especially transfer trailer trucks. This was reflected in the trip distribution calculation, as it was assumed that trucks would utilize the freeway

[3] Technical Memorandum - Estimate Number of Vehicles During Operations (Refer to **Appendix B**)

network, and cars (staff) would utilize both the freeway and arterial/collector roads. It was also assumed that trucks would utilize South Service Road and Osborne Road to access/egress the Site.

5.2.3 Traffic Assignment and Future Total Traffic (2013)

Based on the above noted trip distribution, Site traffic was assigned to the existing boundary road network. The resultant assignment of Site traffic for the weekday a.m. and p.m. peak hours is illustrated in Figure 5-2 and Figure 5-3 for the Base Case scenario (2013 horizon year), and Figures 5-4 and 5-5 for the Alternative Case 1 scenario (2013 horizon year).

Access/egress to/from the Site will be via Osborne Road. As previously noted, trucks will use South Service Road to access the Highway 401 interchange at Courtice Road.

The analysis of traffic effects during construction incorporated existing road network and traffic control at the study area intersections. Growth in background traffic was estimated at 3% per year based on a review of historical traffic data for Courtice Road. The assessment of the Alternative Case 2 (400,000 tpy) is provided in Section 6.5.3 assuming the full build-out of the CEBP. A series of supplementary analyses of the Base Case and Alternative Case 1 scenarios are provided in Sections 6.5.1 and 6.5.2, respectively, which incorporate partial and/or full build-out of the CEBP.

Figure 5-2 Site Traffic Volumes (140,000 tpy AM Peak Hour)

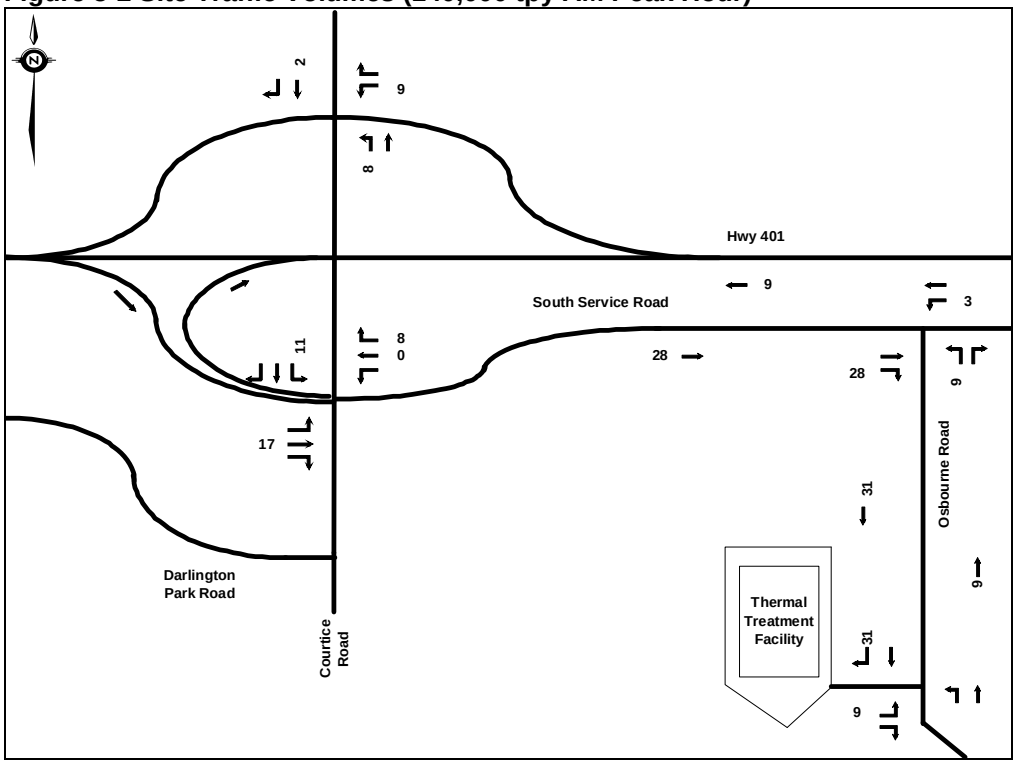


Figure 5-3 Site Traffic Volumes (140,000 tpy PM Peak Hour)

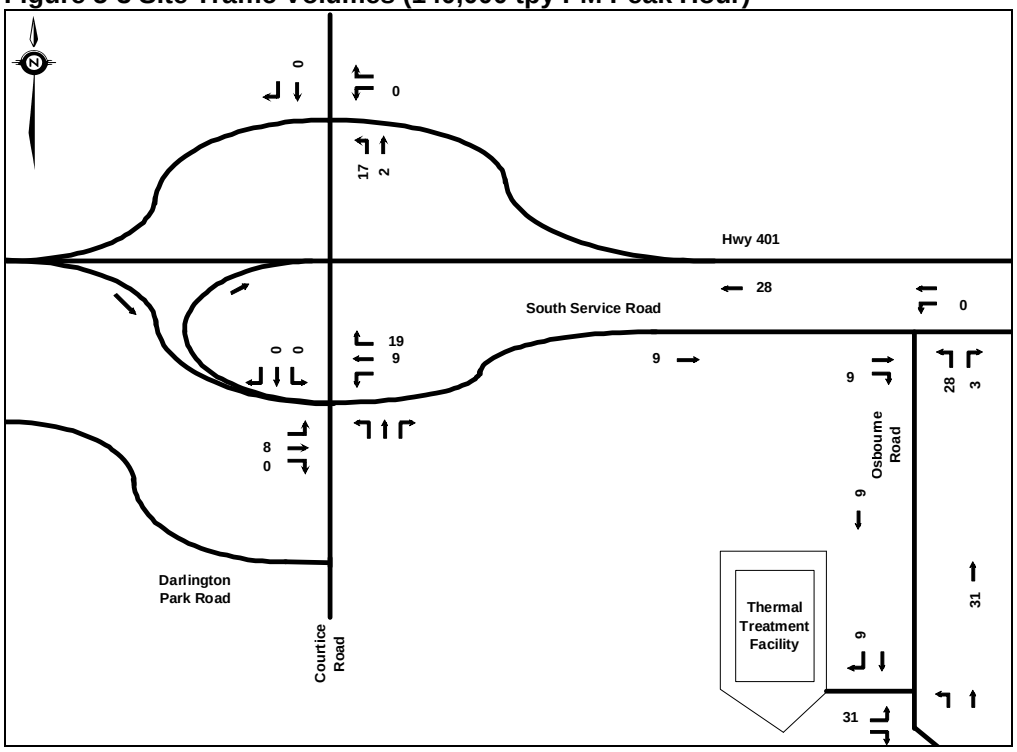


Figure 5-4 Site Traffic Volumes (250,000 tpy AM Peak Hour)

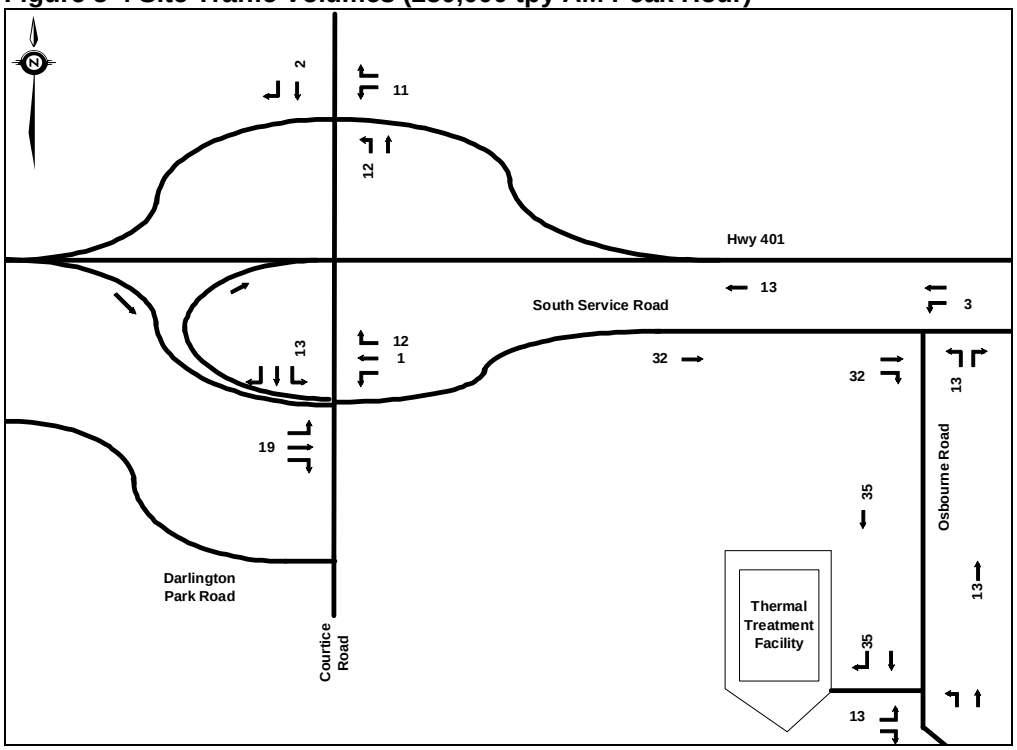


Figure 5-5 Site Traffic Volumes (250,000 tpy PM Peak Hour)

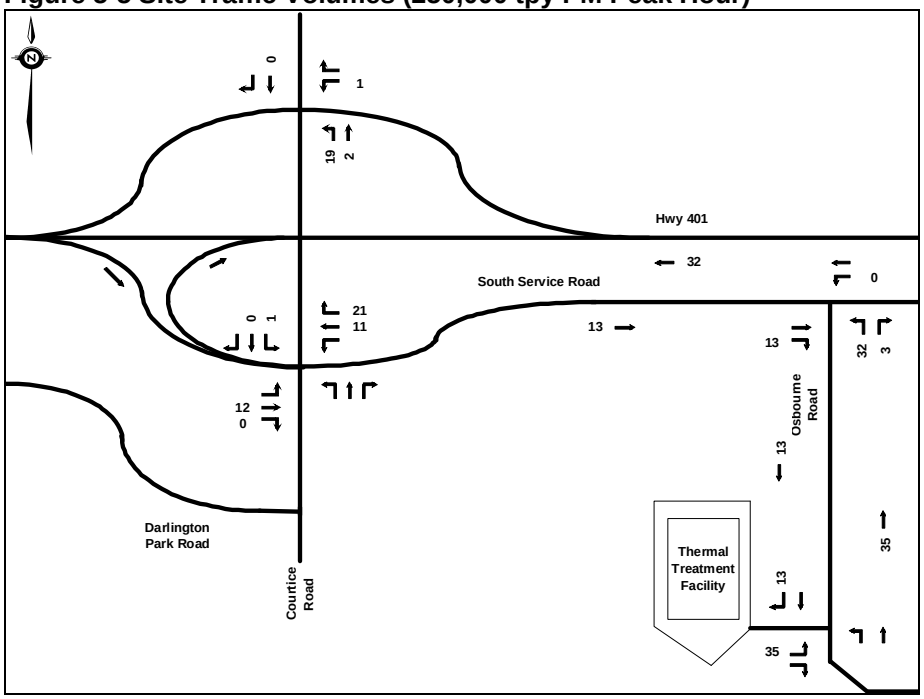


Figure 5-6 Future Total Traffic Volumes – (140,000 tpy 2013 AM Peak Hour)

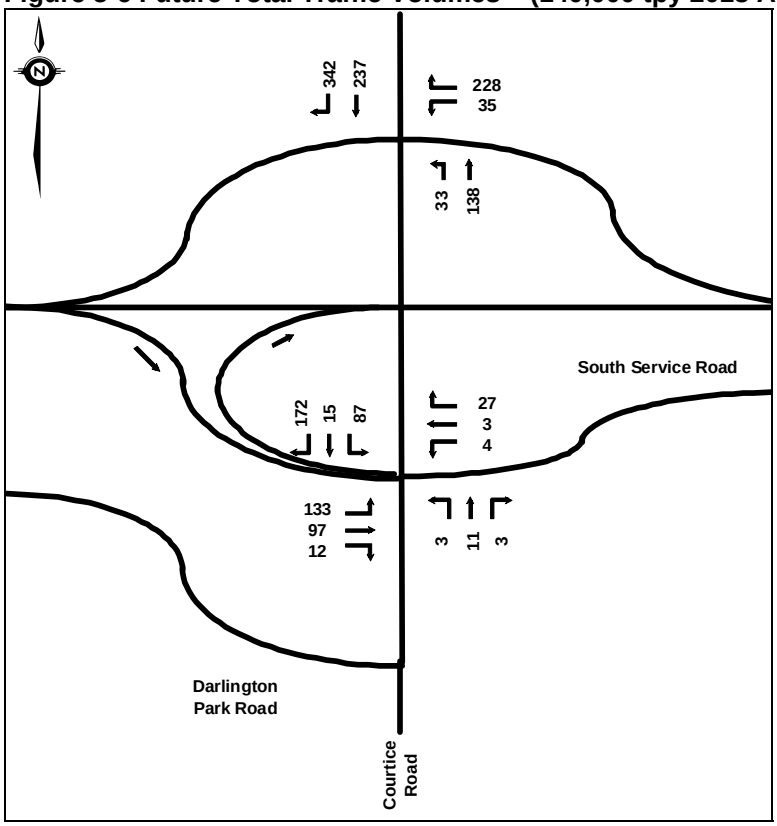


Figure 5-7 Future Total Traffic Volumes – (140,000 tpy 2013 PM Peak Hour)

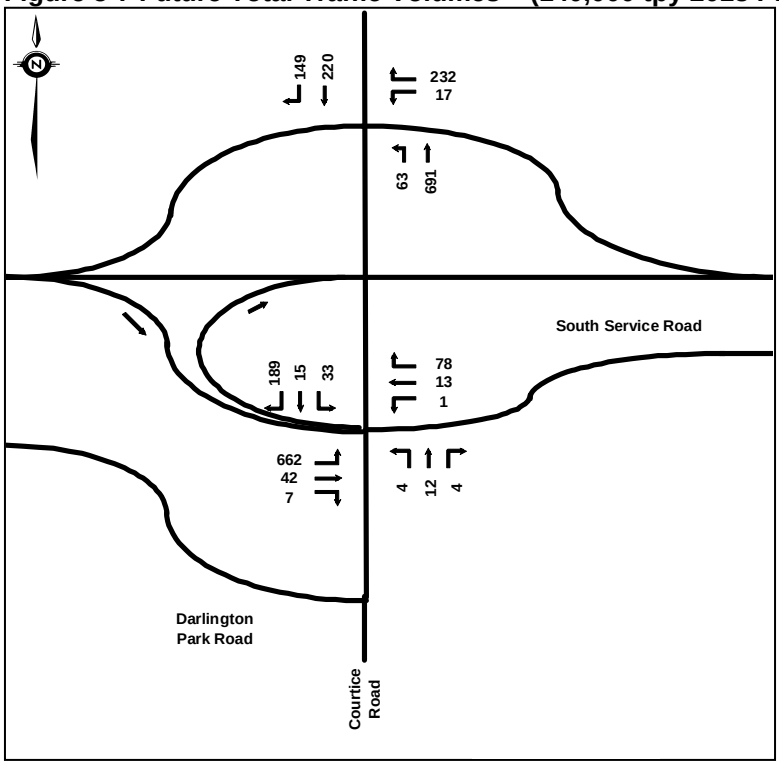


Figure 5-8 Total Traffic Volumes – (250,000 tpy 2013 AM Peak Hour)

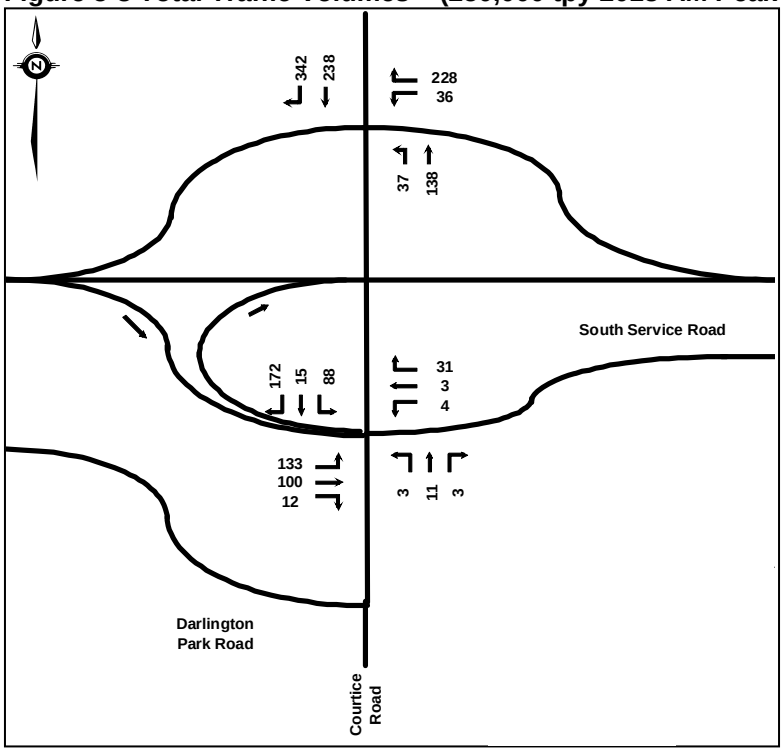
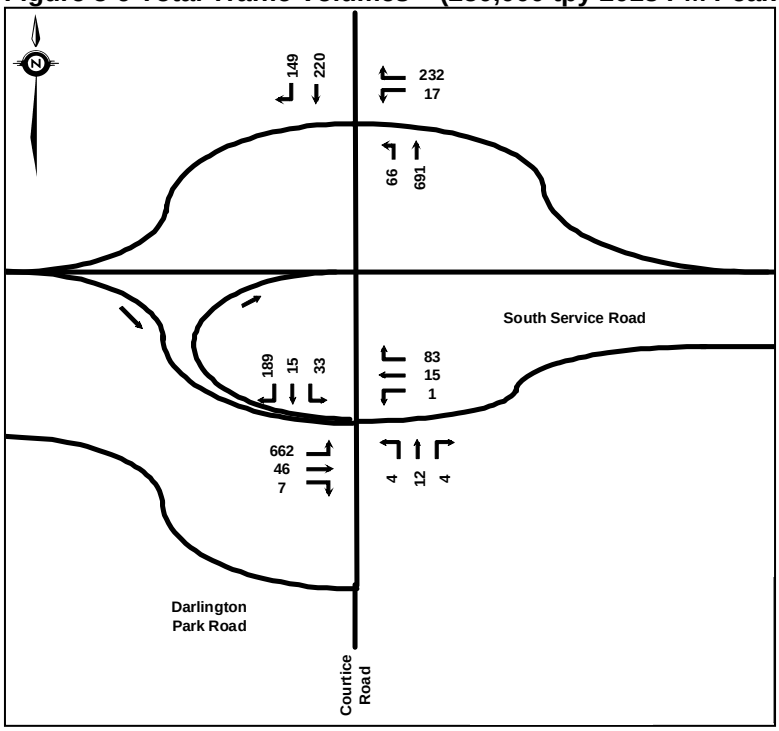


Figure 5-9 Total Traffic Volumes – (250,000 tpy 2013 PM Peak Hour)



5.2.4 Traffic Assessment (2013)

Ramp terminal intersections were analyzed under existing lane configurations and traffic control. Traffic signals at both ramp terminal intersections were found not to be warranted during operations under the Base Case scenario. Intersection capacity analysis results are summarized in Table 5-3.

Table 5-3 Intersection Analysis Results – 2013 (140,000 tpy)

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 10.9 s, 0.25	C, 22.4 s, 0.53
		Critical Movements	-	-
Courtice Road / EB 401	Unsignalized	Intersection	B, 12.0 s, 0.27	D, 32.8 s, 0.85
		Critical Movements	-	EBL: E, 34.5 s, 0.85

Both ramp terminal intersections were found to operate acceptably during both a.m. and p.m. peak hours during operations under the Base Case scenario. The south ramp terminal intersection was found to operate at LOS “D” in the p.m. peak hour with the eastbound left turn operating at LOS “E” and an average delay of 36 seconds per vehicle. It should be noted that the threshold between LOS “D” and LOS “E” operations is 35 seconds of delay. The 95th percentile queue length on the eastbound approach was calculated at approximately 110 metres during the p.m. peak hour.

The results of the Alternative Case 1 scenario (250,000 try) are provide in Table 5-4 below. The results of the analysis were found to be similar to the Base Case scenario with marginal variation of delay and v/c values. Both ramp terminal intersections were found to operate acceptably during both a.m. and p.m. peak hours.

Table 5-4 Intersection Analysis Results – 2013 (250,000 tpy)

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 10.9 s, 0.25	C, 22.5 s, 0.53
		Critical Movements	-	-
Courtice Road / EB 401	Unsignalized	Intersection	B, 12.1 s, 0.28	D, 34.4 s, 0.86
		Critical Movements	-	EBL: E, 36.4 s, 0.86

6.0 FUTURE TRAFFIC CONDITIONS (ULTIMATE)

The assessment of the future traffic conditions was based on partial (2013 horizon) and full (2023 horizon) build-out of the CEBP (CEBP) bounded by Highway 401 to the north, the CN Rail corridor to the south, Courtice Road to the west, and Holt Road to the east. Traffic associated with the Facility was excluded from the calculation of the overall background traffic volumes to be generated by the CEBP.

6.1 Future Background Traffic (CEBP)

Traffic volumes associated with the CEBP formed the basis for calculation of future background traffic volumes. The 2005 CEBP Study report was used to identify future land uses for the subject lands, their locations and general area (in acres).

The CEBP will comprise of prestige business, light industrial and office land uses as illustrated in Figure 6-1. Street names used in Figure 6-1 were taken directly from the CEBP Study report.

Figure 6-1 CEBP (Source: CEBP Study)

Table 6-1 summarizes areas for each of the illustrated blocks and land uses (Figure 6-1). It should be noted that the Site would be situated within blocks 4 and 7.

Table 6-1 CEBP Areas

Blocks	Gross Area (Acres)	Less: 20% for infrastructure (Acres)	Net Developable (Acres)	Zoning
Block 1	22	4	18	MO2 – Energy Park Office Prestige
Block 2	39	8	31	ML1 – Energy Park Light Industrial
Block 3	17	3	14	ML1 – Energy Park Light Industrial
Block 4	13	3	10	ML1 - Energy Park Light Industrial
Block 5	20	4	16	MO1 – Energy Park Office
Block 6	28	5	23	ML1 – Energy Park Light Industrial
Block 7	20	4	16	ML2 – Energy Park Light Industrial
Block 8	23	5	18	MO1 – Energy Park Office
Block 9	15	3	12	MO1 – Energy Park Office
Block 10	32	6	26	ML1 – Energy Park Light Industrial
Block 11	29	6	24	ML2 & ML2-1 – Energy Park Light Industrial
Block 12	19	4	15	MO1 – Energy Park Office
Block 13	16	3	13	ML2 – Energy Park Light Industrial
Block 14	16	3	13	ML1 – Energy Park Light Industrial
Block 15	3	1	3	ML2 – Energy Park Light Industrial
Block 16	7	1	5	ML1 – Energy Park Light Industrial
Total	**319**	**63**	**257**	

Trip generation for the CEBP was determined using the ITE Trip Generation Manual, 8th Edition. Specifically, land use code 770 (Business Park) was used to generate traffic volumes for Park Office Prestige land uses, land use code 750 (Office Park) was used to generate traffic associated with Park Office land uses, and land use code 110 (General Light Industrial) was used to generate traffic volumes associated with light industrial land uses. Table 6-2 summarizes trip generation for the CEBP.

Table 6-2 CEBP Trip Generation (Full Build-Out Without Subject Site)

Land Use Code	Total Area		A.M. Peak Hour						P.M. Peak Hour					
			Rate			Trips			Rate			Trips		
			IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
Park Office Prestige Code 770	9	Acres1	16.03	2.83	18.86	144	25	169	3.37	13.47	16.84	30	121	152
Office Park Code 750*	31	Acres2	23.60	2.05	25.65	732	64	796	4.24	24.04	28.28	132	745	877
Park Light Industrial Code 110*	152	Acres	6.23	1.28	7.51	947	194	1141	1.60	5.66	7.26	243	861	1104

* Note: Blocks 4 and 7 are excluded

BLOCK #	Area		A.M. Peak Hour						P.M. Peak Hour					
			Rate			Trips			Rate			Trips		
			IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
Block 1	9	Acres1	16.03	2.83	18.86	144	25	170	3.37	13.47	16.84	30	121	152
Block 2	31	Acres	6.23	1.28	7.51	193	40	233	1.60	5.66	7.26	50	176	225
Block 3	14	Acres	6.23	1.28	7.51	87	18	105	1.60	5.66	7.26	22	79	102
Block 5	8	Acres2	23.60	2.05	25.65	189	16	205	4.24	24.04	28.28	34	192	226
Block 6	23	Acres	6.23	1.28	7.51	143	29	173	1.60	5.66	7.26	37	130	167
Block 8	9	Acres2	23.60	2.05	25.65	212	18	231	4.24	24.04	28.28	38	216	255
Block 9	6	Acres2	23.60	2.05	25.65	142	12	154	4.24	24.04	28.28	25	144	170
Block 10	26	Acres	6.23	1.28	7.51	162	33	195	1.60	5.66	7.26	42	147	189
Block 11	24	Acres	6.23	1.28	7.51	150	31	180	1.60	5.66	7.26	38	136	174
Block 12	8	Acres2	23.60	2.05	25.65	189	16	205	4.24	24.04	28.28	34	192	226
Block 13	13	Acres	6.23	1.28	7.51	81	17	98	1.60	5.66	7.26	21	74	94
Block 14	13	Acres	6.23	1.28	7.51	81	17	98	1.60	5.66	7.26	21	74	94
Block 15	3	Acres	6.23	1.28	7.51	19	4	23	1.60	5.66	7.26	5	17	22
Block 16	5	Acres	6.23	1.28	7.51	31	6	38	1.60	5.66	7.26	8	28	36
		Total Trips				1823	283		Total Trips			405	1727	

The CEBP is anticipated to generate approximately 2,100 two-way trips during both a.m. and p.m. peak hours once fully built-out, excluding traffic generated by the Facility. The CEBP Study report stated that the development of the CEBP is likely to be completed in two or more phases. As previously noted, this traffic study provides an assessment of traffic operations for 2013 and 2023 horizon years. For analysis purposes, Phase 1 development was assumed to be in place by the 2013 horizon, which incorporates development of lands situated between Courtice Road and Osborne Road (Blocks 3, 5, 6, 9 and 12).

This translates into 842 two-way trips during the a.m. peak hour, and 891 two-way trips during the p.m. peak hour (excluding traffic generated by the proposed Facility), or slightly less than 50% of total traffic under the full build-out scenario (2023 horizon year).

The Facility would add 40, 48, and 62 two-way trips during both the a.m. and p.m. peak hour under the 140,000, 250,000 and 400,000 tpy scenarios respectively. This would account for 1.9%-3.0% of the total trips generated in the fully built-out CEBP.

Trip distribution for the background traffic was based on the results of the Transportation Tomorrow Survey (TTS 2001). Table 6-3 summarizes trip distribution applied to traffic associated with the CEBP.

Table 6-3 Trip Distribution (CEBP)

Planning District	Planning District Name		Trips	Percent of Total Trips	Area Total
1	Metropolitan Toronto	South Toronto	100	1.5%	6%
2		East Central Toronto			
3		West Central Toronto			
4		East Toronto	100	1.5%	
5		West Toronto			
6		East Toronto	200	3.0%	
7	Durham	Brock			92%
8		Uxbridge			
9		Scugog	100	1.5%	
10		Pickering	100	1.5%	
11		Ajax	200	3.0%	
12		Whitby	400	6.0%	
13		Oshawa	1,300	20.0%	
14		Clarington	3,900	60.0%	
15	York	Georgina			2%
16		East Gwillimbury			
17		Newmarket			
18		Aurora			
19		Richmond Hill			
20		Whitchurch-Stouffville			
21		Markham	100	1.5%	
22		King			
23		Vaughn			
24	Peel	Caledon			0%
25		Brampton			
26		Mississauga			
27	Halton	Halton Hills			0%
28		Milton			
29		Oakville			
30		Burlington			
31	Hamilton-Wentworth	Flamborough			0%
32		Dundas			
33		Ancaster			
34		Glanbrook			
35		Stoney Creek			
36		Hamilton			
		TOTAL	**6,500**	**100%**	**100%**

The following chapter discusses the future road network and traffic assignment used for an assessment of the future background traffic conditions.

6.2 Future Road Network

The Municipality of Clarington Official Plan[4] identifies the internal road network needs for the future CEBP. The proposed road network within the CEBP generally utilizes existing roadways, including South Service Road and Osborne Road, as well as introduces new roadways, including Energy Drive, an east-west collector road within the CEBP. The Highway 401 interchange at Courtice Road is assumed to remain a partial Diamond interchange with access to Highway 401 eastbound from the south via a loop ramp.

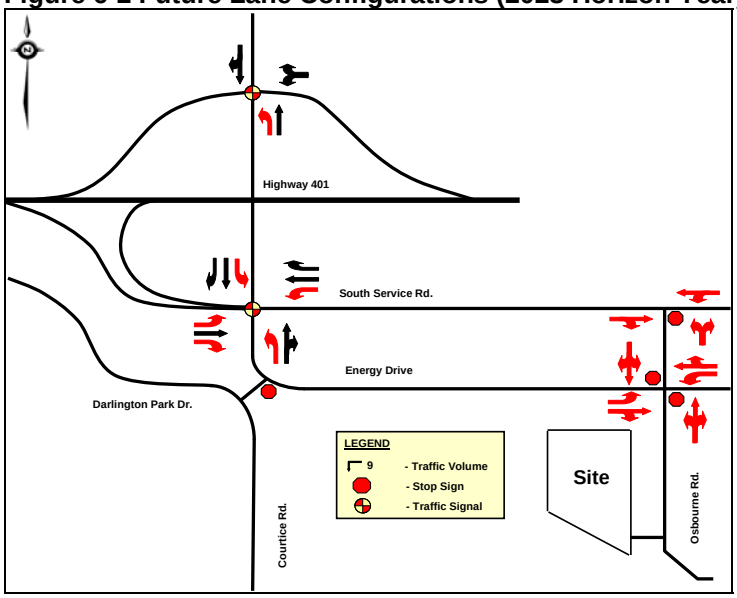
At the time of preparation of this Report, the Ministry of Transportation developed a conceptual design of the Highway 401/Courtice Road interchange as part of their Highway 407 East Preliminary Design project. The proposed interchange eliminates the N/S-E loop ramp, and replaces it with a directional ramp forming a full Diamond interchange. This conceptual reconfiguration of the interchange along with the proposed realignment of South Service Road may preclude certain roadways from being constructed within the CEBP as identified in the Municipality of Clarington Official Plan. Since works associated with the interchange improvements and realignment of South Service Road were still ongoing at the time of preparation of this Report, for the purpose of this analysis, the road network identified in the Municipality of Clarington Official Plan was used to assess future traffic conditions at the study area intersections. The study area intersections include both ramp terminal intersections at the Highway 401/Courtice Road interchange, the intersection of Osborne Road and Energy Drive and the Site access intersection.

In addition, longer term improvements for the Highway 401 corridor include future interchange improvements at Holt Road, located to the east of the subject Site. Although details of the future interchange were unavailable at the time of preparation of this Report, CEBP-related traffic originating from and destined to Highway 401 east was assumed to have the flexibility in using the future interchange at the east end of the study area (2023 horizon year).

The future lane configurations at the study area intersections are illustrated in Figure 6-2. Traffic signals at the north ramp terminal intersection were found to be warranted beyond the 2013 horizon. Lane configurations illustrated in red are recommended improvements or new lane configurations.

[4] Municipality of Clarington Official Plan Land Use Map, Energy Business Park Secondary Plan, January 2, 2007.

Figure 6-2 Future Lane Configurations (2023 Horizon Year)



6.3 Future Background Traffic Assessment

The future background traffic operations incorporating traffic associated with CEBP (excluding the Project) at the study intersections were analyzed on the basis of the below noted traffic volumes in Figures 6-3 through 6-6 for 2013 and 2023 horizon years.

Figure 6-3 Future Background Traffic Volumes – 2013 AM Peak Hour

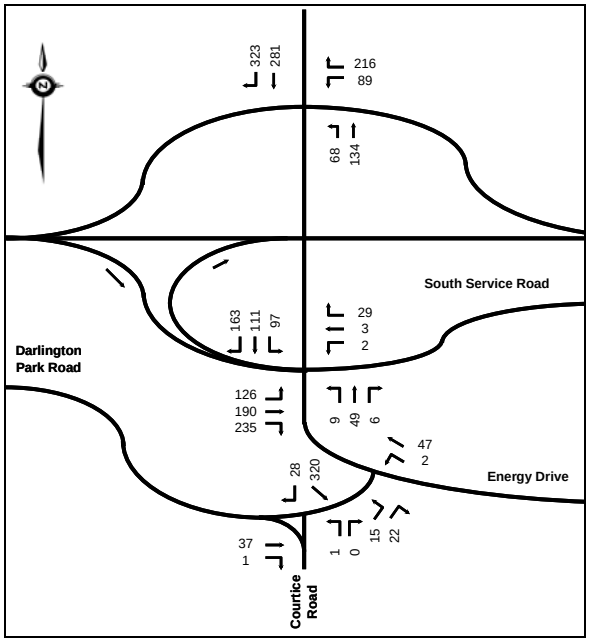


Figure 6-4 Future Background Traffic Volumes – 2013 PM Peak Hour

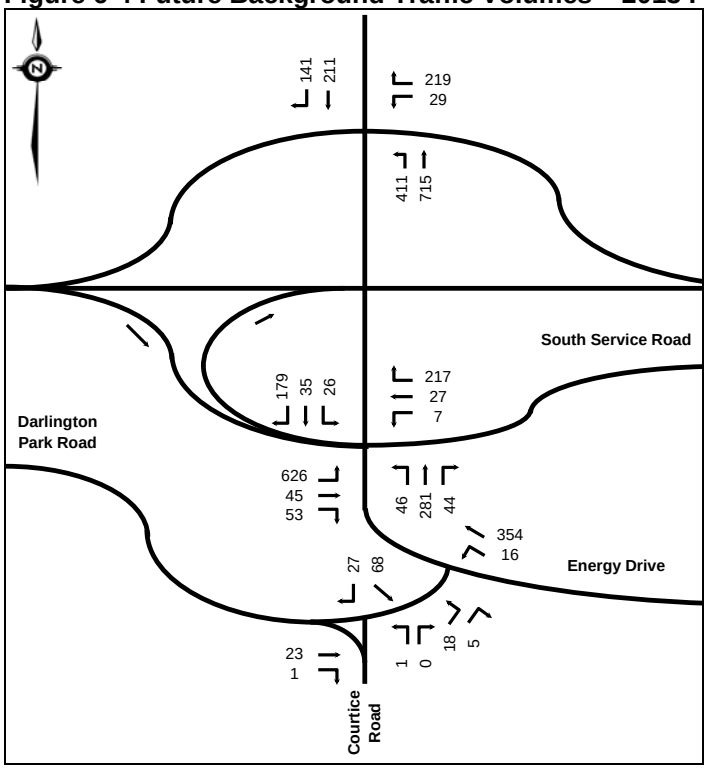


Figure 6-5 Future Background Traffic Volumes – 2023 AM Peak Hour

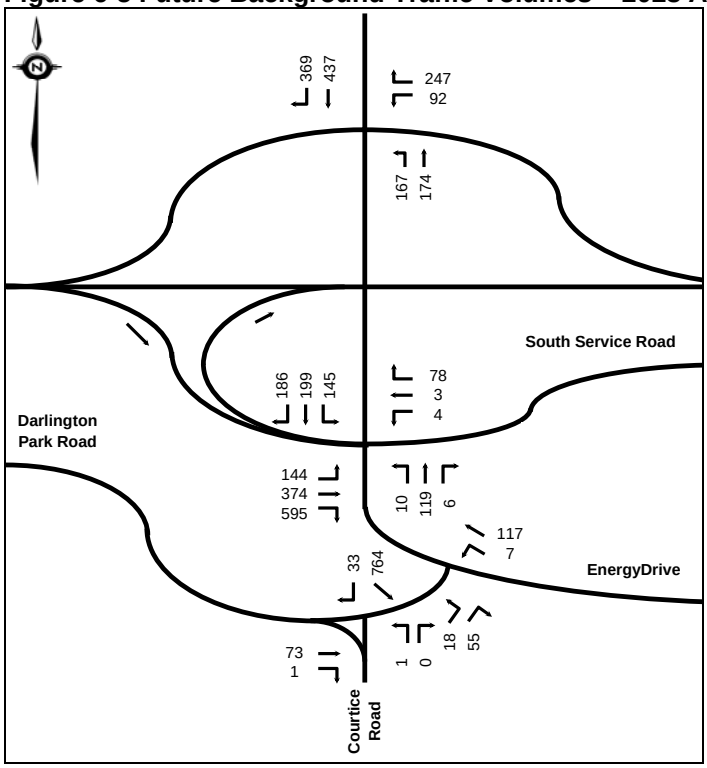
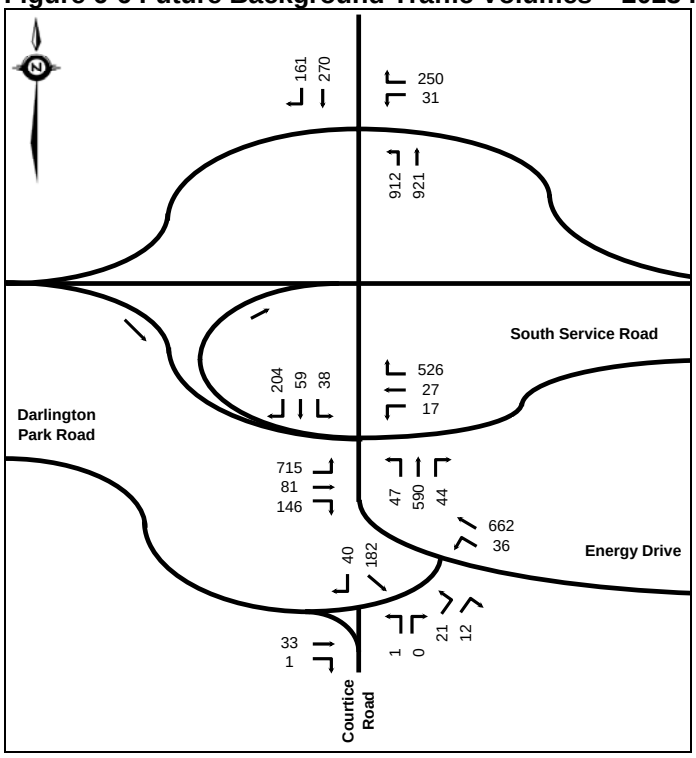


Figure 6-6 Future Background Traffic Volumes – 2023 PM Peak Hour



The following tables summarize the overall Level of Service (LOS), control delay, and v/c for the study area.

Table 6-4 Future Background Traffic Operations – 2013

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 13.0 s, 0.26	E, 42.6 s, 0.73
				WB Left Turn
Courtice Road / WB 401	Signalized	Intersection	B, 12.7 s, 0.46	B, 13.2 s, 0.58
		Critical Movements	-	-
Courtice Road / EB 401	Signalized	Intersection	B, 11.1 s, 0.50	C, 20.1 s, 0.85
		Critical Movements	-	-

Table 6-5 Future Background Traffic Operations – 2023

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Signalized	Intersection	B, 14.1 s, 0.65	C, 26.3 s, 0.94
		Critical Movements	-	NBL: D, 38.6, 0.94
Courtice Road / EB 401	Signalized	Intersection	B, 12.2 s, 0.69	F, 83.5 s, 1.04
		Critical Movements	-	EBL: F, >120 s, 1.04 NBT: F>120 s, 1.04

The analysis revealed deteriorated Levels of Service at the ramp terminal intersections in the p.m. peak hour under the future background traffic conditions. Specifically, the south ramp terminal intersection was found to operate at LOS "F" in the p.m. peak hour. The critical movements include eastbound left turn and northbound through.

6.4 Site Generated Traffic – Alternative Scenario 2 (400,000 tpy, 2023)

Site generated traffic for the Base Case (140,000 tpy) and Alternative Case 1 (250,000 tpy) were previously presented in Figures 5-1 through 5-4 in Section 5.2.3. Peak hour site traffic volumes for Alternative Case 2 (400,000 tpy) including the full build out of the CEBP are illustrated in Figures 6-7 and 6-8.

Figure 6-7 Site Generated Traffic (400,000) – 2023 AM Peak Hour

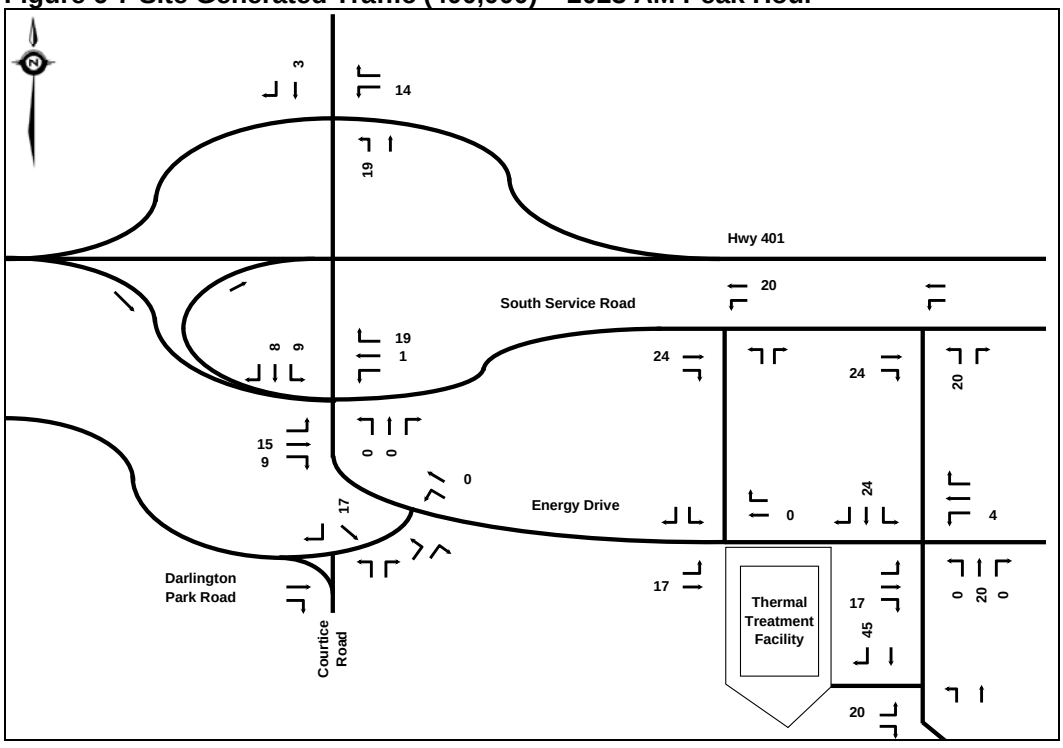
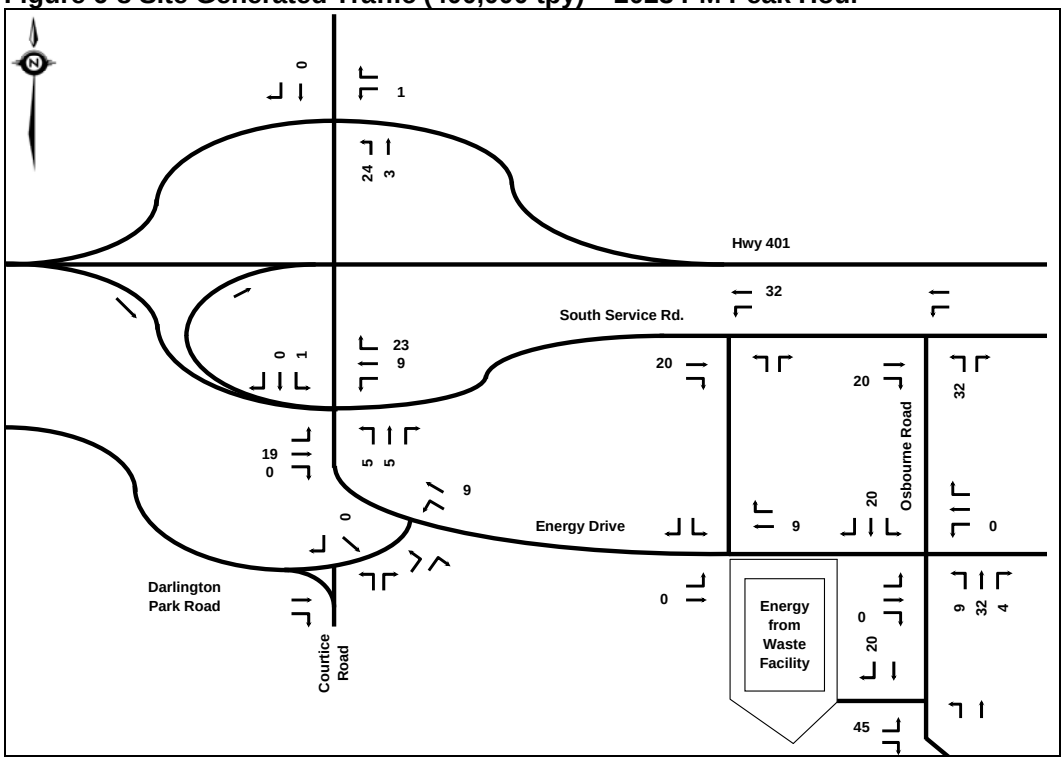


Figure 6-8 Site Generated Traffic (400,000 tpy) – 2023 PM Peak Hour



6.5 Future Total Traffic Conditions

The assessment of future traffic conditions was based on Base Case, and Alternative Cases 1 and 2 for the Site, specifically 140,000 tpy and 250,000 tpy capacity of the Facility and the 2013 horizon year, and the maximum design capacity of 400,000 tpy and the 2023 horizon year. As previously noted, the CEBP is assumed to be fully built-out by the ultimate horizon year of 2023. For the purpose of the 2013 horizon analysis, Phase 1 of the CEBP was assumed to be in place[5]. Phase 1 incorporates land uses within the park from Courtice Road easterly to Osborne Road.

No truck traffic associated with the Project will travel to and from the Site via the potential future Holt Road interchange. Therefore, no truck traffic associated with the Project was modeled to travel to and from the Site via the potential future Holt Road interchange.

6.5.1 Base Case – 140,000 tpy

The total future traffic on the boundary road network was based on the sum of the future background traffic (2013 horizon year) including partial build out of the CEBP and the Site traffic for the Project in the Base Case scenario (140,000 tpy).

Figures 6-9 and 6-10 illustrate future total traffic volumes for a.m. and p.m. peak hours, respectively.

[5] Clarington Energy Business Park Study, March 2005

It should be noted that the south ramp terminal intersection (W-N/S) was found to warrant traffic signals by 2013 assuming CEBP lands between Courtice Road and Osborne Road are fully developed. Traffic volumes at the north ramp terminal intersection (E-N/S) were found not to warrant the signals. Up to one-minute delays can be expected to apply to traffic on the off-ramp during the p.m. peak hour under the stop control.

Figure 6-9 Future Total Traffic Volumes (140,000 tpy) – 2013 AM Peak Hour

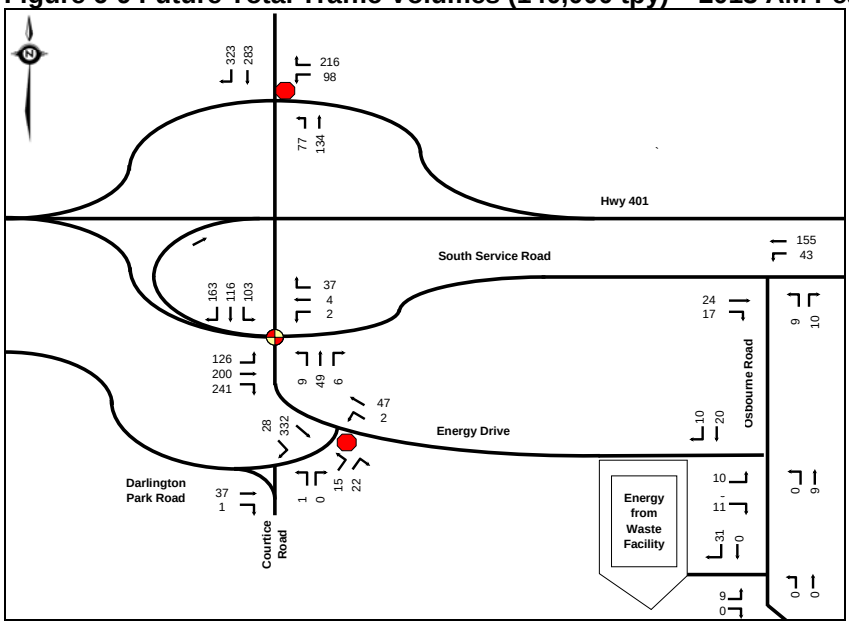


Figure 6-10 Future Total Traffic Volumes (140,000 tpy) – 2013 PM Peak Hour

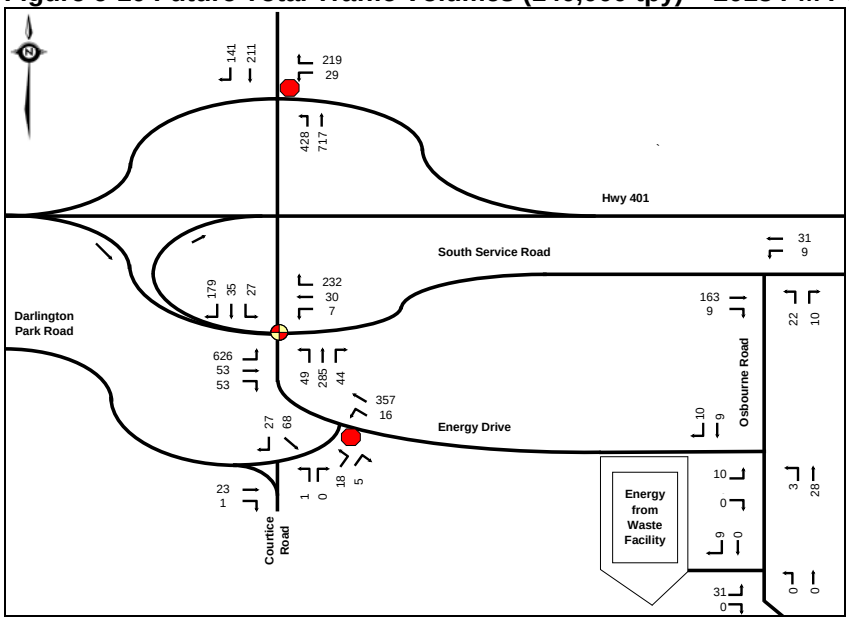


Table 6-6 summarizes the results of intersection analysis for the Base Case scenario. The analysis reveals overall acceptable levels of service with the exception of the north ramp terminal intersection, which was found to operate at LOS "F" in the p.m. peak hour under the stop control. Operations are improved to LOS "B" once the intersection is signalized.

Table 6-6 2013 Intersection Capacity Analysis – Base Case (140,000 tpy)

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 13.6, 0.31	F, 55.5, 0.79
		Critical Movements	-	WB LT
Courtice Road / WB 401	Signalized	Intersection	B, 12.6 s, 0.46	B, 12.2 s, 0.58
		Critical Movements	-	-
Courtice Road / EB 401	Signalized	Intersection	B, 11.1 s, 0.51	C, 20.1 s, 0.85
		Critical Movements	-	-
Energy Drive / Osborne Road	Unsignalized	Intersection	A, 9.7 s, 0.03	B, 10.0 s, 0.04
		Critical Movements	-	-
Park Drive / Osborne Road	Unsignalized	Intersection	A, 9.4 s, 0.01	A, 9.4 s, 0.04
		Critical Movements	-	-
Site Access / Osborne Road	Unsignalized	Intersection	A, 9.6 s, 0.01	A, 9.1 s, 0.03
		Critical Movements	-	-
Park Drive / Darlington Park Road	Unsignalized	Intersection	B, 10.8 s, 0.06	B, 11.2 s, 0.04
		Critical Movements	-	-

6.5.2 Alternative Case 1 – 250,000 tpy

The analysis of total future traffic on the boundary road network was based on the sum of the future background traffic (2013 horizon year) including partial build out of the CEBP and the Site traffic for the Project in Alternative Case 1 (250,000 tpy).

Figures 6-11 and 6-12 illustrate predicted future total traffic volumes for a.m. and p.m. peak hours, respectively.

It should be noted that the south ramp terminal intersection (W-N/S) was found to warrant traffic signals by 2013 assuming CEBP lands between Courtice Road and Osborne Road are fully developed. Traffic volumes at the north ramp terminal intersection (E-N/S) were found not to warrant the signals. Up to one-minute delays can be expected to apply to traffic on the off-ramp during the p.m. peak hour under the stop control.

Figure 6-11 Future Total Traffic Volumes (250,000 tpy) – 2013 AM Peak Hour

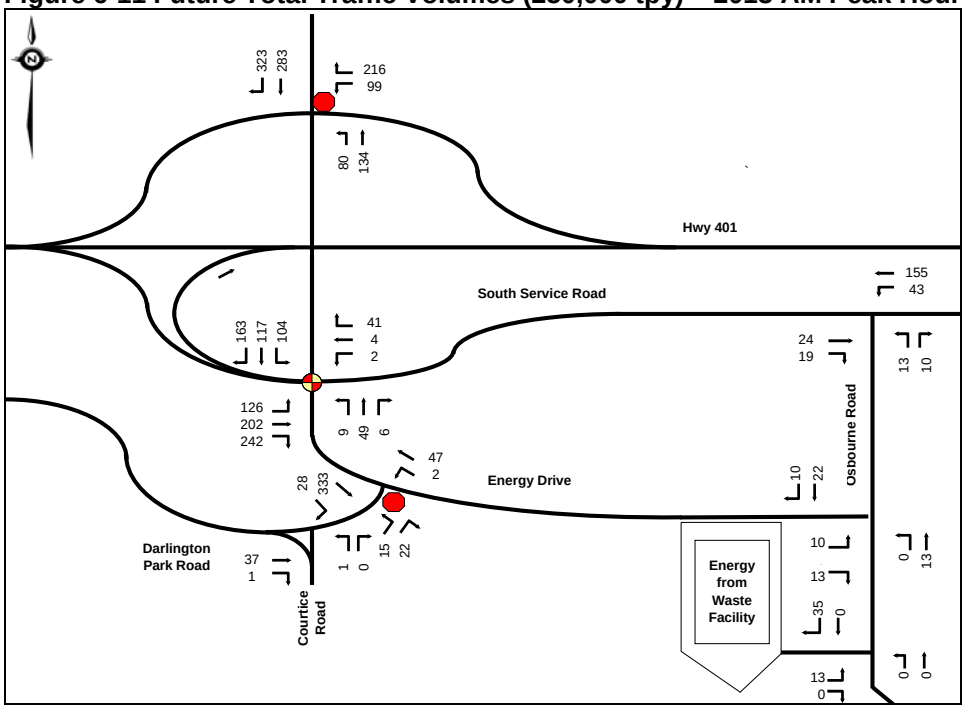


Figure 6-12 Future Total Traffic Volumes (250,000 try) – 2013 PM Peak Hour

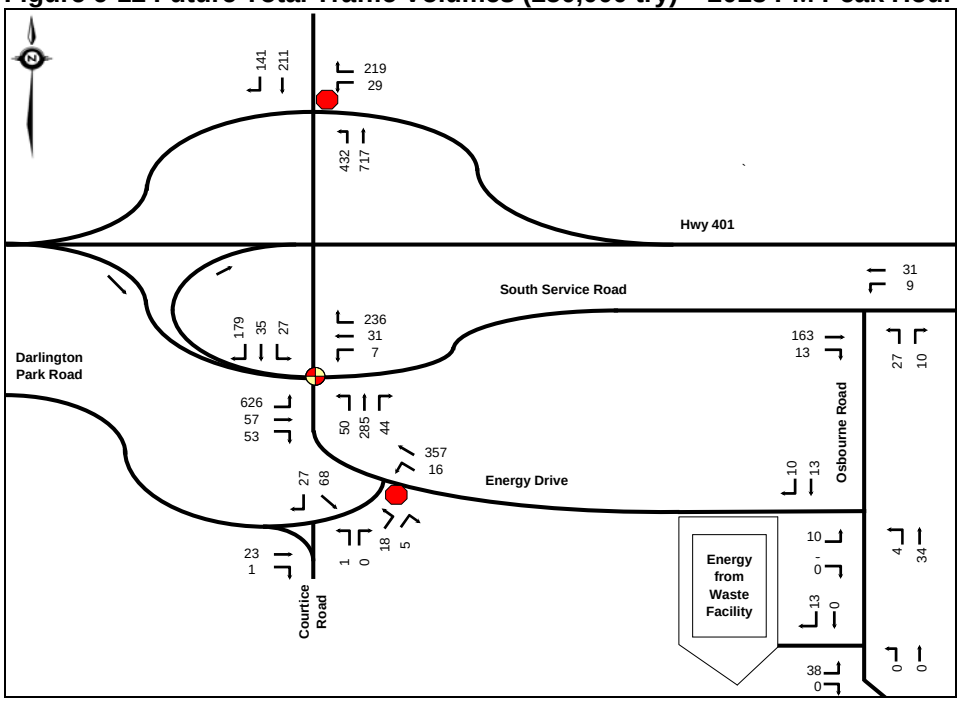


Table 6-7 summarizes 2013 traffic operations under the Alternative Case 1 (250,000 tpy).

Table 6-7 2013 Intersection Capacity Analysis – Alternative Case 1 (250,000 tpy)

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Unsignalized	Intersection	B, 13.8, 0.31	F, 60.5, 0.81
		Critical Movements	-	WB LT
Courtice Road / WB 401	Signalized	Intersection	B, 12.7 s, 0.46	B, 12.2 s, 0.58
		Critical Movements	-	-
Courtice Road / EB 401	Signalized	Intersection	B, 11.1 s, 0.51	C, 20.1 s, 0.85
		Critical Movements	-	-
Energy Drive / Osborne Road	Unsignalized	Intersection	A, 9.9 s, 0.03	B, 10.1 s, 0.05
		Critical Movements	-	-
Park Drive / Osborne Road	Unsignalized	Intersection	A, 9.5 s, 0.02	A, 9.5 s, 0.04
		Critical Movements	-	-
Site Access / Osborne Road	Unsignalized	Intersection	A, 9.6 s, 0.02	A, 9.1 s, 0.04
		Critical Movements	-	-
Park Drive / Darlington Park Road	Unsignalized	Intersection	B, 10.8 s, 0.06	B, 11.2 s, 0.04
		Critical Movements	-	-

As previously noted, the north ramp terminal intersection was found to operate at LOS “F” in the p.m. peak hour under the stop control (off-ramp approach) with an average vehicular delay of 60 seconds per vehicle. It should be noted that the threshold between LOS “E” and LOS “F” operations is 50 seconds. The Level of Service is improved to LOS “B” once the intersection is signalized. All other study area intersections were found to operate at good Levels of Service.

6.5.3 Alternative Case 2 – 400,000 tpy

The maximum design capacity of 400,000 tpy for the Facility was used to analyze traffic operations in the ultimate horizon year 2023. It was also assumed that the CEBP would be fully built-out by 2023, as discussed in Section 6.1 of this Report.

Figures 6-13 and 6-14 illustrate future total a.m. and p.m. peak hour volumes, respectively.

Traffic volumes at both ramp terminal intersections were found to warrant traffic signals by the 2023 horizon year with the full build-out of the CEBP.

Figure 6-13 Future Total Traffic Volumes (400,000 tpy) – 2023 AM Peak Hour

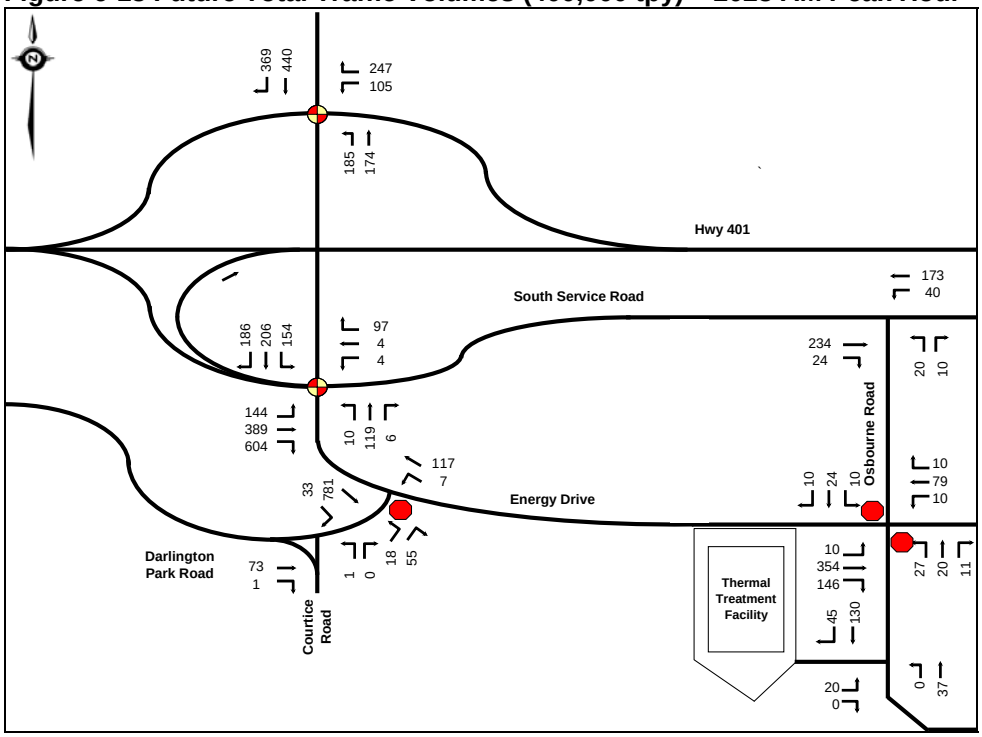


Figure 6-14 Future Total Traffic Volumes (400,000 tpy) – 2023 PM Peak Hour

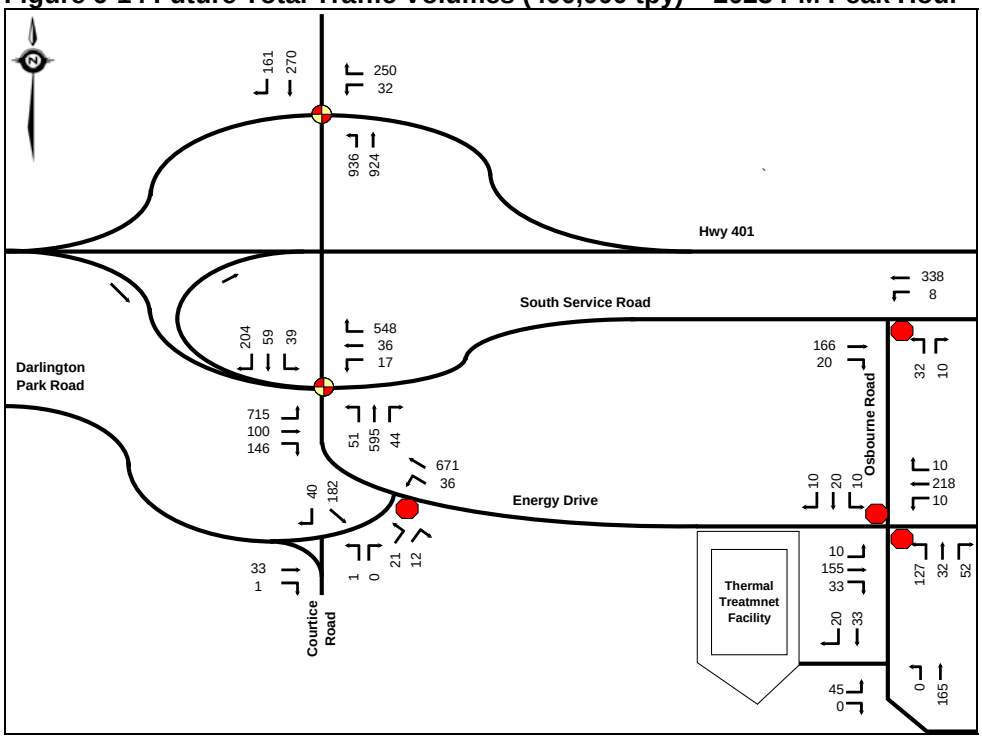


Table 6-8 summarizes the results of the intersection capacity analysis for the 2023 horizon year.

Table 6-8 2023 Intersection Capacity Analysis – Alternative Case 2 (400,000 tpy)

INTERSECTIONS			A.M. PEAK (LOS, Delay, v/c Ratio)	P.M. PEAK (LOS, Delay, v/c Ratio)
Courtice Road / WB 401	Signalized	Intersection	B, 14.3 s, 0.65	D, 30.2 s, 0.74
		Critical Movements	-	NBL: D, 48.9 s, 0.96
Courtice Road / EB 401	Signalized	Intersection	C, 12.6 s, 0.70	F, 88.1 s, 1.05
		Critical Movements	-	EBL: F, >120 s, 1.05 NBT: F, >120 s, 1.05
Energy Drive / Osborne Road	Unsignalized	Intersection	B, 12.1 s, 0.06	B, 12.5 s, 0.26
		Critical Movements	-	-
Park Drive / Osborne Road	Unsignalized	Intersection	C, 15.1 s, 0.14	C, 18.8 s, 0.45
		Critical Movements	-	-
Site Access / Osborne Road	Unsignalized	Intersection	B, 11.1 s, 0.03	B, 10.5 s, 0.06
		Critical Movements	-	-
Park Drive / Darlington Park Road	Unsignalized	Intersection	C, 17.5 s, 0.20	C, 15.5 s, 0.09
		Critical Movements	-	-

Similar to the future background analysis results, the south ramp terminal intersection (W-N/S) was found to operate at LOS “F” during the p.m. peak hour due to heavy left turning traffic. The average vehicular delay was calculated at 88 seconds per vehicle with longer delays for eastbound left turns and northbound through movements. It should be noted that the threshold between LOS “E” and LOS “F” operations is 80 seconds of delay (for signalized intersections). The 95th percentile queue on the off-ramp was calculated at approximately 240 metres in the p.m. peak hour under 2023 traffic conditions. The 95th percentile queue on the northbound approach was calculated at 248 metres for the same peak period. The 95th percentile northbound queue is expected to extend to the south ramp terminal intersection in the p.m. peak hour (2023 horizon). A loop ramp to accommodate traffic origination from the south and destined to the west (S-W) at this location would alleviate the queuing problem. In addition, CEBP traffic destined to Highway 401 west will have the flexibility in accessing Highway 401 by diverting to the future Holt Road interchange at the east end; however, this may result in minor out-of-way travel (back-tracking). In fact, approximately 270 northbound left turning vehicles at the north ramp terminal intersection at the Courtice Road interchange were found to be generated by the CEBP lands east of Osborne Road, which could potentially be diverted to the Holt Road interchange.

Widening of Courtice Road to four lanes could accommodate the anticipated traffic demand associated with the future CEBP. Once Courtice Road is widened, the eastbound approach at the south ramp terminal intersection can incorporate a second left turn lane to minimize traffic queues and delays on the off-ramp. The need for the double left turn is driven by growth in background traffic on Courtice Road, and not the CEBP. With the double left turn lane in place, green time for northbound traffic can be increased resulting in reduced queues and delays on the northbound approach.

The northbound left turn lane at the north ramp terminal intersection is expected to carry over 900 vehicles per hour during the p.m. peak hour. As previously noted, the majority of CEBP-generated traffic was assigned to the Courtice Road interchange. With the future improvements to the Holt Road interchange, additional diversion of traffic from the Courtice Road interchange is expected, resulting in potential reduction of traffic in the northbound left turn lane at the north ramp terminal intersection (Highway 401/Courtice Road interchange).

All other study area intersections were found to operate at good levels of service under the ultimate 2023 traffic conditions and assumed road network/lane configurations.

6.6 Highway 401 Widening and Improvements to Courtice Road/Highway 401 Interchange

At the time of preparation of this Report, the Ministry of Transportation was undertaking a Highway 407 study, which incorporates the East Durham Link, a freeway connection between Highway 401 and the future Highway 407 extension. The East Durham Link will be situated immediately east of Courtice Road with ramps to and from Highway 401. The future interchange with Highway 401 (i.e., directional ramps to and from Highway 401 from and to the East Durham Link) is likely to impact the lands on the south side of Highway 401, which are designated for the future CEBP. In addition, the future improvements to the Highway 401/Courtice Road interchange may preclude certain roadways from being constructed within the CEBP as identified in the Municipality of Clarington Official Plan.

The analysis undertaken as part of this study, assumed the future road network that was provided in the Municipality of Clarington Official Plan. A supplementary analysis may be required to incorporate potential changes to the study area road network due to Highway 401 widening and improvements to the Courtice Road/Highway 401 interchange once designs are finalized.

7.0 SUMMARY AND CONCLUSIONS

The following provides conclusions and recommendations based on the results of the traffic analysis:

- Both ramp terminal intersections (Courtice Road/Highway 401) were found to operate acceptably under existing traffic conditions, lane configurations and traffic control. Traffic signals are not warranted at either ramp terminal intersection, and are not expected to be warranted at the time of construction.
- Access to the Facility would be provided via Courtice Road, South Service Road and Osborne Road;
- Construction of the Facility is expected to generate the most traffic in 2012-2013, although with the lowest truck volumes. Construction in 2012-2013 is expected to generate up to 1 truck and 120 cars (two-way) in the peak hour.
- Study area intersections are expected to operate at good Levels of Service during construction. Construction generated traffic is not expected to have adverse traffic effects at the ramp terminal intersections and other study area intersections.
- Road/pavement improvements may be required for South Service Road and Osborne Road to accommodate traffic associated with either construction or operations. Pavement testing along the haul route will be completed by the Region of Durham if the Project is approved to confirm if road reconstruction/pavement improvements are required. No other mitigation is required to address Project related traffic during construction or operations.
- The Facility is expected to generate 34 daily truck trips in the Base Case scenario (140,000 tpy), 51 daily truck trips in Alternative Case 1 (250,000 tpy) and 77 daily truck trips in Alternative Case 2 (400,000 tpy) ;
- The Facility is expected to generate 18 trucks (inbound and outbound) and 22 cars during the peak hour in the Base Case scenario (140,000 tpy). Alternative Cases 1 and 2 (250,000 tpy and 400,000 tpy) are expected to generate 26 truck/22 cars and 40 truck/22 cars, respectively;
- Ramp terminal intersections were found to operate acceptably during both a.m. and p.m. peak hours during operations of the Facility;
- No traffic control measures are required on the adjacent road network to accommodate traffic during operations of the Facility;
- The future total traffic analysis without the build-out of the CEBP (assuming growth in background traffic based on historical traffic data) revealed acceptable operations at all study area intersections;
- The future CEBP (excluding traffic generated by the Project) is expected to generate approximately 2,100 two-way trips during peak hours once fully built-out. Traffic associated with a partial build-out of the subject lands (Courtice Road to Osborne Road by 2013) was calculated to be in the 800 to 900 vehicles per hour range;
- The Project is anticipated to account for 2%-3% of the total trips generated in the fully built-out CEBP; and,

- Both ramp terminal intersections could require traffic signals by the ultimate 2023 horizon year with the full build-out of the CEBP. With the partial development of the subject lands assumed for the 2013 horizon year, only the south ramp terminal intersection is expected to require traffic signals. Traffic on the westbound approach (off-ramp) at the north ramp terminal intersection is expected to experience delays of up to one minute during the p.m. peak hour with a stop control. Widening of Courtice Road through the interchange could improve traffic operations at the south ramp terminal intersection in the ultimate 2023 horizon year. Other improvements at the ramp terminal intersections include exclusive left and right turn lanes on some approaches, assuming partial or full build out of the CEBP.

APPENDIX A

Levels of Service Definitions

LEVEL OF SERVICE
FOR
SIGNALIZED INTERSECTIONS
(Highway Capacity Manual, 2000)

The assessment of operations for signalized intersections is based on the results of the Highway Capacity Software (HCS), which is based on the methodology in the Highway Capacity Manual, 2000.

Level of service for signalized intersections is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the control delay per vehicle for a 15-minute analysis period.

LOS A described operations with very low delay, up to 10 seconds per vehicle. This level of service occurs when progression is extremely favourable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes operations with delay greater than 10 and up to 20 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

LOS C describes operations with delay greater than 20 and up to 35 seconds per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes operations with delay greater than 35 and up to 55 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavourable progression, long cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes operations with delay greater than 55 and up to 80 seconds per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

LOS F describes operations with delay in excess of 80 seconds per vehicle. This level, considered to be unacceptable to most drivers, often occurs with over-saturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Level of Service	Stopped Delay Per Vehicle (Seconds)
A	$\leq$ 10.0
B	> 10.0 and $\leq$ 20.0
C	> 20.0 and $\leq$ 35.0
D	> 35.0 and < 55.0
E	> 55.0 and $\leq$ 80.0
F	> 80.0

LEVEL OF SERVICE
FOR
UNSIGNALIZED INTERSECTIONS
(TWO-WAY AND ALL-WAY STOP CONTROL)

The assessment of operations for unsignalized intersections is based on the results of the Highway Capacity Software (HCS), which is based on the methodology in the Highway Capacity Manual, 2000.

Level of service for two-way stop controlled intersections is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average control delay per vehicle for a 15-minute analysis period.

Level of Service	Average Total Delay (Seconds/Vehicle)
A	$\leq$ 10
B	> 10 and < 15
C	> 15 and $\leq$ 25
D	> 25 and $\leq$ 35
E	> 35 and $\leq$ 50
F	> 50

APPENDIX B

Technical Memorandum - Estimate Number of Vehicles During Operations

Technical Memorandum – Estimate Number of Vehicles during Operations

1.0 Introduction

1.1 Purpose of this Technical Memorandum

This technical memorandum presents the rationale behind the calculation of the estimated number of additional vehicles entering and leaving the Durham/York thermal treatment facility location in Clarington during operations.

The current and future waste management systems are first explained in Section 2 which details how residual waste is and will be transported to the disposal facility. Section 3 discusses the rationale behind the three facility sizes under consideration, the base case of a 140,000 tpy thermal treatment facility, an alternate case of 250,000 tpy and a second alternate case of 400,000 tpy. Section 4 explains how the waste will be supplied to the thermal treatment facility located in Clarington. Section 5 identifies additional trucks, in addition to the trucks delivering waste to the facility associated with facility operations. Section 6 presents the estimated number of additional vehicles for a facility located in Clarington.

2.0 Current and Future Waste Management System

2.1 Durham Region

Presently residual solid waste is collected from the curbside in packer trucks and taken to several transfer stations. At these transfer stations, waste is loaded into transfer trailers and hauled to a remote landfill in Michigan for disposal. Waste from the Townships of Uxbridge and Scugog, the Towns of Pickering and Ajax and the Regional Waste Management Facilities (WMF) in Port Perry and Oshawa is taken to the Pebblestone Multi-Service Transfer Station in Pickering, located south of Bayly Street and east of Brock Road. Waste from the Town of Whitby and the City of Oshawa is taken to the Miller Waste Transfer Station in Whitby, located on Wentworth Street, east of Thickson Road South. Waste from the Municipality of Clarington is taken to the Waste Management transfer station in Courtice, located north of Highway 401 and east of Courtice Road. Waste from the Township of Brock and the Brock Regional WMF is disposed at the Brock landfill site. In the future, Durham Region is planning to increase its diversion efforts to reduce the overall quantity of waste requiring disposal and send the remaining, approximately 110,000 tonnes per year (tpy) of, residual waste to the proposed thermal treatment facility.

2.2 York Region

Presently residual solid waste is collected from the curbside in packer trucks and taken to several transfer stations. At the transfer stations, it is loaded into transfer trailers and hauled to remote landfills in Michigan and South Western Ontario for disposal. Waste from the Town of Georgina is taken to the Georgina transfer station located at Warden Avenue and Ravenshoe Road. Waste from the northern

municipalities including, the Township of East Gwillimbury, Township of King, and the Towns of Newmarket, Aurora and Whitchurch-Stouffville are taken to the Region's Waste Management Centre (WMC) located in the Davis Drive and Woodbine Avenue area, in East Gwillimbury. The balance of the solid waste from the southern municipalities including the City of Vaughan and the Towns of Richmond Hill and Markham, is taken to the Miller Waste transfer station located in Markham, off Woodbine Avenue, south of Highway 407. In the future, York Region is planning to increase its diversion efforts to reduce the overall quantity of waste requiring disposal. It is assumed that 20,000 tonnes per year (tpy) of the remaining residual waste will be sent to the proposed thermal treatment facility, 100,000 tpy of residual waste will be transported to the Dongara facility in Vaughan and the balance will be transported to the Green Lane landfill in South Western Ontario. If for any reason, the Dongara facility is unable to take York's waste, then York would send 120,000 tonnes per year to the thermal treatment facility.

3.0 Thermal Treatment Facility Sizes

In summary, there are three thermal treatment facility size scenarios under consideration: the base case of 140,000 tonnes per year (tpy), an alternate case of 250,000 tpy and a second alternate case of 400,000 tpy.

Base Case – 140,000 tpy

In the base case scenario, the Region of Durham will send 110,000 tpy of residual waste to the thermal treatment facility. This quantity includes curbside residential waste, waste collected at the Regional Waste Management Facilities (WMF), and residual waste from the Durham Region Material Recycling Facility in Whitby.

In the base case facility size scenario, York Region will send 20,000 tonnes per year to the thermal treatment facility.

In addition to the 130,000 tpy coming to the facility from Durham and York, 10,000 tpy is available for either municipality as a contingency plan, should they need to use it. For the purposes of this study, it is assumed that all 10,000 tpy of contingency will be delivered to the facility via transfer trailers.

Alternative Case 1 – 250,000 tpy

In Alternate Case 1, the Region of Durham will send 130,000 tpy of residual waste to the thermal treatment facility. The 130,000 tpy includes the 110,000 tpy from the base case plus an additional 20,000 tpy to account for population growth and corresponding waste generation outpacing diversion.

Alternate Case 1, assumes that the Dongara facility does not take York's waste, therefore York will send 120,000 tpy to the thermal treatment facility.

Alternative Case 2 – 400,000 tpy

400,000 tpy is the maximum capacity of the thermal treatment facility. In Alternate Case 2, an assumption is made that the Region of Durham and York will each send 200,000 tpy of residual waste to the thermal treatment facility.

Table 3-1 summarizes the annual quantities associated with these two scenarios.

Table 3-1 Quantity of Residual Waste to be Managed by the EFW Facility Size Scenarios

Source of Waste	Base Case Quantity (tpy)	Alternative Case 1 (tpy)	Alternative Case 2 (tpy)
Durham	110,000	130,000	200,000
York	20,000	120,000	200,000
Contingency	10,000	0	0
Total	**140,000**	**250,000**	**400,000**

4.0 Waste Supply to the Thermal Treatment Facility

It is assumed that residual waste from York Region and most of the Region of Durham will be transported in transfer trailer trucks.

Under all three scenarios:

- Waste from the host Municipality of Clarington would be transported directly to the thermal treatment facility in packer trucks; and,
- Waste from the Durham Region waste management facilities (including the Miller Waste Transfer Station in Whitby, and Pebblestone Multi-Service Transfer Station in Pickering) would be transported directly to the facility via transfer trailer trucks.

For the 140,000 tpy facility, 20,000 tpy of residual waste from York Region will be transported in transfer trailers from the Miller Waste Transfer Station located in Markham.

For the 250,000 tpy facility, 120,000 tpy of York Region's residual waste from both the Miller Waste Transfer Station and the Waste Management Centre (WMC) will be transported to the thermal treatment facility in transfer trailer trucks.

For the 400,000 tpy facility, 200,000 tpy of York Region's residual waste from both the Miller Waste Transfer Station and the Waste Management Centre (WMC) will be transported to the thermal treatment facility in transfer trailer trucks.

5.0 Additional Truck Traffic

In addition to the trucks delivering waste to the facility there are additional trucks associated with the transportation of bottom ash or char, air pollution control (APC) system residue and fly ash, and chemicals used in the air pollution control or syngas cleaning systems.

5.1 Bottom and Fly Ash Truck Traffic

Ash will be transported from the thermal treatment facility to final disposal in transfer trailer trucks. It has been assumed that the transfer trailers each hold approximately 40 tonnes of bottom ash and 20 tonnes of fly ash.

The thermal treatment facility will generate the following amount of bottom and fly ash during operations:

Table 5-1 Quantity of Ash Generated by the EFW Facility Size Scenarios

	Amount Generated (tpy)		
	Base Case Quantity 140,000 (tpy)	**Alternative Case 1 250,000 (tpy)**	**Alternative Case 2 400,000 (tpy)**
Bottom Ash	29,400	52,500	84,000
Fly Ash	8,400	15,000	24,000

Table 5-2 summarizes the estimated number of trucks required to remove bottom and fly ash from the facility under each facility size scenario.

Table 5-2 Number of Trucks Needed to Remove Ash from the EFW Facility

Type/Use	**Number of Trucks per Day**[1]		
	Base Case Quantity 140,000 (tpy)	**Alternative Case 1 250,000 (tpy)**	**Alternative Case 2 400,000 (tpy)**
Bottom Ash	3	6	9
Fly Ash	2	3	5
TOTAL	**5**	**9**	**14**

5.2 Chemical Supply Truck Traffic

The thermal treatment facility will use the following amount of reagents during operations:

Table 5-3 Quantity of Reagents to be Used by the EFW Facility

Reagent		**Amount Used (tpy)**		
	Amount Used kg/tonne	**Base Case Quantity 140,000 (tpy)**	**Alternative Case 1 250,000 (tpy)**	**Alternative Case 2 400,000 (tpy)**
Lime	9.09	1,272.6	2,272.5	3636
Ammonia or Urea	0.50	70	125	200

[1] Assume annual quantity of waste is supplied over 250 days per year

Powered Activated Carbon	0.62	86.8	155	248
Portland Cement	5.67	793.8	1,417.5	2268
Pozzolan	5.16	722.4	1290	2064

It has been assumed that 32 tonne trucks will be used to deliver the reagents to the facility. The number of trucks required to deliver reagents to the facility includes:

Table 5-4 Number of Trucks Needed to Deliver Reagents to the EFW Facility

Reagent	Number of Trucks		
	Base Case Quantity 140,000 (tpy)	**Alternative Case 1 250,000 (tpy)**	**Alternative Case 2 400,000 (tpy)**
Lime	1 per week /52 per year	93/year	149/year
Ammonia or Urea	2 per month/24 per year	43/year	69/year
Powered Activated Carbon	1 every four months/3 per year	6/year	9/year
Portland Cement	3 per month /36 per year	65/year	103/year
Pozzolan	3 per month /36 per year	65/year	103/year

It is estimated that at most, two of the above reagent trucks will be at the facility at the same time.

5.3 Ferrous and Non-Ferrous Metal Truck Traffic

Ferrous and non-ferrous metals are recovered from the bottom ash. The number of trucks required to remove ferrous and non-ferrous metals from the facility includes:

Table 5-5 Number of Ferrous and Non-Ferrous Trucks Needed by the EFW Facility

	Number of Trucks		
	Base Case Quantity 140,000 (tpy)	**Alternative Case 1 250,000 (tpy)**	**Alternative Case 2 400,000 (tpy)**
Ferrous Metals	three, 20-tonne, trucks per week/156 per year	279/year	446/year
Non-Ferrous Metals	one 20-tonne truck every two months/6 per year	11/year	18/year

It is estimated that at most, two of the above ferrous and non-ferrous metals trucks will be at the facility at the same time.

6.0 Results

The estimated number of trucks for the different facility sizes (140,000 tpy, 250,000 tpy, and 400,000 tpy) is presented below.

6.1 Waste Supply Trucks

Tables 6-1, 6-2, and 6-3 summarize the estimated number of new waste supply trucks for the base case and alternative facility size scenarios, respectively.

Table 6-1 Number of Waste Supply Trucks for a 140,000 tpy EFW Facility

Source of Waste	Annual Quantity (tonnes)	Type of Truck	Truck Capacity (tonnes)	Number of New Trucks per Day [2]
York Region	20,000	Transfer Trailer	32	3
Region of Durham *(not including Municipality of Clarington)*	96,290	Transfer Trailer	32	13
Municipality of Clarington	14,709	Packer	9	7
Contingency	10,000	Transfer Trailer	32	2
TOTAL	**140,000**			**25**

Table 6-2 Number of Waste Supply Trucks for a 250,000 tpy EFW Facility

Source of Waste	Annual Quantity (tonnes)	Type of Truck	Truck Capacity (tonnes)	Number of New Trucks per Day [3]
York Region	120,000	Transfer Trailer	32	15
Region of Durham *(not including Municipality of Clarington)*	113,797	Transfer Trailer	32	15
Municipality of Clarington	16,203	Packer	9	8
TOTAL	**250,000**			**38**

Table 6-3 Number of Waste Supply Trucks for a 400,000 tpy EFW Facility

Source of Waste	Annual Quantity (tonnes)	Type of Truck	Truck Capacity (tonnes)	Number of New Trucks per Day [4]
York Region	200,000	Transfer Trailer	32	25
Region of Durham *(not including Municipality of Clarington)*	175,073	Transfer Trailer	32	22
Municipality of Clarington	24,927	Packer	9	12
TOTAL	**400,000**			**59**

[2] Assume annual quantity of waste is supplied over 250 days per year
[3] Assume annual quantity of waste is supplied over 250 days per year
[4] Assume annual quantity of waste is supplied over 250 days per year

6.2 Additional Truck Traffic

As mentioned in Section 5 above, there are other trucks, in addition to the residual waste, that will be entering and leaving the EFW facility. These include ash trucks, chemical supply vehicles, and ferrous and non-ferrous metal trucks. Table 6-4 summarizes the estimated number of additional truck traffic.

Table 6-4 Additional Truck Traffic

Type/Use	Number of Additional Trucks per Day [5]		
	Base Case Quantity 140,000 (tpy)	Alternative Case 1 250,000 (tpy)	Alternative Case 2 400,000 (tpy)
Bottom Ash	3	6	9
Fly Ash	2	3	5
Chemical Supplies	2	2	2
Ferrous and Non-Ferrous Metal	2	2	2
TOTAL	**9**	**13**	**18**

6.3 Summary of Number of Trucks

Table 6-5 presents a summary of the total estimated number of trucks per day required for the base case and the alternative case facility size scenarios.

Table 6-5 Summary of Number of Trucks Per Day

Type/Use	Total Number of Trucks per Day [6]		
	Base Case Quantity 140,000 (tpy)	Alternative Case 1 250,000 (tpy)	Alternative Case 2 400,000 (tpy)
Waste Supply	25	38	59
Additional Trucks	9	13	18
TOTAL	**34**	**51**	**77**

6.4 Additional Vehicles

It is assumed that the maximum number of staff vehicles onsite at one time is 33 vehicles.

Visitors and tour buses are expected to come by the facility. It is estimated that five visitors would visit per week (or 1 per day) and one tour bus will come to the facility per month (or 0.048 per day).

[5] Assume annual quantity of waste is supplied over 250 days per year
[6] Assume annual quantity of waste is supplied over 250 days per year

APPENDIX C

Capacity Analysis outputs – Existing Conditions

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:	
Project ID:	
East/West Street:	Hwy 401 on-off ramps
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	22	123		210	305	
Peak-Hour Factor, PHF	0.95	0.95		0.95	0.95	
Hourly Flow Rate, HFR	23	129		221	321	
Percent Heavy Vehicles	20	--	--	--	--	
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	23		204			
Peak Hour Factor, PHF	0.95		0.95			
Hourly Flow Rate, HFR	24		214			
Percent Heavy Vehicles	14		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)	23			238				
C(m) (vph)	942			1010				
v/c	0.02			0.24				
95% queue length	0.08			0.92				
Control Delay	8.9			10.5				
LOS	A			B				
Approach Delay				10.5				
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:	
Project ID:	
East/West Street:	Hwy 401 on-off ramps
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	22	123			210	305
Peak-Hour Factor, PHF	0.95	0.95			0.95	0.95
Peak-15 Minute Volume	6	32			55	80
Hourly Flow Rate, HFR	23	129			221	321
Percent Heavy Vehicles	20	--	--		--	--
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	23		204			
Peak Hour Factor, PHF	0.95		0.95			
Peak-15 Minute Volume	6		54			
Hourly Flow Rate, HFR	24		214			
Percent Heavy Vehicles	14		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:	129	
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)	20		14		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)	20		14		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	542		557		129			
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	129	
Potential Capacity	908	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	908	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		542
Potential Capacity		942
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		942
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.97

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	0.97	0.97

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	557	
Potential Capacity	472	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.75
Movement Capacity	460	

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	0.97	0.97
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	557	
Potential Capacity	472	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.75
Movement Capacity	460	
Results for Two-stage process:		
a		
y		
C t	460	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	24		214			
Movement Capacity (vph)	460		908			
Shared Lane Capacity (vph)		827				

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	460		908			
Volume	24		214			
Delay	13.3		10.2			
Q sep	0.09		0.61			
Q sep +1	1.09		1.61			
round (Qsep +1)	1		2			
n max		2				
C sh		827				
SUM C sep		1010				
n		2				
C act		1010				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	23			238				
C(m) (vph)	942			1010				
v/c	0.02			0.24				
95% queue length	0.08			0.92				
Control Delay	8.9			10.5				
LOS	A			B				
Approach Delay				10.5				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	129	
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)	0.97	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.2	

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: Existing Conditions
Project ID:
East/West Street: Hwy 401 E-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		41	615		196	133	
Peak-Hour Factor, PHF		0.95	0.95		0.95	0.95	
Hourly Flow Rate, HFR		43	647		206	140	
Percent Heavy Vehicles		0	--	--	--	--	
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		15		207			
Peak Hour Factor, PHF		0.95		0.95			
Hourly Flow Rate, HFR		15		217			
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)	43			232				
C(m) (vph)	1224			499				
v/c	0.04			0.46				
95% queue length	0.11			2.43				
Control Delay	8.0			19.5				
LOS	A			C				
Approach Delay				19.5				
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: Existing Conditions
Project ID:
East/West Street: Hwy 401 E-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	41	615			196	133
Peak-Hour Factor, PHF	0.95	0.95			0.95	0.95
Peak-15 Minute Volume	11	162			52	35
Hourly Flow Rate, HFR	43	647			206	140
Percent Heavy Vehicles	0	--	--		--	--
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	15		207			
Peak Hour Factor, PHF	0.95		0.95			
Peak-15 Minute Volume	4		54			
Hourly Flow Rate, HFR	15		217			
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:	647	
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)	0		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	4.1		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)	0		42		4			
t(f)	2.2		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	346		1009		647			
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	647	
Potential Capacity	467	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	467	
Probability of Queue free St.	0.54	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		346
Potential Capacity		1224
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1224
Probability of Queue free St.	1.00	0.96
Maj L-Shared Prob Q free St.		0.94

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	0.94	0.94

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	1009	
Potential Capacity	225	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.94
Maj. L, Min T Adj. Imp Factor.		0.96
Cap. Adj. factor due to Impeding mvmnt	0.96	0.51
Movement Capacity	217	

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	0.94	0.94
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	1009	
Potential Capacity	225	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.94
Maj. L, Min T Adj. Imp Factor.		0.96
Cap. Adj. factor due to Impeding mvmnt	0.96	0.51
Movement Capacity	217	
Results for Two-stage process:		
a		
y		
C t	217	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	15		217			
Movement Capacity (vph)	217		467			
Shared Lane Capacity (vph)		435				

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	217		467			
Volume	15		217			
Delay	22.8		19.2			
Q sep	0.10		1.16			
Q sep +1	1.10		2.16			
round (Qsep +1)	1		2			
n max		2				
C sh		435				
SUM C sep		499				
n		2				
C act		499				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	43			232				
C(m) (vph)	1224			499				
v/c	0.04			0.46				
95% queue length	0.11			2.43				
Control Delay	8.0			19.5				
LOS	A			C				
Approach Delay				19.5				
Approach LOS				C				

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	647	
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)	0.94	
d(M,LT), Delay for stream 1 or 4	8.0	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

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: Existing Volumes
Project ID:
East/West Street: Hwy 401 W-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		3	10	3	67	13	154
Peak-Hour Factor, PHF		0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR		3	10	3	70	13	162
Percent Heavy Vehicles		0	--	--	8	--	--
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	2	17	119	72	11
Peak Hour Factor, PHF		0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR		4	2	17	125	75	11
Percent Heavy Vehicles		17	0	0	8	0	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	70	6		17	162		48
C(m) (vph)	1414	1567	555		1074	726		752
v/c	0.00	0.04	0.01		0.02	0.22		0.06
95% queue length	0.01	0.14	0.03		0.05	0.85		0.20
Control Delay	7.6	7.4	11.6		8.4	11.4		10.1
LOS	A	A	B		A	B		B
Approach Delay				9.2			11.1	
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: Existing Volumes
Project ID:
East/West Street: Hwy 401 W-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	3	10	3	67	13	154
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	1	3	1	18	3	41
Hourly Flow Rate, HFR	3	10	3	70	13	162
Percent Heavy Vehicles	0	--	--	8	--	--
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	2	17	119	72	11
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	1	1	4	31	19	3
Hourly Flow Rate, HFR	4	2	17	125	75	11
Percent Heavy Vehicles	17	0	0	8	0	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:	10	13
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	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	8	17	0	0	8	0	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	7.3	6.5	6.2	7.2	6.5	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	8	17	0	0	8	0	0
t(f)	2.2	2.3	3.7	4.0	3.3	3.6	4.0	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	175	13	295	333	12	171	172	13
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	13
Potential Capacity	1074	1073
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1074	1073
Probability of Queue free St.	0.98	0.99
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	13	175
Potential Capacity	1567	1414
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1567	1414
Probability of Queue free St.	0.96	1.00
Maj L-Shared Prob Q free St.	0.95	1.00
Step 3: TH from Minor St.	**8**	**11**
Conflicting Flows	333	172
Potential Capacity	590	725
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95

Movement Capacity	562	691
Probability of Queue free St.	1.00	0.89

Step 4: LT from Minor St.	7	10

Conflicting Flows	295	171
Potential Capacity	629	779
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.85	0.95
Maj. L, Min T Adj. Imp Factor.	0.88	0.96
Cap. Adj. factor due to Impeding mvmnt	0.88	0.95
Movement Capacity	551	737

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	333	172
Potential Capacity	590	725
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	562	691
Result for 2 stage process:		
a		
y		
C t	562	691
Probability of Queue free St.	1.00	0.89
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	295	171
Potential Capacity	629	779
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.85	0.95
Maj. L, Min T Adj. Imp Factor.	0.88	0.96
Cap. Adj. factor due to Impeding mvmnt	0.88	0.95
Movement Capacity	551	737
Results for Two-stage process:		
a		
y		
C t	551	737

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	2	17	125	75	11
Movement Capacity (vph)	551	562	1074	737	691	1073
Shared Lane Capacity (vph)	555			726		752

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	551	562	1074	737	691	1073
Volume	4	2	17	125	75	11
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	555			726		752
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	70	6		17	162		48
C(m) (vph)	1414	1567	555		1074	726		752
v/c	0.00	0.04	0.01		0.02	0.22		0.06
95% queue length	0.01	0.14	0.03		0.05	0.85		0.20
Control Delay	7.6	7.4	11.6		8.4	11.4		10.1
LOS	A	A	B		A	B		B
Approach Delay				9.2			11.1	
Approach LOS				A			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.96
v(il), Volume for stream 2 or 5	10	13
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	0.95
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	0.3

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:	Existing Volumes
Project ID:	
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	11	4	29	13	169
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR	4	11	4	30	13	177
Percent Heavy Vehicles	0	--	--	7	--	--
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	2	53	591	30	6
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR	1	2	55	622	31	6
Percent Heavy Vehicles	25	0	0	3	0	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	30	3		55	622		37
C(m) (vph)	1396	1571	640		1073	824		816
v/c	0.00	0.02	0.00		0.05	0.75		0.05
95% queue length	0.01	0.06	0.01		0.16	7.19		0.14
Control Delay	7.6	7.3	10.7		8.5	21.5		9.6
LOS	A	A	B		A	C		A
Approach Delay			8.6			20.8		
Approach LOS			A			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:	06/25/2007
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 S Ramps
Jurisdiction:	
Units:	U. S. Metric
Analysis Year:	Existing Volumes
Project ID:	
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	11	4	29	13	169
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	1	3	1	8	3	44
Hourly Flow Rate, HFR	4	11	4	30	13	177
Percent Heavy Vehicles	0	--	--	7	--	--
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	2	53	591	30	6
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	0	1	14	156	8	2
Hourly Flow Rate, HFR	1	2	55	622	31	6
Percent Heavy Vehicles	25	0	0	3	0	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:	11	13
Shared ln volume, major rt vehicles:	4	0
Sat flow rate, major th vehicles:	1900	1900
Sat flow rate, major rt vehicles:	1700	1900
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	7	25	0	0	3	0	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	7.3	6.5	6.2	7.1	6.5	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	7	25	0	0	3	0	0
t(f)	2.2	2.3	3.7	4.0	3.3	3.5	4.0	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	190	15	201	271	13	95	96	13
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	13	13
Potential Capacity	1073	1073
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1073	1073
Probability of Queue free St.	0.95	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	15	190
Potential Capacity	1571	1396
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1571	1396
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	271	96
Potential Capacity	639	798
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98

Movement Capacity	625	780
Probability of Queue free St.	1.00	0.96

Step 4: LT from Minor St.	7	10
Conflicting Flows	201	95
Potential Capacity	710	886
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	0.97
Maj. L, Min T Adj. Imp Factor.	0.95	0.98
Cap. Adj. factor due to Impeding mvmnt	0.95	0.93
Movement Capacity	673	824

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	271	96
Potential Capacity	639	798
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	625	780
Result for 2 stage process:		
a		
y		
C t	625	780
Probability of Queue free St.	1.00	0.96

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	201	95
Potential Capacity	710	886
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	0.97
Maj. L, Min T Adj. Imp Factor.	0.95	0.98
Cap. Adj. factor due to Impeding mvmnt	0.95	0.93
Movement Capacity	673	824
Results for Two-stage process:		
a		
y		
C t	673	824

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	2	55	622	31	6
Movement Capacity (vph)	673	625	1073	824	780	1073
Shared Lane Capacity (vph)	640					816

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	673	625	1073	824	780	1073
Volume	1	2	55	622	31	6
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	640					816
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	30	3		55	622		37
C(m) (vph)	1396	1571	640		1073	824		816
v/c	0.00	0.02	0.00		0.05	0.75		0.05
95% queue length	0.01	0.06	0.01		0.16	7.19		0.14
Control Delay	7.6	7.3	10.7		8.5	21.5		9.6
LOS	A	A	B		A	C		A
Approach Delay				8.6			20.8	
Approach LOS				A			C	

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	11	13
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	1700	1900
P*(oj)	1.00	0.98
d(M,LT), Delay for stream 1 or 4	7.6	7.3
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.1

APPENDIX D

Capacity Analysis Outputs – Construction Assessment

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:	2012 (construction)
Project ID:	
East/West Street:	Hwy 401 on-off ramps
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	25	134		237	332	
Peak-Hour Factor, PHF	0.95	0.95		0.95	0.95	
Hourly Flow Rate, HFR	26	141		249	349	
Percent Heavy Vehicles	20	--	--	--	--	
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	61		222			
Peak Hour Factor, PHF	0.95		0.95			
Hourly Flow Rate, HFR	64		233			
Percent Heavy Vehicles	14		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)	26			297				
C(m) (vph)	896			1140				
v/c	0.03			0.26				
95% queue length	0.09			1.05				
Control Delay	9.1			11.4				
LOS	A			B				
Approach Delay				11.4				
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:	2012 (construction)
Project ID:	
East/West Street:	Hwy 401 on-off ramps
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	25	134			237	332
Peak-Hour Factor, PHF	0.95	0.95			0.95	0.95
Peak-15 Minute Volume	7	35			62	87
Hourly Flow Rate, HFR	26	141			249	349
Percent Heavy Vehicles	20	--	--		--	--
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	61		222			
Peak Hour Factor, PHF	0.95		0.95			
Peak-15 Minute Volume	16		58			
Hourly Flow Rate, HFR	64		233			
Percent Heavy Vehicles	14		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:	141	
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)	20		14		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)	20		14		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	598		617		141			
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	141	
Potential Capacity	894	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	894	
Probability of Queue free St.	0.74	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		598
Potential Capacity		896
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		896
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.97

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	0.97	0.97

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	617	
Potential Capacity	435	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.97	0.72
Movement Capacity	422	

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	0.97	0.97
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	617	
Potential Capacity	435	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.97	0.72
Movement Capacity	422	
Results for Two-stage process:		
a		
y		
C t	422	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	64		233			
Movement Capacity (vph)	422		894			
Shared Lane Capacity (vph)		720				

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	422		894			
Volume	64		233			
Delay	15.0		10.4			
Q sep	0.27		0.68			
Q sep +1	1.27		1.68			
round (Qsep +1)	1		2			
n max		2				
C sh		720				
SUM C sep		1140				
n		2				
C act		1140				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	26			297				
C(m) (vph)	896			1140				
v/c	0.03			0.26				
95% queue length	0.09			1.05				
Control Delay	9.1			11.4				
LOS	A			B				
Approach Delay				11.4				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	141	
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)	0.97	
d(M,LT), Delay for stream 1 or 4	9.1	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

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: No Energy Park Scenario
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		110	679		214	145	
Peak-Hour Factor, PHF		1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR		110	679		214	145	
Percent Heavy Vehicles		0	--	--	--	--	
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		16		226			
Peak Hour Factor, PHF		1.00		1.00			
Hourly Flow Rate, HFR		16		226			
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)	110			242				
C(m) (vph)	1211			480				
v/c	0.09			0.50				
95% queue length	0.30			2.98				
Control Delay	8.3			21.8				
LOS	A			C				
Approach Delay				21.8				
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: No Energy Park Scenario
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	110	679			214	145
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	28	170			54	36
Hourly Flow Rate, HFR	110	679			214	145
Percent Heavy Vehicles	0	--	--		--	--
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	16		226			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		56			
Hourly Flow Rate, HFR	16		226			
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:	679	
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)	0		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	4.1		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)	0		42		4			
t(f)	2.2		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	359		1185		679			
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	679	
Potential Capacity	448	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	448	
Probability of Queue free St.	0.50	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		359
Potential Capacity		1211
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1211
Probability of Queue free St.	1.00	0.91
Maj L-Shared Prob Q free St.		0.85

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	0.85	0.85

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1185	
Potential Capacity	174	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.85
Maj. L, Min T Adj. Imp Factor.		0.88
Cap. Adj. factor due to Impeding mvmnt	0.91	0.44
Movement Capacity	158	

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	0.85	0.85
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	1185	
Potential Capacity	174	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.85
Maj. L, Min T Adj. Imp Factor.		0.88
Cap. Adj. factor due to Impeding mvmnt	0.91	0.44
Movement Capacity	158	
Results for Two-stage process:		
a		
y		
C t	158	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	16		226			
Movement Capacity (vph)	158		448			
Shared Lane Capacity (vph)		400				

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	158		448			
Volume	16		226			
Delay	30.3		21.1			
Q sep	0.13		1.33			
Q sep +1	1.13		2.33			
round (Qsep +1)	1		2			
n max		2				
C sh		400				
SUM C sep		480				
n		2				
C act		480				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	110			242				
C(m) (vph)	1211			480				
v/c	0.09			0.50				
95% queue length	0.30			2.98				
Control Delay	8.3			21.8				
LOS	A			C				
Approach Delay				21.8				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.91	1.00
v(il), Volume for stream 2 or 5	679	
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)	0.85	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.3	

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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: 2012 (construction)
Project ID:
East/West Street: Hwy 401 W-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	2	19	118	14	168
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR	4	2	20	124	14	176
Percent Heavy Vehicles	0	--	--	8	--	--
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	3	11	3	130	144	12
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR	3	11	3	136	151	12
Percent Heavy Vehicles	17	0	0	8	0	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)	4	124	14		3	211		87
C(m) (vph)	1396	1555	435		1074	588		609
v/c	0.00	0.08	0.03		0.00	0.36		0.14
95% queue length	0.01	0.26	0.10		0.01	1.62		0.50
Control Delay	7.6	7.5	13.6		8.4	14.5		11.9
LOS	A	A	B		A	B		B
Approach Delay			12.6			13.7		
Approach LOS			B			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: 2012 (construction)
Project ID:
East/West Street: Hwy 401 W-N/S
North/South Street: Courtice Rd.
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	2	19	118	14	168
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	1	1	5	31	4	44
Hourly Flow Rate, HFR	4	2	20	124	14	176
Percent Heavy Vehicles	0	--	--	8	--	--
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	3	11	3	130	144	12
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	1	3	1	34	38	3
Hourly Flow Rate, HFR	3	11	3	136	151	12
Percent Heavy Vehicles	17	0	0	8	0	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:	2	14
Shared ln volume, major rt vehicles:	20	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	8	17	0	0	8	0	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	7.3	6.5	6.2	7.2	6.5	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	8	17	0	0	8	0	0
t(f)	2.2	2.3	3.7	4.0	3.3	3.6	4.0	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	190	22	452	458	12	288	292	14
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	14
Potential Capacity	1074	1072
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1074	1072
Probability of Queue free St.	1.00	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	22	190
Potential Capacity	1555	1396
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1555	1396
Probability of Queue free St.	0.92	1.00
Maj L-Shared Prob Q free St.	0.92	1.00

Step 3: TH from Minor St.	8	11
Conflicting Flows	458	292
Potential Capacity	502	622
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92

Movement Capacity	460	570
Probability of Queue free St.	0.98	0.74
Step 4: LT from Minor St.	7	10
Conflicting Flows	452	288
Potential Capacity	493	652
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.67	0.89
Maj. L, Min T Adj. Imp Factor.	0.75	0.92
Cap. Adj. factor due to Impeding mvmnt	0.74	0.92
Movement Capacity	364	598

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	458	292
Potential Capacity	502	622
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity	460	570
Result for 2 stage process:		
a		
y		
C t	460	570
Probability of Queue free St.	0.98	0.74
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	452	288
Potential Capacity	493	652
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.67	0.89
Maj. L, Min T Adj. Imp Factor.	0.75	0.92
Cap. Adj. factor due to Impeding mvmnt	0.74	0.92
Movement Capacity	364	598
Results for Two-stage process:		
a		
y		
C t	364	598

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	3	11	3	136	151	12
Movement Capacity (vph)	364	460	1074	598	570	1072
Shared Lane Capacity (vph)	435			588		609

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	364	460	1074	598	570	1072
Volume	3	11	3	136	151	12
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	435			588		609
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)	4	124	14		3	211		87
C(m) (vph)	1396	1555	435		1074	588		609
v/c	0.00	0.08	0.03		0.00	0.36		0.14
95% queue length	0.01	0.26	0.10		0.01	1.62		0.50
Control Delay	7.6	7.5	13.6		8.4	14.5		11.9
LOS	A	A	B		A	B		B
Approach Delay				12.6			13.7	
Approach LOS				B			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.92
v(il), Volume for stream 2 or 5	2	14
v(i2), Volume for stream 3 or 6	20	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	0.92
d(M,LT), Delay for stream 1 or 4	7.6	7.5
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.6

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:	2012 (construction)
Project ID:	
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

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	32	14	184
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR	4	12	4	33	14	193
Percent Heavy Vehicles	0	--	--	7	--	--
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	27	132	644	34	7
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Hourly Flow Rate, HFR	1	28	138	677	35	7
Percent Heavy Vehicles	25	0	0	3	0	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	29		138	677		42
C(m) (vph)	1376	1569	606		1072	708		809
v/c	0.00	0.02	0.05		0.13	0.96		0.05
95% queue length	0.01	0.06	0.15		0.44	14.11		0.16
Control Delay	7.6	7.3	11.2		8.9	48.0		9.7
LOS	A	A	B		A	E		A
Approach Delay				9.3			45.8	
Approach LOS				A			E	

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:	2012 (construction)
Project ID:	
East/West Street:	Hwy 401 W-N/S
North/South Street:	Courtice Rd.
Intersection Orientation:	NS
Study period (hrs):	0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	4	12	4	32	14	184
Peak-Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	1	3	1	8	4	48
Hourly Flow Rate, HFR	4	12	4	33	14	193
Percent Heavy Vehicles	0	--	--	7	--	--
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	27	132	644	34	7
Peak Hour Factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Peak-15 Minute Volume	0	7	35	169	9	2
Hourly Flow Rate, HFR	1	28	138	677	35	7
Percent Heavy Vehicles	25	0	0	3	0	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	14
Shared ln volume, major rt vehicles:	4	0
Sat flow rate, major th vehicles:	1900	1900
Sat flow rate, major rt vehicles:	1700	1900
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	7	25	0	0	3	0	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	7.3	6.5	6.2	7.1	6.5	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	7	25	0	0	3	0	0
t(f)	2.2	2.3	3.7	4.0	3.3	3.5	4.0	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	207	16	220	295	14	116	104	14
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	14	14
Potential Capacity	1072	1072
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1072	1072
Probability of Queue free St.	0.87	0.99
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	16	207
Potential Capacity	1569	1376
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1569	1376
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	295	104
Potential Capacity	620	790
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98

Movement Capacity	605	771
Probability of Queue free St.	0.95	0.95

Step 4: LT from Minor St.	7	10
Conflicting Flows	220	116
Potential Capacity	690	858
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.94	0.83
Movement Capacity	650	708

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	295	104
Potential Capacity	620	790
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	605	771
Result for 2 stage process:		
a		
y		
C t	605	771
Probability of Queue free St.	0.95	0.95

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	220	116
Potential Capacity	690	858
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.94	0.83
Movement Capacity	650	708
Results for Two-stage process:		
a		
y		
C t	650	708

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	28	138	677	35	7
Movement Capacity (vph)	650	605	1072	708	771	1072
Shared Lane Capacity (vph)	606					809

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	650	605	1072	708	771	1072
Volume	1	28	138	677	35	7
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	606					809
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	29		138	677		42
C(m) (vph)	1376	1569	606		1072	708		809
v/c	0.00	0.02	0.05		0.13	0.96		0.05
95% queue length	0.01	0.06	0.15		0.44	14.11		0.16
Control Delay	7.6	7.3	11.2		8.9	48.0		9.7
LOS	A	A	B		A	E		A
Approach Delay				9.3			45.8	
Approach LOS				A			E	

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	14
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	1700	1900
P*(oj)	1.00	0.98
d(M,LT), Delay for stream 1 or 4	7.6	7.3
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.0	0.2

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:
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 (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	

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 (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

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 (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	

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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 (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 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	348	379	12	209	209	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	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:
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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

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 (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 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	580		621		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		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:
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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 (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:
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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 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

APPENDIX F

Capacity Analysis Outputs – Future Background Conditions (With CEBP)

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 1/5/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Background
Project ID:
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		68	134		281	323	
Peak-Hour Factor, PHF		1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR		68	134		281	323	
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		89		216			
Peak Hour Factor, PHF		1.00		1.00			
Hourly Flow Rate, HFR		89		216			
Percent Heavy Vehicles		25		10			
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)	68			305				
C(m) (vph)	871			1158				
v/c	0.08			0.26				
95% queue length	0.25			1.07				
Control Delay	9.5			13.0				
LOS	A			B				
Approach Delay				13.0				
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: 1/5/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Background
Project ID:
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	68	134			281	323
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	17	34			70	81
Hourly Flow Rate, HFR	68	134			281	323
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	89		216			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	22		54			
Hourly Flow Rate, HFR	89		216			
Percent Heavy Vehicles	25		10			
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:	134	
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		25		10			
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		6.7		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		25		10			
t(f)	2.4		3.7		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	604		712		134			
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	134	
Potential Capacity	894	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	894	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		604
Potential Capacity		871
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		871
Probability of Queue free St.	1.00	0.92
Maj L-Shared Prob Q free St.		0.92

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	0.92	0.92

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	712	
Potential Capacity	367	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.92
Maj. L, Min T Adj. Imp Factor.		0.94
Cap. Adj. factor due to Impeding mvmnt	0.92	0.71
Movement Capacity	338	

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	0.92	0.92
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	712	
Potential Capacity	367	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.92
Maj. L, Min T Adj. Imp Factor.		0.94
Cap. Adj. factor due to Impeding mvmnt	0.92	0.71
Movement Capacity	338	
Results for Two-stage process:		
a		
y		
C t	338	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	89		216			
Movement Capacity (vph)	338		894			
Shared Lane Capacity (vph)		604				

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	338		894			
Volume	89		216			
Delay	19.4		10.3			
Q sep	0.48		0.62			
Q sep +1	1.48		1.62			
round (Qsep +1)	1		2			
n max		2				
C sh		604				
SUM C sep		1158				
n		2				
C act		1158				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	68			305				
C(m) (vph)	871			1158				
v/c	0.08			0.26				
95% queue length	0.25			1.07				
Control Delay	9.5			13.0				
LOS	A			B				
Approach Delay				13.0				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.92	1.00
v(il), Volume for stream 2 or 5	134	
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)	0.92	
d(M,LT), Delay for stream 1 or 4	9.5	
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: 1/5/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Background
Project ID:
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		411	715		211	141	
Peak-Hour Factor, PHF		1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR		411	715		211	141	
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		29		219			
Peak Hour Factor, PHF		1.00		1.00			
Hourly Flow Rate, HFR		29		219			
Percent Heavy Vehicles		25		10			
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)	411			248				
C(m) (vph)	1090			340				
v/c	0.38			0.73				
95% queue length	1.81			7.02				
Control Delay	10.3			42.6				
LOS	B			E				
Approach Delay				42.6				
Approach LOS				E				

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: 1/5/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Background
Project ID:
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	411	715			211	141
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	103	179			53	35
Hourly Flow Rate, HFR	411	715			211	141
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	29		219			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	7		55			
Hourly Flow Rate, HFR	29		219			
Percent Heavy Vehicles	25		10			
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:	715	
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		25		10			
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		6.7		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		25		10			
t(f)	2.4		3.7		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	352		1819		715			
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	715	
Potential Capacity	418	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	418	
Probability of Queue free St.	0.48	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		352
Potential Capacity		1090
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1090
Probability of Queue free St.	1.00	0.62
Maj L-Shared Prob Q free St.		0.35

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	0.35	0.35

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	1819	
Potential Capacity	75	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.35
Maj. L, Min T Adj. Imp Factor.		0.48
Cap. Adj. factor due to Impeding mvmnt	0.62	0.23
Movement Capacity	47	

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	0.35	0.35
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	1819	
Potential Capacity	75	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.35
Maj. L, Min T Adj. Imp Factor.		0.48
Cap. Adj. factor due to Impeding mvmnt	0.62	0.23
Movement Capacity	47	
Results for Two-stage process:		
a		
y		
C t	47	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	29		219			
Movement Capacity (vph)	47		418			
Shared Lane Capacity (vph)		217				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

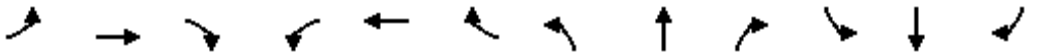
Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	47		418			
Volume	29		219			
Delay	188.4		23.0			
Q sep	1.52		1.40			
Q sep +1	2.52		2.40			
round (Qsep +1)	3		2			
n max		3				
C sh		217				
SUM C sep		402				
n		2				
C act		340				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	411			248				
C(m) (vph)	1090			340				
v/c	0.38			0.73				
95% queue length	1.81			7.02				
Control Delay	10.3			42.6				
LOS	B			E				
Approach Delay				42.6				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.62	1.00
v(il), Volume for stream 2 or 5	715	
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)	0.35	
d(M,LT), Delay for stream 1 or 4	10.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	6.7	

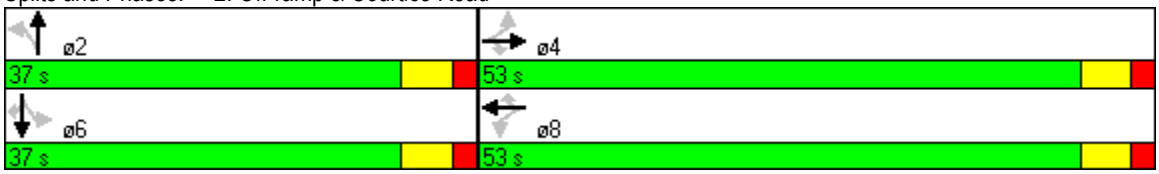


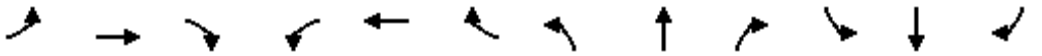
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	126	190	235	2	3	29	9	49	6	97	111	163
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.984				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1512	1690	1750	0	1690	1883	1601
Flt Permitted	0.756			0.638			0.685			0.721		
Satd. Flow (perm)	1345	1779	1512	1135	1779	1512	1218	1750	0	1283	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			235			29		6				163
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	2%	2%
Adj. Flow (vph)	126	190	235	2	3	29	9	49	6	97	111	163
Shared Lane Traffic (%)												
Lane Group Flow (vph)	126	190	235	2	3	29	9	55	0	97	111	163
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	11.8	11.8	11.8	11.8	11.8	11.8	31.1	31.1		31.1	31.1	31.1
Actuated g/C Ratio	0.21	0.21	0.21	0.21	0.21	0.21	0.57	0.57		0.57	0.57	0.57
v/c Ratio	0.43	0.50	0.46	0.01	0.01	0.08	0.01	0.06		0.13	0.10	0.17
Control Delay	23.3	23.4	6.2	16.0	16.0	7.7	6.7	6.2		7.3	6.9	2.0
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	23.3	23.4	6.2	16.0	16.0	7.7	6.7	6.2		7.3	6.9	2.0
LOS	C	C	A	B	B	A	A	A		A	A	A
Approach Delay		16.1			8.9			6.3			4.9	
Approach LOS		B			A			A			A	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 55			
Natural Cycle: 45			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.50			
Intersection Signal Delay: 11.1		Intersection LOS: B	
Intersection Capacity Utilization 38.7%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road





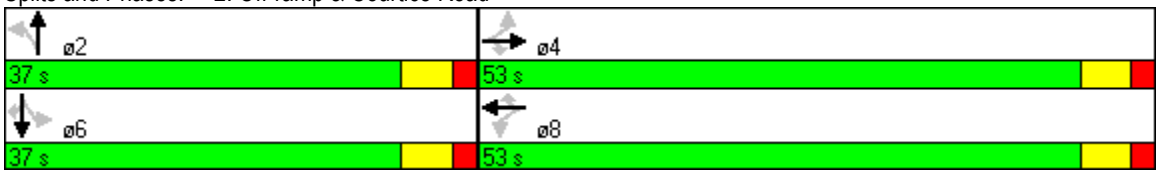
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	144	389	604	4	4	97	10	119	6	145	206	186
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.993				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1512	1690	1766	0	1690	1883	1601
Flt Permitted	0.755			0.396			0.629			0.677		
Satd. Flow (perm)	1343	1779	1512	704	1779	1512	1119	1766	0	1204	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			506			97		3				186
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	2%	2%
Adj. Flow (vph)	144	389	604	4	4	97	10	119	6	145	206	186
Shared Lane Traffic (%)												
Lane Group Flow (vph)	144	389	604	4	4	97	10	125	0	145	206	186
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

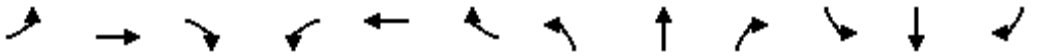
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	23.4	23.4	23.4	23.4	23.4	23.4	31.5	31.5		31.5	31.5	31.5
Actuated g/C Ratio	0.35	0.35	0.35	0.35	0.35	0.35	0.47	0.47		0.47	0.47	0.47
v/c Ratio	0.31	0.63	0.70	0.02	0.01	0.16	0.02	0.15		0.26	0.23	0.22
Control Delay	16.8	22.5	8.3	12.8	12.5	3.9	13.4	13.0		14.9	13.7	3.4
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	16.8	22.5	8.3	12.8	12.5	3.9	13.4	13.0		14.9	13.7	3.4
LOS	B	C	A	B	B	A	B	B		B	B	A
Approach Delay		14.2			4.5			13.0			10.4	
Approach LOS		B			A			B			B	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 67
Natural Cycle: 50
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.70
Intersection Signal Delay: 12.5 — Intersection LOS: B
Intersection Capacity Utilization 66.6% — ICU Level of Service C
Analysis Period (min) 60

Splits and Phases: 2: Off-ramp & Courtice Road



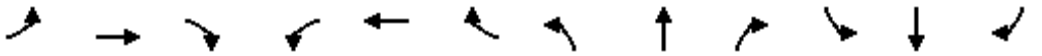


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	626	45	53	7	27	217	46	281	44	26	35	179
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.980				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1779	1512	1690	1779	1512	1690	1743	0	1706	1883	1601
Flt Permitted	0.740			0.728			0.734			0.429		
Satd. Flow (perm)	1380	1779	1512	1295	1779	1512	1306	1743	0	770	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			53			154		8				179
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	8%	8%	8%	8%	8%	8%	8%	8%	7%	2%	2%
Adj. Flow (vph)	626	45	53	7	27	217	46	281	44	26	35	179
Shared Lane Traffic (%)												
Lane Group Flow (vph)	626	45	53	7	27	217	46	325	0	26	35	179
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	67.0	67.0	67.0	67.0	67.0	67.0	23.0	23.0	0.0	23.0	23.0	23.0
Total Split (%)	74.4%	74.4%	74.4%	74.4%	74.4%	74.4%	25.6%	25.6%	0.0%	25.6%	25.6%	25.6%
Maximum Green (s)	61.0	61.0	61.0	61.0	61.0	61.0	17.0	17.0		17.0	17.0	17.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	34.4	34.4	34.4	34.4	34.4	34.4	17.7	17.7		17.7	17.7	17.7
Actuated g/C Ratio	0.53	0.53	0.53	0.53	0.53	0.53	0.27	0.27		0.27	0.27	0.27
v/c Ratio	0.85	0.05	0.06	0.01	0.03	0.25	0.13	0.67		0.12	0.07	0.32
Control Delay	25.6	6.1	1.9	5.6	5.9	2.9	24.3	33.4		25.7	23.5	6.6
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	25.6	6.1	1.9	5.6	5.9	2.9	24.3	33.4		25.7	23.5	6.6
LOS	C	A	A	A	A	A	C	C		C	C	A
Approach Delay		22.6			3.3			32.3			11.1	
Approach LOS		C			A			C			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 64.5			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 20.1		Intersection LOS: C	
Intersection Capacity Utilization 80.6%		ICU Level of Service D	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road

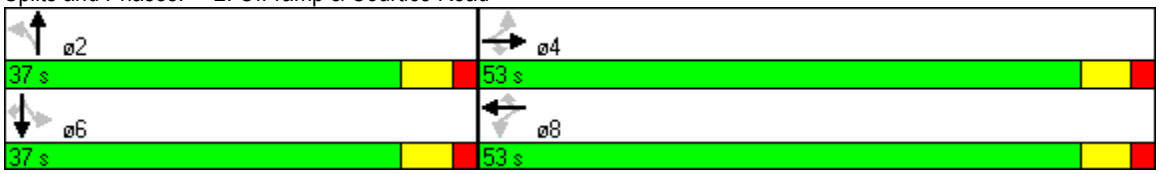


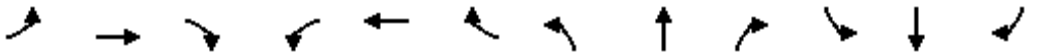
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	715	81	146	17	27	526	47	590	44	38	59	204
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.990				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1601	1690	1761	0	1706	1883	1601
Flt Permitted	0.740			0.704			0.719			0.129		
Satd. Flow (perm)	1316	1779	1512	1252	1779	1601	1279	1761	0	232	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			146			113		5				204
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	2%	8%	8%	8%	7%	2%	2%
Adj. Flow (vph)	715	81	146	17	27	526	47	590	44	38	59	204
Shared Lane Traffic (%)												
Lane Group Flow (vph)	715	81	146	17	27	526	47	634	0	38	59	204
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left			Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	1.8		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			0.0			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Actuated g/C Ratio	0.52	0.52	0.52	0.52	0.52	0.52	0.34	0.34		0.34	0.34	0.34
v/c Ratio	1.04	0.09	0.17	0.03	0.03	0.59	0.11	1.04		0.48	0.09	0.30
Control Delay	139.5	11.1	2.5	10.6	10.6	14.6	21.0	148.5		47.6	20.6	4.4
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	139.5	11.1	2.5	10.6	10.6	14.6	21.0	148.5		47.6	20.6	4.4
LOS	F	B	A	B	B	B	C	F		D	C	A
Approach Delay		107.2			14.3			139.7			13.0	
Approach LOS		F			B			F			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Natural Cycle: 100			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 1.04			
Intersection Signal Delay: 83.5		Intersection LOS: F	
Intersection Capacity Utilization 120.9%		ICU Level of Service H	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road



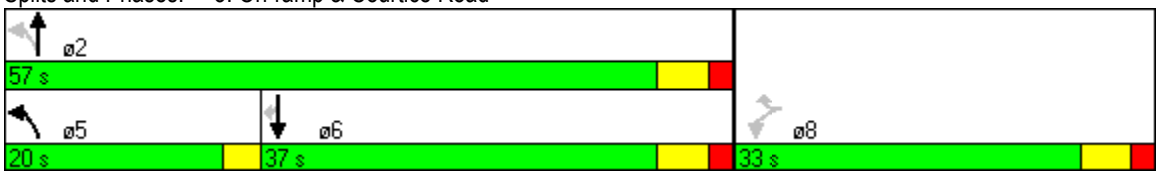


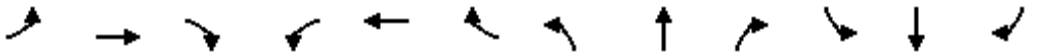
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	100	0	216	80	134	0	0	284	323
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1526	1521	1883	0	0	1779	1601
Flt Permitted				0.950			0.447					
Satd. Flow (perm)	0	0	0	1690	0	1526	716	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						216						323
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	7%	20%	2%	0%	0%	8%	2%
Adj. Flow (vph)	0	0	0	100	0	216	80	134	0	0	284	323
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	100	0	216	80	134	0	0	284	323
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	33.0	0.0	33.0	20.0	57.0	0.0	0.0	37.0	37.0
Total Split (%)	0.0%	0.0%	0.0%	36.7%	0.0%	36.7%	22.2%	63.3%	0.0%	0.0%	41.1%	41.1%
Maximum Green (s)				27.0		27.0	17.0	51.0			31.0	31.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				27.0		27.0	54.0	51.0			31.0	31.0
Actuated g/C Ratio				0.30		0.30	0.60	0.57			0.34	0.34
v/c Ratio				0.20		0.35	0.14	0.13			0.46	0.42

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				24.8		5.3	8.3	9.5			26.1	4.5
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				24.8		5.3	8.3	9.5			26.1	4.5
LOS				C		A	A	A			C	A
Approach Delay								9.0			14.6	
Approach LOS								A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 55			
Control Type: Pretimed			
Maximum v/c Ratio: 0.46			
Intersection Signal Delay: 12.7		Intersection LOS: B	
Intersection Capacity Utilization 36.6%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



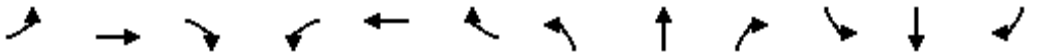


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	92	0	247	167	174	0	0	437	369
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1526	1521	1883	0	0	1779	1601
Flt Permitted				0.950			0.303					
Satd. Flow (perm)	0	0	0	1690	0	1526	485	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						247						369
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	7%	20%	2%	0%	0%	8%	2%
Adj. Flow (vph)	0	0	0	92	0	247	167	174	0	0	437	369
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	92	0	247	167	174	0	0	437	369
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	30.0	0.0	30.0	20.0	60.0	0.0	0.0	40.0	40.0
Total Split (%)	0.0%	0.0%	0.0%	33.3%	0.0%	33.3%	22.2%	66.7%	0.0%	0.0%	44.4%	44.4%
Maximum Green (s)				24.0		24.0	17.0	54.0			34.0	34.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				24.0		24.0	57.0	54.0			34.0	34.0
Actuated g/C Ratio				0.27		0.27	0.63	0.60			0.38	0.38
v/c Ratio				0.20		0.42	0.33	0.15			0.65	0.44

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				27.1		6.0	8.7	8.4			28.7	4.0
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				27.1		6.0	8.7	8.4			28.7	4.0
LOS				C		A	A	A			C	A
Approach Delay								8.6			17.4	
Approach LOS								A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 55			
Control Type: Pretimed			
Maximum v/c Ratio: 0.65			
Intersection Signal Delay: 14.1		Intersection LOS: B	
Intersection Capacity Utilization 49.0%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road

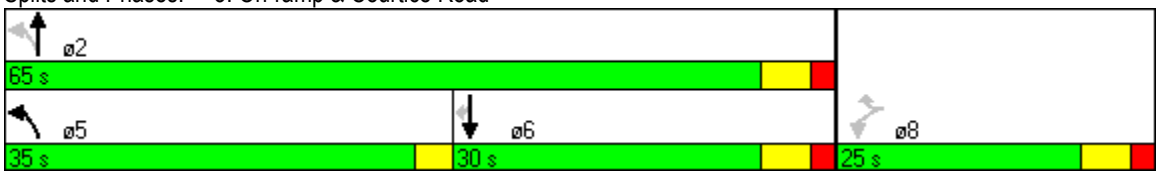


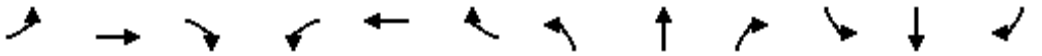
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	29	0	219	432	717	0	0	211	141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1570	1825	1883	0	0	1779	1601
Flt Permitted				0.950			0.492					
Satd. Flow (perm)	0	0	0	1690	0	1570	945	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						219						141
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	4%	0%	2%	2%	0%	8%	2%
Adj. Flow (vph)	0	0	0	29	0	219	432	717	0	0	211	141
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	29	0	219	432	717	0	0	211	141
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	25.0	0.0	25.0	35.0	65.0	0.0	0.0	30.0	30.0
Total Split (%)	0.0%	0.0%	0.0%	27.8%	0.0%	27.8%	38.9%	72.2%	0.0%	0.0%	33.3%	33.3%
Maximum Green (s)				19.0		19.0	32.0	59.0			24.0	24.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				19.0		19.0	62.0	59.0			24.0	24.0
Actuated g/C Ratio				0.21		0.21	0.69	0.66			0.27	0.27
v/c Ratio				0.08		0.43	0.45	0.58			0.45	0.27

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				29.3		7.4	7.4	11.0			31.1	6.1
Queue Delay				0.0		0.0	0.0	0.5			0.0	0.0
Total Delay				29.3		7.4	7.4	11.5			31.1	6.1
LOS				C		A	A	B			C	A
Approach Delay								10.0			21.1	
Approach LOS								A			C	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 60			
Control Type: Pretimed			
Maximum v/c Ratio: 0.58			
Intersection Signal Delay: 12.2		Intersection LOS: B	
Intersection Capacity Utilization 61.3%		ICU Level of Service B	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



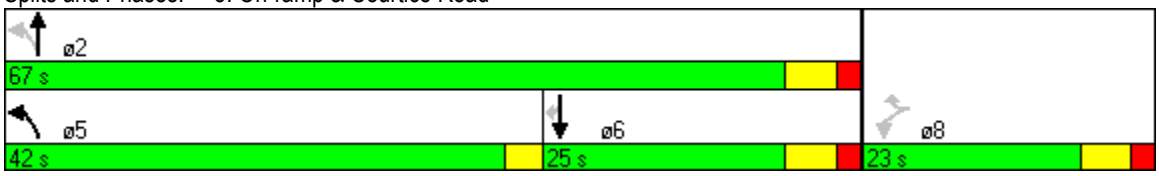


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	31	0	250	912	921	0	0	270	161
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1601	1825	1883	0	0	1779	1601
Flt Permitted				0.950			0.336					
Satd. Flow (perm)	0	0	0	1690	0	1601	645	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						184						161
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	4%	2%	0%	2%	2%	0%	8%	2%
Adj. Flow (vph)	0	0	0	31	0	250	912	921	0	0	270	161
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	31	0	250	912	921	0	0	270	161
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	23.0	0.0	23.0	42.0	67.0	0.0	0.0	25.0	25.0
Total Split (%)	0.0%	0.0%	0.0%	25.6%	0.0%	25.6%	46.7%	74.4%	0.0%	0.0%	27.8%	27.8%
Maximum Green (s)				17.0		17.0	39.0	61.0			19.0	19.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				17.0		17.0	64.0	61.0			19.0	19.0
Actuated g/C Ratio				0.19		0.19	0.71	0.68			0.21	0.21
v/c Ratio				0.10		0.55	0.94	0.72			0.72	0.35

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				31.2		15.2	38.6	13.4			46.0	7.4
Queue Delay				0.0		0.0	0.0	1.3			0.0	0.0
Total Delay				31.2		15.2	38.6	14.6			46.0	7.4
LOS				C		B	D	B			D	A
Approach Delay								26.5			31.6	
Approach LOS								C			C	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 80			
Control Type: Pretimed			
Maximum v/c Ratio: 0.94			
Intersection Signal Delay: 26.3		Intersection LOS: C	
Intersection Capacity Utilization 79.7%		ICU Level of Service D	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



APPENDIX G

Capacity Analysis Outputs – Future Total Conditions (With CEBP)

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	1/5/2009
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:	
Units:	U. S. Customary
Analysis Year:	Future Total
Project ID:	
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	80	134		284	323	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	80	134		284	323	
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	100	216				
Peak Hour Factor, PHF	1.00	1.00				
Hourly Flow Rate, HFR	100	216				
Percent Heavy Vehicles	25	10				
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)	80		316					
C(m) (vph)	869		1014					
v/c	0.09		0.31					
95% queue length	0.30		1.35					
Control Delay	9.6		13.8					
LOS	A		B					
Approach Delay			13.8					
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:	1/5/2009
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:	
Units:	U. S. Customary
Analysis Year:	Future Total
Project ID:	
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	80	134			284	323
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	20	34			71	81
Hourly Flow Rate, HFR	80	134			284	323
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	100	216				
Peak Hour Factor, PHF	1.00	1.00				
Peak-15 Minute Volume	25	54				
Hourly Flow Rate, HFR	100	216				
Percent Heavy Vehicles	25	10				
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:	134	
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		25		10			
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		6.7		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		25		10			
t(f)	2.4		3.7		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	607		740		134			
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	134	
Potential Capacity	894	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	894	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		607
Potential Capacity		869
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		869
Probability of Queue free St.	1.00	0.91
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	740	
Potential Capacity	353	
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	0.91	0.70
Movement Capacity	321	

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	740	
Potential Capacity	353	
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	0.91	0.70
Movement Capacity	321	
Results for Two-stage process:		
a		
y		
C t	321	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	100		216			
Movement Capacity (vph)	321		894			
Shared Lane Capacity (vph)		571				

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	321		894			
Volume	100		216			
Delay	21.3		10.3			
Q sep	0.59		0.62			
Q sep +1	1.59		1.62			
round (Qsep +1)	2		2			
n max		2				
C sh		571				
SUM C sep		1014				
n		2				
C act		1014				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	80			316				
C(m) (vph)	869			1014				
v/c	0.09			0.31				
95% queue length	0.30			1.35				
Control Delay	9.6			13.8				
LOS	A			B				
Approach Delay				13.8				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.91	1.00
v(il), Volume for stream 2 or 5	134	
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	9.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	M. Raso
Agency/Co.:	Durham/York Waste Study
Date Performed:	1/5/2009
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:	
Units:	U. S. Customary
Analysis Year:	Future Total
Project ID:	
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	432	717		211	141	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	432	717		211	141	
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	29		219			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	29		219			
Percent Heavy Vehicles	25		10			
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)	432			248				
C(m) (vph)	1090			307				
v/c	0.40			0.81				
95% queue length	1.96			9.53				
Control Delay	10.5			60.5				
LOS	B			F				
Approach Delay				60.5				
Approach LOS				F				

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:	1/5/2009
Analysis Time Period:	PM
Intersection:	Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:	
Units:	U. S. Customary
Analysis Year:	Future Total
Project ID:	
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	432	717			211	141
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	108	179			53	35
Hourly Flow Rate, HFR	432	717			211	141
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	29		219			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	7		55			
Hourly Flow Rate, HFR	29		219			
Percent Heavy Vehicles	25		10			
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:	717	
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		25		10			
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		6.7		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		25		10			
t(f)	2.4		3.7		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	352		1863		717			
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	717	
Potential Capacity	416	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	416	
Probability of Queue free St.	0.47	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		352
Potential Capacity		1090
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1090
Probability of Queue free St.	1.00	0.60
Maj L-Shared Prob Q free St.		0.31

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	0.31	0.31

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1863	
Potential Capacity	70	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.31
Maj. L, Min T Adj. Imp Factor.		0.45
Cap. Adj. factor due to Impeding mvmnt	0.60	0.21
Movement Capacity	42	

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	0.31	0.31
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	1863	
Potential Capacity	70	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.31
Maj. L, Min T Adj. Imp Factor.		0.45
Cap. Adj. factor due to Impeding mvmnt	0.60	0.21
Movement Capacity	42	
Results for Two-stage process:		
a		
y		
C t	42	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	29		219			
Movement Capacity (vph)	42		416			
Shared Lane Capacity (vph)		204				

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	42		416			
Volume	29		219			
Delay	241.2		23.2			
Q sep	1.94		1.41			
Q sep +1	2.94		2.41			
round (Qsep +1)	3		2			
n max		3				
C sh		204				
SUM C sep		359				
n		2				
C act		307				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	432			248				
C(m) (vph)	1090			307				
v/c	0.40			0.81				
95% queue length	1.96			9.53				
Control Delay	10.5			60.5				
LOS	B			F				
Approach Delay				60.5				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.60	1.00
v(il), Volume for stream 2 or 5	717	
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)	0.31	
d(M,LT), Delay for stream 1 or 4	10.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	7.2	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Energy Drive/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Energy Drive
North/South Street: Osbourne Road
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		24	21	40	155	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		24	21	40	155	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		13			10	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		13			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration			LR			

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		40		23				
C(m) (vph)		1427		765				
v/c		0.03		0.03				
95% queue length		0.09		0.09				
Control Delay		7.6		9.9				
LOS		A		A				
Approach Delay				9.9				
Approach LOS				A				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Energy Drive/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Energy Drive
North/South Street: Osbourne Road
Intersection Orientation: EW 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		24	21	40	155	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		6	5	10	39	
Hourly Flow Rate, HFR		24	21	40	155	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		13			10	
Peak Hour Factor, PHF		1.00			1.00	
Peak-15 Minute Volume		3			2	
Hourly Flow Rate, HFR		13			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
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 (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:	155	
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	25		25			
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	6.7		6.4			
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	25		25			
t(f)		2.4	3.7		3.5			

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		45	269		34			
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	34	
Potential Capacity	977	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	977	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	45	
Potential Capacity	1427	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1427	
Probability of Queue free St.	0.97	1.00
Maj L-Shared Prob Q free St.	0.97	

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	0.97	0.97

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	269	
Potential Capacity	674	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity	655	

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	0.97	0.97
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	269	
Potential Capacity	674	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity	655	
Results for Two-stage process:		
a		
y		
C t	655	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	13		10			
Movement Capacity (vph)	655		977			
Shared Lane Capacity (vph)		765				

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	655		977			
Volume	13		10			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		765				
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		LT		LR				
v (vph)		40		23				
C(m) (vph)		1427		765				
v/c		0.03		0.03				
95% queue length		0.09		0.09				
Control Delay		7.6		9.9				
LOS		A		A				
Approach Delay				9.9				
Approach LOS				A				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		155
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)		0.97
d(M,LT), Delay for stream 1 or 4		7.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.2

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		163	13	8	31	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		163	13	8	31	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		27			10	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		27			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				No	/	/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		8		37				
C(m) (vph)		1273		743				
v/c		0.01		0.05				
95% queue length		0.02		0.16				
Control Delay		7.8		10.1				
LOS		A		B				
Approach Delay				10.1				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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		163	13	8	31	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		41	3	2	8	
Hourly Flow Rate, HFR		163	13	8	31	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	27		10			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	7		2			
Hourly Flow Rate, HFR	27		10			
Percent Heavy Vehicles	25		25			
Percent Grade (%)	0			0		
Flared Approach: Exists?/Storage			No	/		/
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 (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:	31	
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	25		25			
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	6.7		6.4			
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	25		25			
t(f)		2.4	3.7		3.5			

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		176	217		170			
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	170	
Potential Capacity	818	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	818	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	176	
Potential Capacity	1273	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1273	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

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	0.99	0.99

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	217	
Potential Capacity	723	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	718	

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	0.99	0.99
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	217	
Potential Capacity	723	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	718	
Results for Two-stage process:		
a		
y		
C t	718	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	27		10			
Movement Capacity (vph)	718		818			
Shared Lane Capacity (vph)		743				

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	718		818			
Volume	27		10			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		743				
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		LT		LR				
v (vph)		8		37				
C(m) (vph)		1273		743				
v/c		0.01		0.05				
95% queue length		0.02		0.16				
Control Delay		7.8		10.1				
LOS		A		B				
Approach Delay				10.1				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		31
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)		0.99
d(M,LT), Delay for stream 1 or 4		7.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Osbourne Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	10	0	14			
Peak-Hour Factor, PHF	1.00	1.00	1.00			
Hourly Flow Rate, HFR	10	0	14			
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	0	0			
Configuration	LTRLR					
Upstream Signal?	No			No		

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	0	13		24	10	
Peak Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	0	13		24	10	
Percent Heavy Vehicles	10	25		25	10	
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			/		No	/
Lanes	0	1		1	0	
Configuration	LT			TR		

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR		LT					TR
v (vph)	10		13					34
C(m) (vph)	1572		818					872
v/c	0.01		0.02					0.04
95% queue length	0.02		0.05					0.12
Control Delay	7.3		9.5					9.3
LOS	A		A					A
Approach Delay				9.5			9.3	
Approach LOS				A			A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Osbourne Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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	10	0	14			
Peak-Hour Factor, PHF	1.00	1.00	1.00			
Peak-15 Minute Volume	2	0	4			
Hourly Flow Rate, HFR	10	0	14			
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	0	0			
Configuration	LTRLR					
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	0	13		24	10	
Peak Hour Factor, PHF	1.00	1.00		1.00	1.00	
Peak-15 Minute Volume	0	3		6	2	
Hourly Flow Rate, HFR	0	13		24	10	
Percent Heavy Vehicles	10	25		25	10	
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			/		No	/
RT Channelized						
Lanes	0	1		1	0	
Configuration	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:	0	
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:	0	

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	6.5			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)	10		10	25			25	10
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
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	4.2		7.2	6.8			6.8	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	4.00			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)	10		10	25			25	10
t(f)	2.3		3.6	4.2			4.2	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	0		44	27			34	0
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	0		0					0
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		0
Potential Capacity		1062
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1062
Probability of Queue free St.	1.00	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows		0
Potential Capacity		1572
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1572
Probability of Queue free St.	1.00	0.99
Maj L-Shared Prob Q free St.		0.99

Step 3: TH from Minor St.	8	11
Conflicting Flows	27	34
Potential Capacity	823	816
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99

Movement Capacity	818	811
Probability of Queue free St.	0.98	0.97

Step 4: LT from Minor St.	7	10

Conflicting Flows	44	
Potential Capacity	939	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	0.98
Maj. L, Min T Adj. Imp Factor.	0.97	0.98
Cap. Adj. factor due to Impeding mvmnt	0.96	0.98
Movement Capacity	905	

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	27	34
Potential Capacity	823	816
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	818	811
Result for 2 stage process:		
a		
y		
C t	818	811
Probability of Queue free St.	0.98	0.97

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	44	
Potential Capacity	939	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	0.98
Maj. L, Min T Adj. Imp Factor.	0.97	0.98
Cap. Adj. factor due to Impeding mvmnt	0.96	0.98
Movement Capacity	905	
Results for Two-stage process:		
a		
y		
C t	905	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	0	13			24	10
Movement Capacity (vph)	905	818			811	1062
Shared Lane Capacity (vph)	818					872

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	905	818			811	1062
Volume	0	13			24	10
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	818					872
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					TR
v (vph)	10		13					34
C(m) (vph)	1572		818					872
v/c	0.01		0.02					0.04
95% queue length	0.02		0.05					0.12
Control Delay	7.3		9.5					9.3
LOS	A		A					A
Approach Delay				9.5			9.3	
Approach LOS				A			A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	1.00
v(il), Volume for stream 2 or 5	0	
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)	0.99	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	0	
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Osbourne Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

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

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	8	30			13	10
Peak Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	8	30			13	10
Percent Heavy Vehicles	10	25			25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes	0	1			1	0
Configuration	LT				TR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR		LT					TR
v (vph)	10		38					23
C(m) (vph)	1572		845					914
v/c	0.01		0.04					0.03
95% queue length	0.02		0.14					0.08
Control Delay	7.3		9.5					9.0
LOS	A		A					A
Approach Delay				9.5			9.0	
Approach LOS				A			A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Osbourne Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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	10	0	0			
Peak-Hour Factor, PHF	1.00	1.00	1.00			
Peak-15 Minute Volume	2	0	0			
Hourly Flow Rate, HFR	10	0	0			
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	0	0			
Configuration	LTRLR					
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	8	30			13	10
Peak Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	2	8			3	2
Hourly Flow Rate, HFR	8	30			13	10
Percent Heavy Vehicles	10	25			25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized						
Lanes	0	1			1	0
Configuration	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:	0	
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:	0	

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	6.5			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)	10		10	25			25	10
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
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	4.2		7.2	6.8			6.8	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	4.00			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)	10		10	25			25	10
t(f)	2.3		3.6	4.2			4.2	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	0		32	20			20	0
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	0		0					0
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		0
Potential Capacity		1062
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1062
Probability of Queue free St.	1.00	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows		0
Potential Capacity		1572
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1572
Probability of Queue free St.	1.00	0.99
Maj L-Shared Prob Q free St.		0.99

Step 3: TH from Minor St.	8	11
Conflicting Flows	20	20
Potential Capacity	830	830
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99

Movement Capacity	825	825
Probability of Queue free St.	0.96	0.98

Step 4: LT from Minor St.	7	10

Conflicting Flows	32	
Potential Capacity	956	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	0.96
Maj. L, Min T Adj. Imp Factor.	0.98	0.97
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity	931	

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	20	20
Potential Capacity	830	830
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	825	825
Result for 2 stage process:		
a		
y		
C t	825	825
Probability of Queue free St.	0.96	0.98

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	32	
Potential Capacity	956	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	0.96
Maj. L, Min T Adj. Imp Factor.	0.98	0.97
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity	931	
Results for Two-stage process:		
a		
y		
C t	931	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	8	30			13	10
Movement Capacity (vph)	931	825			825	1062
Shared Lane Capacity (vph)	845					914

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	931	825			825	1062
Volume	8	30			13	10
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	845					914
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					TR
v (vph)	10		38					23
C(m) (vph)	1572		845					914
v/c	0.01		0.04					0.03
95% queue length	0.02		0.14					0.08
Control Delay	7.3		9.5					9.0
LOS	A		A					A
Approach Delay				9.5			9.0	
Approach LOS				A			A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	1.00
v(il), Volume for stream 2 or 5	0	
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)	0.99	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	0	
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	38	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	0	0		0	38	
Percent Heavy Vehicles	0	--	--	--	--	
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				13		0
Peak Hour Factor, PHF				1.00		1.00
Hourly Flow Rate, HFR				13		0
Percent Heavy Vehicles				100		0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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)	0						13	
C(m) (vph)	1585						796	
v/c	0.00						0.02	
95% queue length	0.00						0.05	
Control Delay	7.3						9.6	
LOS	A						A	
Approach Delay							9.6	
Approach LOS							A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	38	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Peak-15 Minute Volume	0	0		0	10	
Hourly Flow Rate, HFR	0	0		0	38	
Percent Heavy Vehicles	0	--	--	--	--	
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				13		0
Peak Hour Factor, PHF				1.00		1.00
Peak-15 Minute Volume				3		0
Hourly Flow Rate, HFR				13		0
Percent Heavy Vehicles				100		0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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 (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:	0	
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)	0					100		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					0.70		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	4.1					7.4		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)	0					100		0
t(f)	2.2					4.4		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	38					19		19
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		19
Potential Capacity		1065
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1065
Probability of Queue free St.	1.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		38
Potential Capacity		1585
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1585
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.		1.00

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		19
Potential Capacity		796
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		796

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	1.00	1.00
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		19
Potential Capacity		796
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		796
Results for Two-stage process:		
a		
y		
C t		796

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				13		0
Movement Capacity (vph)				796		1065
Shared Lane Capacity (vph)					796	

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				796		1065
Volume				13		0
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					796	
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	LT						LR	
v (vph)	0						13	
C(m) (vph)	1585						796	
v/c	0.00						0.02	
95% queue length	0.00						0.05	
Control Delay	7.3						9.6	
LOS	A						A	
Approach Delay							9.6	
Approach LOS							A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	0	
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)	1.00	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	13	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	0	0		0	13	
Percent Heavy Vehicles	0	--	--	--	--	
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				38	0	
Peak Hour Factor, PHF				1.00	1.00	
Hourly Flow Rate, HFR				38	0	
Percent Heavy Vehicles				44	0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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)	0						38	
C(m) (vph)	1619						917	
v/c	0.00						0.04	
95% queue length	0.00						0.13	
Control Delay	7.2						9.1	
LOS	A						A	
Approach Delay							9.1	
Approach LOS							A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	13	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Peak-15 Minute Volume	0	0		0	3	
Hourly Flow Rate, HFR	0	0		0	13	
Percent Heavy Vehicles	0	--	--	--	--	
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				38	0	
Peak Hour Factor, PHF				1.00	1.00	
Peak-15 Minute Volume				10	0	
Hourly Flow Rate, HFR				38	0	
Percent Heavy Vehicles				44	0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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 (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:	0	
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)	0					44		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					0.70		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	4.1					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					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)	0					44		0
t(f)	2.2					3.9		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	13					6		6
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		6
Potential Capacity		1083
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1083
Probability of Queue free St.	1.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		13
Potential Capacity		1619
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1619
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.		1.00

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		6
Potential Capacity		917
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		917

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	1.00	1.00
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		6
Potential Capacity		917
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		917
Results for Two-stage process:		
a		
y		
C t		917

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				38		0
Movement Capacity (vph)				917		1083
Shared Lane Capacity (vph)					917	

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				917		1083
Volume				38		0
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					917	
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	LT						LR	
v (vph)	0						38	
C(m) (vph)	1619						917	
v/c	0.00						0.04	
95% queue length	0.00						0.13	
Control Delay	7.2						9.1	
LOS	A						A	
Approach Delay							9.1	
Approach LOS							A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	0	
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)	1.00	
d(M,LT), Delay for stream 1 or 4	7.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		333	28	2	47	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		333	28	2	47	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		15			22	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		15			22	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		2		37				
C(m) (vph)		1209		661				
v/c		0.00		0.06				
95% queue length		0.00		0.18				
Control Delay		8.0		10.8				
LOS		A		B				
Approach Delay				10.8				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	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		333	28	2	47	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		83	7	0	12	
Hourly Flow Rate, HFR		333	28	2	47	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	15		22			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		6			
Hourly Flow Rate, HFR	15		22			
Percent Heavy Vehicles	0		0			
Percent Grade (%)	0			0		
Flared Approach: Exists?/Storage			No	/		/
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 (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:	47	
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)		0	0		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	0.70		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		4.1	6.4		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	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)		0	0		0			
t(f)		2.2	3.5		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		361	398		347			
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	347	
Potential Capacity	701	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	701	
Probability of Queue free St.	0.97	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	361	
Potential Capacity	1209	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1209	
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.	1.00	

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	398	
Potential Capacity	611	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		1.00
Maj. L, Min T Adj. Imp Factor.		1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	0.97
Movement Capacity	610	

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	1.00	1.00
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	398	
Potential Capacity	611	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		1.00
Maj. L, Min T Adj. Imp Factor.		1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	0.97
Movement Capacity	610	
Results for Two-stage process:		
a		
y		
C t	610	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	15		22			
Movement Capacity (vph)	610		701			
Shared Lane Capacity (vph)		661				

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	610		701			
Volume	15		22			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		661				
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		LT		LR				
v (vph)		2		37				
C(m) (vph)		1209		661				
v/c		0.00		0.06				
95% queue length		0.00		0.18				
Control Delay		8.0		10.8				
LOS		A		B				
Approach Delay				10.8				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5		47
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)		1.00
d(M,LT), Delay for stream 1 or 4		8.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.0

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		68	27	16	361	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		68	27	16	361	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		18			5	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		18			5	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		16		23				
C(m) (vph)		1512		604				
v/c		0.01		0.04				
95% queue length		0.03		0.12				
Control Delay		7.4		11.2				
LOS		A		B				
Approach Delay				11.2				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	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		68	27	16	361	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		17	7	4	90	
Hourly Flow Rate, HFR		68	27	16	361	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		18			5	
Peak Hour Factor, PHF		1.00			1.00	
Peak-15 Minute Volume		4			1	
Hourly Flow Rate, HFR		18			5	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
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 (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:	361	
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)		0	0		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	0.70		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		4.1	6.4		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	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)		0	0		0			
t(f)		2.2	3.5		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		95	475		82			
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	82	
Potential Capacity	983	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	983	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	95	
Potential Capacity	1512	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1512	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

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	0.99	0.99

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	475	
Potential Capacity	552	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	546	

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	0.99	0.99
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	475	
Potential Capacity	552	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	546	
Results for Two-stage process:		
a		
y		
C t	546	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	18		5			
Movement Capacity (vph)	546		983			
Shared Lane Capacity (vph)		604				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

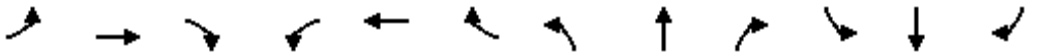
Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	546		983			
Volume	18		5			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		604				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		16		23				
C(m) (vph)		1512		604				
v/c		0.01		0.04				
95% queue length		0.03		0.12				
Control Delay		7.4		11.2				
LOS		A		B				
Approach Delay				11.2				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		361
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)		0.99
d(M,LT), Delay for stream 1 or 4		7.4
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1



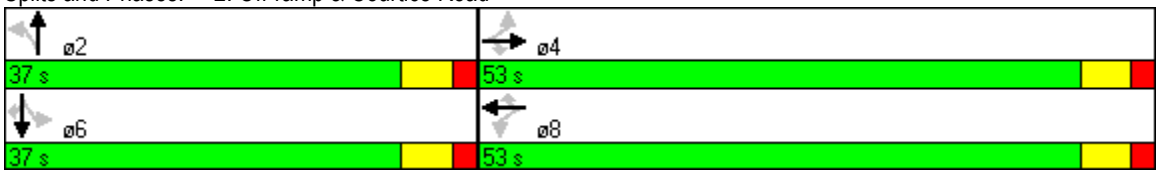
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	126	203	243	2	4	41	9	49	6	97	117	163
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.984				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1512	1690	1750	0	1690	1883	1601
Flt Permitted	0.755			0.630			0.682			0.721		
Satd. Flow (perm)	1343	1779	1512	1121	1779	1512	1213	1750	0	1283	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			243			41		6				163
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	2%	2%
Adj. Flow (vph)	126	203	243	2	4	41	9	49	6	97	117	163
Shared Lane Traffic (%)												
Lane Group Flow (vph)	126	203	243	2	4	41	9	55	0	97	117	163
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

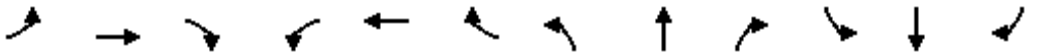
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	12.4	12.4	12.4	12.4	12.4	12.4	31.1	31.1		31.1	31.1	31.1
Actuated g/C Ratio	0.22	0.22	0.22	0.22	0.22	0.22	0.56	0.56		0.56	0.56	0.56
v/c Ratio	0.42	0.51	0.46	0.01	0.01	0.11	0.01	0.06		0.14	0.11	0.17
Control Delay	22.7	23.4	6.0	15.5	15.8	6.9	7.0	6.5		7.6	7.2	2.1
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	22.7	23.4	6.0	15.5	15.8	6.9	7.0	6.5		7.6	7.2	2.1
LOS	C	C	A	B	B	A	A	A		A	A	A
Approach Delay		15.9			8.0			6.5			5.1	
Approach LOS		B			A			A			A	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 55.6
Natural Cycle: 45
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.51
Intersection Signal Delay: 11.1 Intersection LOS: B
Intersection Capacity Utilization 39.5% ICU Level of Service A
Analysis Period (min) 60

Splits and Phases: 2: Off-ramp & Courtice Road



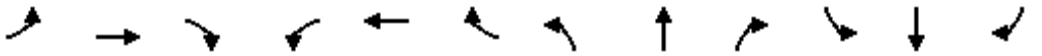


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	626	57	53	7	35	236	50	285	44	27	35	179
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.980				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1779	1512	1690	1779	1512	1690	1743	0	1706	1883	1601
Flt Permitted	0.734			0.720			0.734			0.419		
Satd. Flow (perm)	1369	1779	1512	1281	1779	1512	1306	1743	0	752	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			53			150		8				179
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	8%	8%	8%	8%	8%	8%	8%	8%	7%	2%	2%
Adj. Flow (vph)	626	57	53	7	35	236	50	285	44	27	35	179
Shared Lane Traffic (%)												
Lane Group Flow (vph)	626	57	53	7	35	236	50	329	0	27	35	179
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	67.0	67.0	67.0	67.0	67.0	67.0	23.0	23.0	0.0	23.0	23.0	23.0
Total Split (%)	74.4%	74.4%	74.4%	74.4%	74.4%	74.4%	25.6%	25.6%	0.0%	25.6%	25.6%	25.6%
Maximum Green (s)	61.0	61.0	61.0	61.0	61.0	61.0	17.0	17.0		17.0	17.0	17.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	35.0	35.0	35.0	35.0	35.0	35.0	17.7	17.7		17.7	17.7	17.7
Actuated g/C Ratio	0.54	0.54	0.54	0.54	0.54	0.54	0.27	0.27		0.27	0.27	0.27
v/c Ratio	0.85	0.06	0.06	0.01	0.04	0.27	0.14	0.69		0.13	0.07	0.32
Control Delay	25.6	6.1	1.9	5.6	5.9	3.3	24.9	34.5		26.4	24.0	6.7
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	25.6	6.1	1.9	5.6	5.9	3.3	24.9	34.5		26.4	24.0	6.7
LOS	C	A	A	A	A	A	C	C		C	C	A
Approach Delay		22.4			3.7			33.3			11.4	
Approach LOS		C			A			C			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 65.2			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 20.1		Intersection LOS: C	
Intersection Capacity Utilization 82.0%		ICU Level of Service D	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road

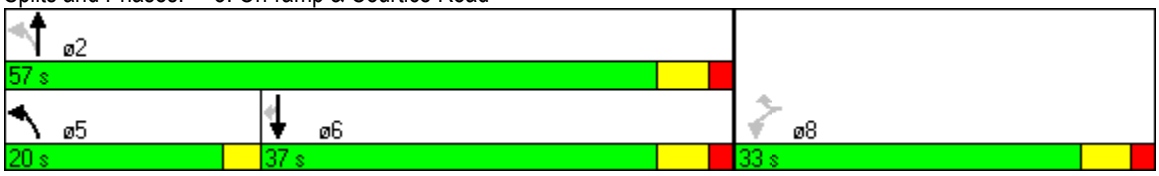


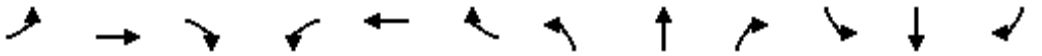
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	100	0	216	80	134	0	0	284	323
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1526	1521	1883	0	0	1779	1601
Flt Permitted				0.950			0.447					
Satd. Flow (perm)	0	0	0	1690	0	1526	716	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						216						323
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	7%	20%	2%	0%	0%	8%	2%
Adj. Flow (vph)	0	0	0	100	0	216	80	134	0	0	284	323
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	100	0	216	80	134	0	0	284	323
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	33.0	0.0	33.0	20.0	57.0	0.0	0.0	37.0	37.0
Total Split (%)	0.0%	0.0%	0.0%	36.7%	0.0%	36.7%	22.2%	63.3%	0.0%	0.0%	41.1%	41.1%
Maximum Green (s)				27.0		27.0	17.0	51.0			31.0	31.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				27.0		27.0	54.0	51.0			31.0	31.0
Actuated g/C Ratio				0.30		0.30	0.60	0.57			0.34	0.34
v/c Ratio				0.20		0.35	0.14	0.13			0.46	0.42

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				24.8		5.3	8.3	9.5			26.1	4.5
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				24.8		5.3	8.3	9.5			26.1	4.5
LOS				C		A	A	A			C	A
Approach Delay								9.0			14.6	
Approach LOS								A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 55			
Control Type: Pretimed			
Maximum v/c Ratio: 0.46			
Intersection Signal Delay: 12.7		Intersection LOS: B	
Intersection Capacity Utilization 36.6%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



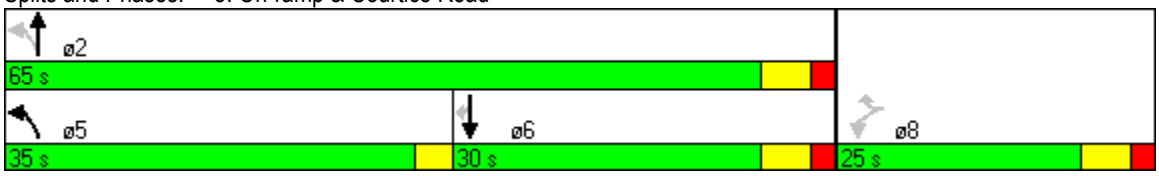


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	29	0	219	432	717	0	0	211	141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1570	1825	1883	0	0	1779	1601
Flt Permitted				0.950			0.492					
Satd. Flow (perm)	0	0	0	1690	0	1570	945	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						219						141
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	4%	0%	2%	2%	0%	8%	2%
Adj. Flow (vph)	0	0	0	29	0	219	432	717	0	0	211	141
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	29	0	219	432	717	0	0	211	141
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	25.0	0.0	25.0	35.0	65.0	0.0	0.0	30.0	30.0
Total Split (%)	0.0%	0.0%	0.0%	27.8%	0.0%	27.8%	38.9%	72.2%	0.0%	0.0%	33.3%	33.3%
Maximum Green (s)				19.0		19.0	32.0	59.0			24.0	24.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				19.0		19.0	62.0	59.0			24.0	24.0
Actuated g/C Ratio				0.21		0.21	0.69	0.66			0.27	0.27
v/c Ratio				0.08		0.43	0.45	0.58			0.45	0.27

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				29.3		7.4	7.4	11.0			31.1	6.1
Queue Delay				0.0		0.0	0.0	0.5			0.0	0.0
Total Delay				29.3		7.4	7.4	11.5			31.1	6.1
LOS				C		A	A	B			C	A
Approach Delay								10.0			21.1	
Approach LOS								A			C	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 60			
Control Type: Pretimed			
Maximum v/c Ratio: 0.58			
Intersection Signal Delay: 12.2		Intersection LOS: B	
Intersection Capacity Utilization 61.3%		ICU Level of Service B	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



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TWO-WAY STOP CONTROL SUMMARY

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 1/5/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Total
Project ID: 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		77	134		283	323	
Peak-Hour Factor, PHF		1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR		77	134		283	323	
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		98		216			
Peak Hour Factor, PHF		1.00		1.00			
Hourly Flow Rate, HFR		98		216			
Percent Heavy Vehicles		25		10			
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)	77			314				
C(m) (vph)	869			1041				
v/c	0.09			0.30				
95% queue length	0.29			1.29				
Control Delay	9.5			13.6				
LOS	A			B				
Approach Delay				13.6				
Approach LOS				B				

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Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: M. Raso
Agency/Co.: Durham/York Waste Study
Date Performed: 1/5/2009
Analysis Time Period: AM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Total
Project ID: 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	77	134			283	323
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	19	34			71	81
Hourly Flow Rate, HFR	77	134			283	323
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	98		216			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	24		54			
Hourly Flow Rate, HFR	98		216			
Percent Heavy Vehicles	25		10			
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:	134	
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		25		10			
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		6.7		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		25		10			
t(f)	2.4		3.7		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	606		732		134			
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	134	
Potential Capacity	894	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	894	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		606
Potential Capacity		869
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		869
Probability of Queue free St.	1.00	0.91
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	732	
Potential Capacity	357	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.93
Cap. Adj. factor due to Impeding mvmnt	0.91	0.70
Movement Capacity	325	

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	732	
Potential Capacity	357	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.93
Cap. Adj. factor due to Impeding mvmnt	0.91	0.70
Movement Capacity	325	
Results for Two-stage process:		
a		
y		
C t	325	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	98		216			
Movement Capacity (vph)	325		894			
Shared Lane Capacity (vph)		578				

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	325		894			
Volume	98		216			
Delay	20.8		10.3			
Q sep	0.57		0.62			
Q sep +1	1.57		1.62			
round (Qsep +1)	2		2			
n max		2				
C sh		578				
SUM C sep		1041				
n		2				
C act		1041				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	77			314				
C(m) (vph)	869			1041				
v/c	0.09			0.30				
95% queue length	0.29			1.29				
Control Delay	9.5			13.6				
LOS	A			B				
Approach Delay				13.6				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.91	1.00
v(il), Volume for stream 2 or 5	134	
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	9.5	
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: 1/5/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Total
Project ID: 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		428	717			211	141
Peak-Hour Factor, PHF		1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR		428	717			211	141
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		29		219			
Peak Hour Factor, PHF		1.00		1.00			
Hourly Flow Rate, HFR		29		219			
Percent Heavy Vehicles		25		10			
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)	428			248				
C(m) (vph)	1090			314				
v/c	0.39			0.79				
95% queue length	1.93			8.88				
Control Delay	10.4			55.5				
LOS	B			F				
Approach Delay				55.5				
Approach LOS				F				

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: 1/5/2009
Analysis Time Period: PM
Intersection: Courtice Rd. & Hwy 401 N Ramps
Jurisdiction:
Units: U. S. Customary
Analysis Year: Future Total
Project ID: 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	428	717			211	141
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	107	179			53	35
Hourly Flow Rate, HFR	428	717			211	141
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	29		219			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	7		55			
Hourly Flow Rate, HFR	29		219			
Percent Heavy Vehicles	25		10			
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:	717	
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		25		10			
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		6.7		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		25		10			
t(f)	2.4		3.7		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	352		1855		717			
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	717	
Potential Capacity	416	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	416	
Probability of Queue free St.	0.47	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		352
Potential Capacity		1090
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1090
Probability of Queue free St.	1.00	0.61
Maj L-Shared Prob Q free St.		0.32

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	0.32	0.32

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	1855	
Potential Capacity	71	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.32
Maj. L, Min T Adj. Imp Factor.		0.45
Cap. Adj. factor due to Impeding mvmnt	0.61	0.21
Movement Capacity	43	

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	0.32	0.32
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	1855	
Potential Capacity	71	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.32
Maj. L, Min T Adj. Imp Factor.		0.45
Cap. Adj. factor due to Impeding mvmnt	0.61	0.21
Movement Capacity	43	
Results for Two-stage process:		
a		
y		
C t	43	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	29		219			
Movement Capacity (vph)	43		416			
Shared Lane Capacity (vph)		207				

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	43		416			
Volume	29		219			
Delay	228.7		23.2			
Q sep	1.84		1.41			
Q sep +1	2.84		2.41			
round (Qsep +1)	3		2			
n max		3				
C sh		207				
SUM C sep		368				
n		2				
C act		314				

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

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	428			248				
C(m) (vph)	1090			314				
v/c	0.39			0.79				
95% queue length	1.93			8.88				
Control Delay	10.4			55.5				
LOS	B			F				
Approach Delay				55.5				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.61	1.00
v(il), Volume for stream 2 or 5	717	
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)	0.32	
d(M,LT), Delay for stream 1 or 4	10.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	7.1	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID:	Energy from Waste (140,000 tpy)
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		24	17	43	156	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		24	17	43	156	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		9			10	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		9			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration			LR			

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		43		19				
C(m) (vph)		1432		789				
v/c		0.03		0.02				
95% queue length		0.09		0.07				
Control Delay		7.6		9.7				
LOS		A		A				
Approach Delay				9.7				
Approach LOS				A				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID:	Energy from Waste (140,000 tpy)
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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		24	17	43	156	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		6	4	11	39	
Hourly Flow Rate, HFR		24	17	43	156	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		9			10	
Peak Hour Factor, PHF		1.00			1.00	
Peak-15 Minute Volume		2			2	
Hourly Flow Rate, HFR		9			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
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 (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:	156	
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	25		25			
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	6.7		6.4			
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	25		25			
t(f)		2.4	3.7		3.5			

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		41	274		32			
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	32	
Potential Capacity	980	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	980	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	41	
Potential Capacity	1432	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1432	
Probability of Queue free St.	0.97	1.00
Maj L-Shared Prob Q free St.	0.97	

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	0.97	0.97

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	274	
Potential Capacity	669	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.97
Cap. Adj. factor due to Impeding mvmnt	0.97	0.96
Movement Capacity	649	

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	0.97	0.97
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	274	
Potential Capacity	669	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.97
Cap. Adj. factor due to Impeding mvmnt	0.97	0.96
Movement Capacity	649	
Results for Two-stage process:		
a		
y		
C t	649	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	9		10			
Movement Capacity (vph)	649		980			
Shared Lane Capacity (vph)		789				

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	649		980			
Volume	9		10			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		789				
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		LT		LR				
v (vph)		43		19				
C(m) (vph)		1432		789				
v/c		0.03		0.02				
95% queue length		0.09		0.07				
Control Delay		7.6		9.7				
LOS		A		A				
Approach Delay				9.7				
Approach LOS				A				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		156
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)		0.97
d(M,LT), Delay for stream 1 or 4		7.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.3

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID:	Energy from Waste (140,000 tpy)
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		163	9	9	31	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		163	9	9	31	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		22			10	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		22			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				No	/	/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		9		32				
C(m) (vph)		1277		747				
v/c		0.01		0.04				
95% queue length		0.02		0.13				
Control Delay		7.8		10.0+				
LOS		A		B				
Approach Delay				10.0+				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone:	Fax:
E-Mail:	

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID:	Energy from Waste (140,000 tpy)
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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		163	9	9	31	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		41	2	2	8	
Hourly Flow Rate, HFR		163	9	9	31	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		22			10	
Peak Hour Factor, PHF		1.00			1.00	
Peak-15 Minute Volume		6			2	
Hourly Flow Rate, HFR		22			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				No	/	/
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 (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:	31	
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	25		25			
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	6.7		6.4			
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	25		25			
t(f)		2.4	3.7		3.5			

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		172	217		168			
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	168	
Potential Capacity	820	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	820	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	172	
Potential Capacity	1277	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1277	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

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	0.99	0.99

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	217	
Potential Capacity	723	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	718	

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	0.99	0.99
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	217	
Potential Capacity	723	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	718	
Results for Two-stage process:		
a		
y		
C t	718	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	22		10			
Movement Capacity (vph)	718		820			
Shared Lane Capacity (vph)		747				

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	718		820			
Volume	22		10			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		747				
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		LT		LR				
v (vph)		9		32				
C(m) (vph)		1277		747				
v/c		0.01		0.04				
95% queue length		0.02		0.13				
Control Delay		7.8		10.0+				
LOS		A		B				
Approach Delay				10.0+				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		31
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)		0.99
d(M,LT), Delay for stream 1 or 4		7.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Park Drive/Osbourne Rd.
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste (140,000 tpy)
East/West Street: Park Drive
North/South Street: Osbourne Road
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	10	0	11			
Peak-Hour Factor, PHF	1.00	1.00	1.00			
Hourly Flow Rate, HFR	10	0	11			
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	0	0			
Configuration		LTRLR				
Upstream Signal?		No			No	

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

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR		LT					TR
v (vph)	10		9					10
C(m) (vph)	1572		819					1062
v/c	0.01		0.01					0.01
95% queue length	0.02		0.03					0.03
Control Delay	7.3		9.4					8.4
LOS	A		A					A
Approach Delay				9.4			8.4	
Approach LOS				A			A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Park Drive/Osbourne Rd.
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste (140,000 tpy)
East/West Street: Park Drive
North/South Street: Osbourne Road
Intersection Orientation: EW 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	10	0	11			
Peak-Hour Factor, PHF	1.00	1.00	1.00			
Peak-15 Minute Volume	2	0	3			
Hourly Flow Rate, HFR	10	0	11			
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	0	0			
Configuration		LTRLR				
Upstream Signal?		No			No	

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

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	6.5			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)	10		10	25			25	10
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
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	4.2		7.2	6.8			6.8	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	4.00			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)	10		10	25			25	10
t(f)	2.3		3.6	4.2			4.2	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	0		31	26			31	0
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	0		0					0
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		0
Potential Capacity		1062
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1062
Probability of Queue free St.	1.00	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows		0
Potential Capacity		1572
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1572
Probability of Queue free St.	1.00	0.99
Maj L-Shared Prob Q free St.		0.99

Step 3: TH from Minor St.	8	11
Conflicting Flows	26	31
Potential Capacity	824	819
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99

Movement Capacity	819	814
Probability of Queue free St.	0.99	1.00

Step 4: LT from Minor St.	7	10

Conflicting Flows	31	
Potential Capacity	957	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.99	0.98
Maj. L, Min T Adj. Imp Factor.	1.00	0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	943	

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	26	31
Potential Capacity	824	819
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	819	814
Result for 2 stage process:		
a		
y		
C t	819	814
Probability of Queue free St.	0.99	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	31	
Potential Capacity	957	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.99	0.98
Maj. L, Min T Adj. Imp Factor.	1.00	0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	943	
Results for Two-stage process:		
a		
y		
C t	943	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	0	9			0	10
Movement Capacity (vph)	943	819			814	1062
Shared Lane Capacity (vph)	819					1062

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	943	819			814	1062
Volume	0	9			0	10
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	819					1062
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					TR
v (vph)	10		9					10
C(m) (vph)	1572		819					1062
v/c	0.01		0.01					0.01
95% queue length	0.02		0.03					0.03
Control Delay	7.3		9.4					8.4
LOS	A		A					A
Approach Delay				9.4			8.4	
Approach LOS				A			A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	1.00
v(il), Volume for stream 2 or 5	0	
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)	0.99	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	0	
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Park Drive/Osbourne Rd.
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Park Drive
North/South Street: Osbourne Road
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

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

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	7	24		10	9	
Peak Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	7	24		10	9	
Percent Heavy Vehicles	10	25		25	10	
Percent Grade (%)		0		0		
Flared Approach: Exists?/Storage			/		No	/
Lanes	0	1		1	0	
Configuration	LT			TR		

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR		LT					TR
v (vph)	10		31					19
C(m) (vph)	1572		848					923
v/c	0.01		0.04					0.02
95% queue length	0.02		0.11					0.06
Control Delay	7.3		9.4					9.0
LOS	A		A					A
Approach Delay				9.4			9.0	
Approach LOS				A			A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Park Drive/Osbourne Rd.
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste
East/West Street: Park Drive
North/South Street: Osbourne Road
Intersection Orientation: EW 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	10	0	0			
Peak-Hour Factor, PHF	1.00	1.00	1.00			
Peak-15 Minute Volume	2	0	0			
Hourly Flow Rate, HFR	10	0	0			
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	0	0			
Configuration	LTRLR					
Upstream Signal?	No			No		

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	7	24			10	9
Peak Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	2	6			2	2
Hourly Flow Rate, HFR	7	24			10	9
Percent Heavy Vehicles	10	25			25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized						
Lanes	0	1			1	0
Configuration	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:	0	
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:	0	

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	6.5			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)	10		10	25			25	10
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
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	4.2		7.2	6.8			6.8	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	4.00			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)	10		10	25			25	10
t(f)	2.3		3.6	4.2			4.2	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	0		30	20			20	0
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	0		0					0
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		0
Potential Capacity		1062
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1062
Probability of Queue free St.	1.00	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows		0
Potential Capacity		1572
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1572
Probability of Queue free St.	1.00	0.99
Maj L-Shared Prob Q free St.		0.99

Step 3: TH from Minor St.	8	11
Conflicting Flows	20	20
Potential Capacity	830	830
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99

Movement Capacity	825	825
Probability of Queue free St.	0.97	0.99

Step 4: LT from Minor St.	7	10

Conflicting Flows	30	
Potential Capacity	959	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	0.96
Maj. L, Min T Adj. Imp Factor.	0.99	0.97
Cap. Adj. factor due to Impeding mvmnt	0.98	0.97
Movement Capacity	938	

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	20	20
Potential Capacity	830	830
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	825	825
Result for 2 stage process:		
a		
y		
C t	825	825
Probability of Queue free St.	0.97	0.99

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	30	
Potential Capacity	959	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	0.96
Maj. L, Min T Adj. Imp Factor.	0.99	0.97
Cap. Adj. factor due to Impeding mvmnt	0.98	0.97
Movement Capacity	938	
Results for Two-stage process:		
a		
y		
C t	938	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	7	24			10	9
Movement Capacity (vph)	938	825			825	1062
Shared Lane Capacity (vph)	848					923

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	938	825			825	1062
Volume	7	24			10	9
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh	848					923
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					TR
v (vph)	10		31					19
C(m) (vph)	1572		848					923
v/c	0.01		0.04					0.02
95% queue length	0.02		0.11					0.06
Control Delay	7.3		9.4					9.0
LOS	A		A					A
Approach Delay				9.4			9.0	
Approach LOS				A			A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	1.00
v(il), Volume for stream 2 or 5	0	
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)	0.99	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	0	
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste (140,000 tpy)
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	31	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	0	0		0	31	
Percent Heavy Vehicles	0	--	--	--	--	
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				9	0	
Peak Hour Factor, PHF				1.00	1.00	
Hourly Flow Rate, HFR				9	0	
Percent Heavy Vehicles				100	0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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)	0						9	
C(m) (vph)	1595						799	
v/c	0.00						0.01	
95% queue length	0.00						0.03	
Control Delay	7.3						9.6	
LOS	A						A	
Approach Delay							9.6	
Approach LOS							A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste (140,000 tpy)
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	31	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Peak-15 Minute Volume	0	0		0	8	
Hourly Flow Rate, HFR	0	0		0	31	
Percent Heavy Vehicles	0	--	--	--	--	
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				9	0	
Peak Hour Factor, PHF				1.00	1.00	
Peak-15 Minute Volume				2	0	
Hourly Flow Rate, HFR				9	0	
Percent Heavy Vehicles				100	0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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 (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:	0	
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)	0					100		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					0.70		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	4.1					7.4		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					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)	0					100		0
t(f)	2.2					4.4		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	31					16		16
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		16
Potential Capacity		1069
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1069
Probability of Queue free St.	1.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		31
Potential Capacity		1595
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1595
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.		1.00

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		16
Potential Capacity		799
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		799

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	1.00	1.00
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		16
Potential Capacity		799
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		799
Results for Two-stage process:		
a		
y		
C t		799

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				9		0
Movement Capacity (vph)				799		1069
Shared Lane Capacity (vph)					799	

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				799		1069
Volume				9		0
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					799	
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	LT						LR	
v (vph)	0						9	
C(m) (vph)	1595						799	
v/c	0.00						0.01	
95% queue length	0.00						0.03	
Control Delay	7.3						9.6	
LOS	A						A	
Approach Delay							9.6	
Approach LOS							A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	0	
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)	1.00	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste (140,000 tpy)
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	9	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	0	0		0	9	
Percent Heavy Vehicles	0	--	--	--	--	
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				31	0	
Peak Hour Factor, PHF				1.00	1.00	
Hourly Flow Rate, HFR				31	0	
Percent Heavy Vehicles				44	0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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)	0						31	
C(m) (vph)	1624						919	
v/c	0.00						0.03	
95% queue length	0.00						0.10	
Control Delay	7.2						9.1	
LOS	A						A	
Approach Delay							9.1	
Approach LOS							A	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2013
Project ID: Energy from Waste (140,000 tpy)
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	0		0	9	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Peak-15 Minute Volume	0	0		0	2	
Hourly Flow Rate, HFR	0	0		0	9	
Percent Heavy Vehicles	0	--	--	--	--	
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				31	0	
Peak Hour Factor, PHF				1.00	1.00	
Peak-15 Minute Volume				8	0	
Hourly Flow Rate, HFR				31	0	
Percent Heavy Vehicles				44	0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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 (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:	0	
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)	0					44		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					0.70		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	4.1					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)	0					44		0
t(f)	2.2					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	9					4		4
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		4
Potential Capacity		1085
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1085
Probability of Queue free St.	1.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		9
Potential Capacity		1624
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1624
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.		1.00

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		4
Potential Capacity		919
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		919

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	1.00	1.00
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		4
Potential Capacity		919
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		919
Results for Two-stage process:		
a		
y		
C t		919

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				31		0
Movement Capacity (vph)				919		1085
Shared Lane Capacity (vph)					919	

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				919		1085
Volume				31		0
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					919	
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	LT						LR	
v (vph)	0						31	
C(m) (vph)	1624						919	
v/c	0.00						0.03	
95% queue length	0.00						0.10	
Control Delay	7.2						9.1	
LOS	A						A	
Approach Delay							9.1	
Approach LOS							A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	0	
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)	1.00	
d(M,LT), Delay for stream 1 or 4	7.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste (140,000 tpy)	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		332	28	2	47	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		332	28	2	47	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		15			22	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		15			22	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		2		37				
C(m) (vph)		1210		662				
v/c		0.00		0.06				
95% queue length		0.00		0.18				
Control Delay		8.0		10.8				
LOS		A		B				
Approach Delay				10.8				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste (140,000 tpy)	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	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		332	28	2	47	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		83	7	0	12	
Hourly Flow Rate, HFR		332	28	2	47	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	15		22			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		6			
Hourly Flow Rate, HFR	15		22			
Percent Heavy Vehicles	0		0			
Percent Grade (%)	0			0		
Flared Approach: Exists?/Storage			No	/		/
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 (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:	47	
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)		0	0		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	0.70		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		4.1	6.4		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	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)		0	0		0			
t(f)		2.2	3.5		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		360	397		346			
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	346	
Potential Capacity	702	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	702	
Probability of Queue free St.	0.97	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	360	
Potential Capacity	1210	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1210	
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.	1.00	

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	397	
Potential Capacity	612	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		1.00
Maj. L, Min T Adj. Imp Factor.		1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	0.97
Movement Capacity	611	

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	1.00	1.00
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	397	
Potential Capacity	612	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		1.00
Maj. L, Min T Adj. Imp Factor.		1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	0.97
Movement Capacity	611	
Results for Two-stage process:		
a		
y		
C t	611	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	15		22			
Movement Capacity (vph)	611		702			
Shared Lane Capacity (vph)		662				

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	611		702			
Volume	15		22			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		662				
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		LT		LR				
v (vph)		2		37				
C(m) (vph)		1210		662				
v/c		0.00		0.06				
95% queue length		0.00		0.18				
Control Delay		8.0		10.8				
LOS		A		B				
Approach Delay				10.8				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5		47
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)		1.00
d(M,LT), Delay for stream 1 or 4		8.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.0

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste (140,000 tpy)	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		68	27	16	360	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		68	27	16	360	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		18			5	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		18			5	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		16		23				
C(m) (vph)		1512		605				
v/c		0.01		0.04				
95% queue length		0.03		0.12				
Control Delay		7.4		11.2				
LOS		A		B				
Approach Delay				11.2				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2013
Project ID: Energy from Waste (140,000 tpy)	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	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		68	27	16	360	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		17	7	4	90	
Hourly Flow Rate, HFR		68	27	16	360	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		18			5	
Peak Hour Factor, PHF		1.00			1.00	
Peak-15 Minute Volume		4			1	
Hourly Flow Rate, HFR		18			5	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
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 (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:	360	
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)		0	0		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	0.70		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		4.1	6.4		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	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)		0	0		0			
t(f)		2.2	3.5		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		95	474		82			
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	82	
Potential Capacity	983	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	983	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	95	
Potential Capacity	1512	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1512	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

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	0.99	0.99

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	474	
Potential Capacity	553	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	547	

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	0.99	0.99
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	474	
Potential Capacity	553	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	547	
Results for Two-stage process:		
a		
y		
C t	547	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	18		5			
Movement Capacity (vph)	547		983			
Shared Lane Capacity (vph)		605				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

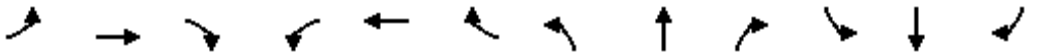
Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	547		983			
Volume	18		5			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		605				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		16		23				
C(m) (vph)		1512		605				
v/c		0.01		0.04				
95% queue length		0.03		0.12				
Control Delay		7.4		11.2				
LOS		A		B				
Approach Delay				11.2				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		360
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)		0.99
d(M,LT), Delay for stream 1 or 4		7.4
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

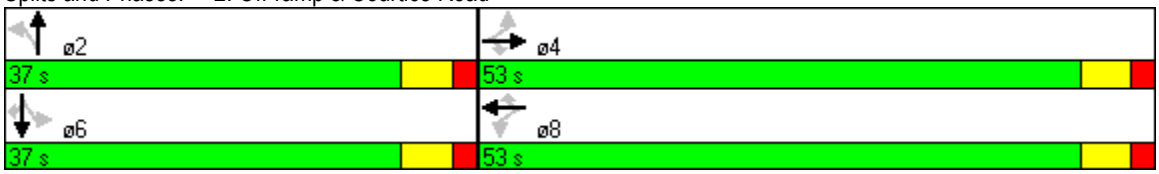


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	126	200	241	2	4	37	9	49	6	103	116	163
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.984				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1512	1690	1750	0	1690	1883	1601
Flt Permitted	0.755			0.632			0.682			0.721		
Satd. Flow (perm)	1343	1779	1512	1124	1779	1512	1213	1750	0	1283	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			241			37		6				163
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	2%	2%
Adj. Flow (vph)	126	200	241	2	4	37	9	49	6	103	116	163
Shared Lane Traffic (%)												
Lane Group Flow (vph)	126	200	241	2	4	37	9	55	0	103	116	163
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	12.3	12.3	12.3	12.3	12.3	12.3	31.1	31.1		31.1	31.1	31.1
Actuated g/C Ratio	0.22	0.22	0.22	0.22	0.22	0.22	0.56	0.56		0.56	0.56	0.56
v/c Ratio	0.42	0.51	0.46	0.01	0.01	0.10	0.01	0.06		0.14	0.11	0.17
Control Delay	22.8	23.4	6.0	15.5	15.8	7.1	7.0	6.4		7.6	7.1	2.1
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	22.8	23.4	6.0	15.5	15.8	7.1	7.0	6.4		7.6	7.1	2.1
LOS	C	C	A	B	B	A	A	A		A	A	A
Approach Delay		15.9			8.3			6.5			5.1	
Approach LOS		B			A			A			A	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 55.5			
Natural Cycle: 45			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.51			
Intersection Signal Delay: 11.1		Intersection LOS: B	
Intersection Capacity Utilization 39.4%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road

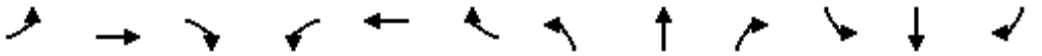


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	626	53	53	7	33	232	49	285	44	27	35	179
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.980				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1779	1512	1690	1779	1512	1690	1743	0	1706	1883	1601
Flt Permitted	0.736			0.722			0.734			0.420		
Satd. Flow (perm)	1373	1779	1512	1284	1779	1512	1306	1743	0	754	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			53			150		8				179
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	8%	8%	8%	8%	8%	8%	8%	8%	7%	2%	2%
Adj. Flow (vph)	626	53	53	7	33	232	49	285	44	27	35	179
Shared Lane Traffic (%)												
Lane Group Flow (vph)	626	53	53	7	33	232	49	329	0	27	35	179
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	67.0	67.0	67.0	67.0	67.0	67.0	23.0	23.0	0.0	23.0	23.0	23.0
Total Split (%)	74.4%	74.4%	74.4%	74.4%	74.4%	74.4%	25.6%	25.6%	0.0%	25.6%	25.6%	25.6%
Maximum Green (s)	61.0	61.0	61.0	61.0	61.0	61.0	17.0	17.0		17.0	17.0	17.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	34.8	34.8	34.8	34.8	34.8	34.8	17.7	17.7		17.7	17.7	17.7
Actuated g/C Ratio	0.54	0.54	0.54	0.54	0.54	0.54	0.27	0.27		0.27	0.27	0.27
v/c Ratio	0.85	0.06	0.06	0.01	0.03	0.26	0.14	0.69		0.13	0.07	0.32
Control Delay	25.5	6.1	1.9	5.6	5.9	3.3	24.8	34.4		26.3	23.9	6.7
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	25.5	6.1	1.9	5.6	5.9	3.3	24.8	34.4		26.3	23.9	6.7
LOS	C	A	A	A	A	A	C	C		C	C	A
Approach Delay		22.4			3.7			33.1			11.4	
Approach LOS		C			A			C			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 65			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 20.1		Intersection LOS: C	
Intersection Capacity Utilization 81.7%		ICU Level of Service D	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road

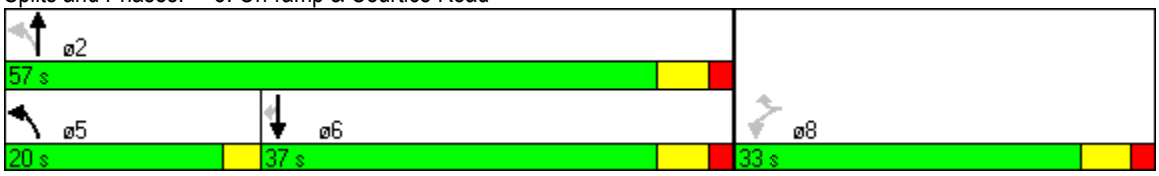


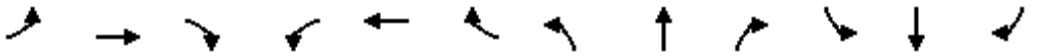
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	98	0	216	77	134	0	0	283	323
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1526	1521	1883	0	0	1779	1601
Flt Permitted				0.950			0.448					
Satd. Flow (perm)	0	0	0	1690	0	1526	717	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						216						323
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	7%	20%	2%	0%	0%	8%	2%
Adj. Flow (vph)	0	0	0	98	0	216	77	134	0	0	283	323
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	98	0	216	77	134	0	0	283	323
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	33.0	0.0	33.0	20.0	57.0	0.0	0.0	37.0	37.0
Total Split (%)	0.0%	0.0%	0.0%	36.7%	0.0%	36.7%	22.2%	63.3%	0.0%	0.0%	41.1%	41.1%
Maximum Green (s)				27.0		27.0	17.0	51.0			31.0	31.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				27.0		27.0	54.0	51.0			31.0	31.0
Actuated g/C Ratio				0.30		0.30	0.60	0.57			0.34	0.34
v/c Ratio				0.19		0.35	0.13	0.13			0.46	0.42

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				24.7		5.3	8.2	9.5			26.1	4.5
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				24.7		5.3	8.2	9.5			26.1	4.5
LOS				C		A	A	A			C	A
Approach Delay								9.0			14.5	
Approach LOS								A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 55			
Control Type: Pretimed			
Maximum v/c Ratio: 0.46			
Intersection Signal Delay: 12.6		Intersection LOS: B	
Intersection Capacity Utilization 36.3%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



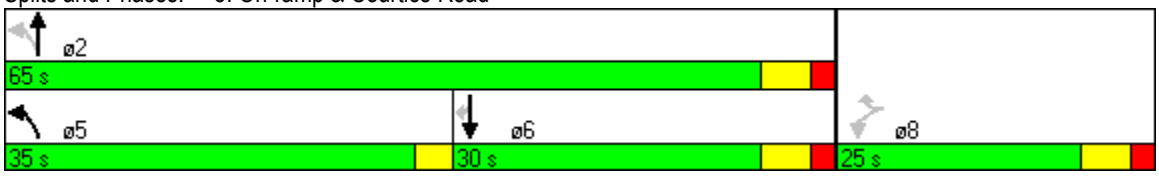


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	29	0	219	428	717	0	0	211	141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1570	1825	1883	0	0	1779	1601
Flt Permitted				0.950			0.492					
Satd. Flow (perm)	0	0	0	1690	0	1570	945	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						219						141
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	4%	0%	2%	2%	0%	8%	2%
Adj. Flow (vph)	0	0	0	29	0	219	428	717	0	0	211	141
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	29	0	219	428	717	0	0	211	141
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	25.0	0.0	25.0	35.0	65.0	0.0	0.0	30.0	30.0
Total Split (%)	0.0%	0.0%	0.0%	27.8%	0.0%	27.8%	38.9%	72.2%	0.0%	0.0%	33.3%	33.3%
Maximum Green (s)				19.0		19.0	32.0	59.0			24.0	24.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				19.0		19.0	62.0	59.0			24.0	24.0
Actuated g/C Ratio				0.21		0.21	0.69	0.66			0.27	0.27
v/c Ratio				0.08		0.43	0.44	0.58			0.45	0.27

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				29.3		7.4	7.3	11.0			31.1	6.1
Queue Delay				0.0		0.0	0.0	0.5			0.0	0.0
Total Delay				29.3		7.4	7.3	11.5			31.1	6.1
LOS				C		A	A	B			C	A
Approach Delay								9.9			21.1	
Approach LOS								A			C	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 60			
Control Type: Pretimed			
Maximum v/c Ratio: 0.58			
Intersection Signal Delay: 12.2		Intersection LOS: B	
Intersection Capacity Utilization 61.3%		ICU Level of Service B	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		234	24	40	173	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		234	24	40	173	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		20			10	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		20			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		40		30				
C(m) (vph)		1184		539				
v/c		0.03		0.06				
95% queue length		0.10		0.18				
Control Delay		8.1		12.1				
LOS		A		B				
Approach Delay				12.1				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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		234	24	40	173	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		58	6	10	43	
Hourly Flow Rate, HFR		234	24	40	173	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	20		10			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	5		2			
Hourly Flow Rate, HFR	20		10			
Percent Heavy Vehicles	25		25			
Percent Grade (%)	0			0		
Flared Approach: Exists?/Storage			No	/		/
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 (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:	173	
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	25		25			
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	6.7		6.4			
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	25		25			
t(f)		2.4	3.7		3.5			

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		258	499		246			
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	246	
Potential Capacity	740	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	740	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	258	
Potential Capacity	1184	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1184	
Probability of Queue free St.	0.97	1.00
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	499	
Potential Capacity	492	
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	0.97	0.96
Movement Capacity	475	

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	499	
Potential Capacity	492	
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	0.97	0.96
Movement Capacity	475	
Results for Two-stage process:		
a		
y		
C t	475	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	20		10			
Movement Capacity (vph)	475		740			
Shared Lane Capacity (vph)		539				

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	475		740			
Volume	20		10			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		539				
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		LT		LR				
v (vph)		40		30				
C(m) (vph)		1184		539				
v/c		0.03		0.06				
95% queue length		0.10		0.18				
Control Delay		8.1		12.1				
LOS		A		B				
Approach Delay				12.1				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		173
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		8.1
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.3

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		166	20	8	338	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		166	20	8	338	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		32			10	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		32			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration			LR			

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		8		42				
C(m) (vph)		1262		521				
v/c		0.01		0.08				
95% queue length		0.02		0.26				
Control Delay		7.9		12.5				
LOS		A		B				
Approach Delay				12.5				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Energy Drive/Osbourne Road
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Energy Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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		166	20	8	338	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		42	5	2	84	
Hourly Flow Rate, HFR		166	20	8	338	
Percent Heavy Vehicles		--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		32			10	
Peak Hour Factor, PHF		1.00			1.00	
Peak-15 Minute Volume		8			2	
Hourly Flow Rate, HFR		32			10	
Percent Heavy Vehicles		25			25	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
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 (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:	338	
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	25		25			
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	6.7		6.4			
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	25		25			
t(f)		2.4	3.7		3.5			

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		186	530		176			
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	176	
Potential Capacity	811	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	811	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	186	
Potential Capacity	1262	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1262	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

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	0.99	0.99

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	530	
Potential Capacity	472	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	469	

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	0.99	0.99
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	530	
Potential Capacity	472	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.98
Movement Capacity	469	
Results for Two-stage process:		
a		
y		
C t	469	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	32		10			
Movement Capacity (vph)	469		811			
Shared Lane Capacity (vph)		521				

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	469		811			
Volume	32		10			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		521				
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		LT		LR				
v (vph)		8		42				
C(m) (vph)		1262		521				
v/c		0.01		0.08				
95% queue length		0.02		0.26				
Control Delay		7.9		12.5				
LOS		A		B				
Approach Delay				12.5				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		338
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)		0.99
d(M,LT), Delay for stream 1 or 4		7.9
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Osbourne Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	10	354	146	10	100	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	10	354	146	10	100	10
Percent Heavy Vehicles	10	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L		TR	L		TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	27	20	11	10	24	10
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	27	20	11	10	24	10
Percent Heavy Vehicles	10	25	2	2	25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No	/		No	/
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR			LTR	
v (vph)	10	10		58			44	
C(m) (vph)	1432	956		414			424	
v/c	0.01	0.01		0.14			0.10	
95% queue length	0.02	0.03		0.49			0.35	
Control Delay	7.5	8.8		15.1			14.5	
LOS	A	A		C			B	
Approach Delay				15.1			14.5	
Approach LOS				C			B	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Osbourne Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Osbourne Road
Intersection Orientation: EW	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	10	354	146	10	100	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	2	88	36	2	25	2
Hourly Flow Rate, HFR	10	354	146	10	100	10
Percent Heavy Vehicles	10	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L		TR	L		TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	27	20	11	10	24	10
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	7	5	3	2	6	2
Hourly Flow Rate, HFR	27	20	11	10	24	10
Percent Heavy Vehicles	10	25	2	2	25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No	/		No	/
RT Channelized						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

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:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

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)	10	25	10	25	2	2	25	10
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	4.2	4.3	7.2	6.8	6.2	7.1	6.8	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	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)	10	25	10	25	2	2	25	10
t(f)	2.3	2.4	3.6	4.2	3.3	3.5	4.2	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	110	500	589	577	427	587	645	105
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	427	105
Potential Capacity	628	928
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	628	928
Probability of Queue free St.	0.98	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	500	110
Potential Capacity	956	1432
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	956	1432
Probability of Queue free St.	0.99	0.99
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows	577	645
Potential Capacity	398	362
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98

Movement Capacity	391	356
Probability of Queue free St.	0.95	0.93
Step 4: LT from Minor St.	7	10
Conflicting Flows	589	587
Potential Capacity	408	421
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.93
Maj. L, Min T Adj. Imp Factor.	0.94	0.95
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	378	392

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	577	645
Potential Capacity	398	362
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	391	356
Result for 2 stage process:		
a		
y		
C t	391	356
Probability of Queue free St.	0.95	0.93
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	589	587
Potential Capacity	408	421
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.93
Maj. L, Min T Adj. Imp Factor.	0.94	0.95
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	378	392
Results for Two-stage process:		
a		
y		
C t	378	392

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	27	20	11	10	24	10
Movement Capacity (vph)	378	391	628	392	356	928
Shared Lane Capacity (vph)		414			424	

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	378	391	628	392	356	928
Volume	27	20	11	10	24	10
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		414			424	
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	L	L		LTR			LTR	
v (vph)	10	10		58			44	
C(m) (vph)	1432	956		414			424	
v/c	0.01	0.01		0.14			0.10	
95% queue length	0.02	0.03		0.49			0.35	
Control Delay	7.5	8.8		15.1			14.5	
LOS	A	A		C			B	
Approach Delay				15.1			14.5	
Approach LOS				C			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	0.99
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	7.5	8.8
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Park Drive/Osbourne Rd.
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2023
Project ID: Energy from Waste
East/West Street: Park Drive
North/South Street: Osbourne Road
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	10	155	33	10	314	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	10	155	33	10	314	10
Percent Heavy Vehicles	10	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L		TR	L		TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	127	32	52	10	20	10
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR	127	32	52	10	20	10
Percent Heavy Vehicles	10	25	2	2	25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No	/		No	/
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR			LTR	
v (vph)	10	10		211			40	
C(m) (vph)	1192	1259		471			445	
v/c	0.01	0.01		0.45			0.09	
95% queue length	0.03	0.02		2.39			0.30	
Control Delay	8.0	7.9		18.8			13.9	
LOS	A	A		C			B	
Approach Delay				18.8			13.9	
Approach LOS				C			B	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Park Drive/Osbourne Rd.
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2023
Project ID: Energy from Waste
East/West Street: Park Drive
North/South Street: Osbourne Road
Intersection Orientation: EW 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	10	155	33	10	314	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	2	39	8	2	78	2
Hourly Flow Rate, HFR	10	155	33	10	314	10
Percent Heavy Vehicles	10	--	--	25	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L		TR	L		TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	127	32	52	10	20	10
Peak Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Peak-15 Minute Volume	32	8	13	2	5	2
Hourly Flow Rate, HFR	127	32	52	10	20	10
Percent Heavy Vehicles	10	25	2	2	25	10
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No	/		No	/
RT Channelized						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

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:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

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)	10	25	10	25	2	2	25	10
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	4.2	4.3	7.2	6.8	6.2	7.1	6.8	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	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)	10	25	10	25	2	2	25	10
t(f)	2.3	2.4	3.6	4.2	3.3	3.5	4.2	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	324	188	546	536	172	573	547	319
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	172	319
Potential Capacity	872	703
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	872	703
Probability of Queue free St.	0.94	0.99

Step 2: LT from Major St.	4	1
Conflicting Flows	188	324
Potential Capacity	1259	1192
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1259	1192
Probability of Queue free St.	0.99	0.99
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows	536	547
Potential Capacity	420	414
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98

Movement Capacity	413	407
Probability of Queue free St.	0.92	0.95
Step 4: LT from Minor St.	7	10
Conflicting Flows	546	573
Potential Capacity	436	430
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	0.91
Maj. L, Min T Adj. Imp Factor.	0.95	0.93
Cap. Adj. factor due to Impeding mvmnt	0.94	0.87
Movement Capacity	409	376

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	536	547
Potential Capacity	420	414
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	413	407
Result for 2 stage process:		
a		
y		
C t	413	407
Probability of Queue free St.	0.92	0.95
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	546	573
Potential Capacity	436	430
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	0.91
Maj. L, Min T Adj. Imp Factor.	0.95	0.93
Cap. Adj. factor due to Impeding mvmnt	0.94	0.87
Movement Capacity	409	376
Results for Two-stage process:		
a		
y		
C t	409	376

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	127	32	52	10	20	10
Movement Capacity (vph)	409	413	872	376	407	703
Shared Lane Capacity (vph)		471			445	

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	409	413	872	376	407	703
Volume	127	32	52	10	20	10
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		471			445	
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	L	L		LTR			LTR	
v (vph)	10	10		211			40	
C(m) (vph)	1192	1259		471			445	
v/c	0.01	0.01		0.45			0.09	
95% queue length	0.03	0.02		2.39			0.30	
Control Delay	8.0	7.9		18.8			13.9	
LOS	A	A		C			B	
Approach Delay				18.8			13.9	
Approach LOS				C			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	0.99
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.0	7.9
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2023
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	37		130	45	
Peak-Hour Factor, PHF	1.00	1.00		1.00	1.00	
Hourly Flow Rate, HFR	0	37		130	45	
Percent Heavy Vehicles	0	--	--	--	--	
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				20		0
Peak Hour Factor, PHF				1.00		1.00
Hourly Flow Rate, HFR				20		0
Percent Heavy Vehicles				100		0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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)	0						20	
C(m) (vph)	1414						621	
v/c	0.00						0.03	
95% queue length	0.00						0.10	
Control Delay	7.5						11.0	
LOS	A						B	
Approach Delay							11.0	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: AM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2023
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	37			130	45
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	0	9			32	11
Hourly Flow Rate, HFR	0	37			130	45
Percent Heavy Vehicles	0	--	--		--	--
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				20		0
Peak Hour Factor, PHF				1.00		1.00
Peak-15 Minute Volume				5		0
Hourly Flow Rate, HFR				20		0
Percent Heavy Vehicles				100		0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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 (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:	37	
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)	0					100		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					0.70		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	4.1					7.4		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)	0					100		0
t(f)	2.2					4.4		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	175					189		152
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		152
Potential Capacity		900
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		900
Probability of Queue free St.	1.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		175
Potential Capacity		1414
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1414
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.		1.00

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		189
Potential Capacity		621
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		621

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	1.00	1.00
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		189
Potential Capacity		621
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		621
Results for Two-stage process:		
a		
y		
C t		621

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				20		0
Movement Capacity (vph)				621		900
Shared Lane Capacity (vph)					621	

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				621		900
Volume				20		0
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					621	
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	LT						LR	
v (vph)	0						20	
C(m) (vph)	1414						621	
v/c	0.00						0.03	
95% queue length	0.00						0.10	
Control Delay	7.5						11.0	
LOS	A						B	
Approach Delay							11.0	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	37	
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)	1.00	
d(M,LT), Delay for stream 1 or 4	7.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2023
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	165			33	20
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	0	165			33	20
Percent Heavy Vehicles	0	--	--		--	--
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				45		0
Peak Hour Factor, PHF				1.00		1.00
Hourly Flow Rate, HFR				45		0
Percent Heavy Vehicles				44		0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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)	0						45	
C(m) (vph)	1566						695	
v/c	0.00						0.06	
95% queue length	0.00						0.21	
Control Delay	7.3						10.5	
LOS	A						B	
Approach Delay							10.5	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: AA
Agency/Co.: URS Canada Inc
Date Performed: 30/04/09
Analysis Time Period: PM Peak Hour
Intersection: Site Access/Osbourne Road
Jurisdiction: Clarington
Units: U. S. Metric
Analysis Year: 2023
Project ID: Energy from Waste
East/West Street: Site Access
North/South Street: Osbourne Road
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	0	165			33	20
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	0	41			8	5
Hourly Flow Rate, HFR	0	165			33	20
Percent Heavy Vehicles	0	--	--		--	--
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				45		0
Peak Hour Factor, PHF				1.00		1.00
Peak-15 Minute Volume				11		0
Hourly Flow Rate, HFR				45		0
Percent Heavy Vehicles				44		0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
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 (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:	165	
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)	0					44		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					0.70		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	4.1					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)	0					44		0
t(f)	2.2					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	53					208		43
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		43
Potential Capacity		1033
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1033
Probability of Queue free St.	1.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		53
Potential Capacity		1566
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1566
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.		1.00

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	1.00	1.00

Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		208
Potential Capacity		695
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		695

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	1.00	1.00
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		208
Potential Capacity		695
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		695
Results for Two-stage process:		
a		
y		
C t		695

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				45		0
Movement Capacity (vph)				695		1033
Shared Lane Capacity (vph)					695	

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				695		1033
Volume				45		0
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					695	
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	LT						LR	
v (vph)	0						45	
C(m) (vph)	1566						695	
v/c	0.00						0.06	
95% queue length	0.00						0.21	
Control Delay	7.3						10.5	
LOS	A						B	
Approach Delay							10.5	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	165	
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)	1.00	
d(M,LT), Delay for stream 1 or 4	7.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		781	33	7	117	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		781	33	7	117	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		18			55	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		18			55	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		7		73				
C(m) (vph)		822		361				
v/c		0.01		0.20				
95% queue length		0.03		0.76				
Control Delay		9.4		17.5				
LOS		A		C				
Approach Delay				17.5				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	AM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	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		781	33	7	117	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		195	8	2	29	
Hourly Flow Rate, HFR		781	33	7	117	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	18		55			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		14			
Hourly Flow Rate, HFR	18		55			
Percent Heavy Vehicles	0		0			
Percent Grade (%)	0			0		
Flared Approach: Exists?/Storage			No	/		/
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 (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:	117	
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)		0	0		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	0.70		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		4.1	6.4		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	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)		0	0		0			
t(f)		2.2	3.5		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		814	929		798			
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	798	
Potential Capacity	389	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	389	
Probability of Queue free St.	0.86	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	814	
Potential Capacity	822	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	822	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

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	0.99	0.99

Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	929	
Potential Capacity	300	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.85
Movement Capacity	297	

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	0.99	0.99
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	929	
Potential Capacity	300	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.85
Movement Capacity	297	
Results for Two-stage process:		
a		
y		
C t	297	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	18		55			
Movement Capacity (vph)	297		389			
Shared Lane Capacity (vph)		361				

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	297		389			
Volume	18		55			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		361				
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		LT		LR				
v (vph)		7		73				
C(m) (vph)		822		361				
v/c		0.01		0.20				
95% queue length		0.03		0.76				
Control Delay		9.4		17.5				
LOS		A		C				
Approach Delay				17.5				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		117
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)		0.99
d(M,LT), Delay for stream 1 or 4		9.4
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS+: Unsignalized Intersections Release 5.2

TWO-WAY STOP CONTROL SUMMARY

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		182	40	36	671	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		182	40	36	671	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume		21			12	
Peak Hour Factor, PHF		1.00			1.00	
Hourly Flow Rate, HFR		21			12	
Percent Heavy Vehicles		0			0	
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes		0		0		
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		36		33				
C(m) (vph)		1359		375				
v/c		0.03		0.09				
95% queue length		0.08		0.29				
Control Delay		7.7		15.5				
LOS		A		C				
Approach Delay				15.5				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.2

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	AA
Agency/Co.:	URS Canada Inc
Date Performed:	30/04/09
Analysis Time Period:	PM Peak Hour
Intersection:	Park Drive/Darlington Park Rd.
Jurisdiction:	Clarington
Units: U. S. Metric	
Analysis Year:	2023
Project ID: Energy from Waste	
East/West Street:	Park Drive
North/South Street:	Darlington Park Road
Intersection Orientation: EW	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		182	40	36	671	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		46	10	9	168	
Hourly Flow Rate, HFR		182	40	36	671	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	21		12			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	5		3			
Hourly Flow Rate, HFR	21		12			
Percent Heavy Vehicles	0		0			
Percent Grade (%)	0			0		
Flared Approach: Exists?/Storage			No	/		/
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 (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:	671	
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)		0	0		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	0.70		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		4.1	6.4		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	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)		0	0		0			
t(f)		2.2	3.5		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		222	945		202			
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	202	
Potential Capacity	844	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	844	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	222	
Potential Capacity	1359	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1359	
Probability of Queue free St.	0.97	1.00
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	945	
Potential Capacity	293	
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	0.97	0.95
Movement Capacity	285	

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	945	
Potential Capacity	293	
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	0.97	0.95
Movement Capacity	285	
Results for Two-stage process:		
a		
y		
C t	285	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	21		12			
Movement Capacity (vph)	285		844			
Shared Lane Capacity (vph)		375				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

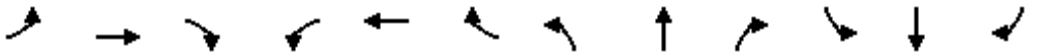
Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	285		844			
Volume	21		12			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		375				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		36		33				
C(m) (vph)		1359		375				
v/c		0.03		0.09				
95% queue length		0.08		0.29				
Control Delay		7.7		15.5				
LOS		A		C				
Approach Delay				15.5				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		671
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		7.7
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.3



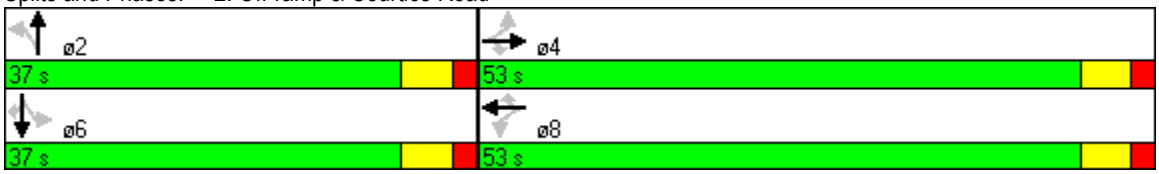
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	144	389	604	4	4	97	10	119	6	154	206	186
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.993				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1512	1690	1766	0	1690	1883	1601
Flt Permitted	0.755			0.396			0.629			0.677		
Satd. Flow (perm)	1343	1779	1512	704	1779	1512	1119	1766	0	1204	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			506			97		3				186
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	2%	2%
Adj. Flow (vph)	144	389	604	4	4	97	10	119	6	154	206	186
Shared Lane Traffic (%)												
Lane Group Flow (vph)	144	389	604	4	4	97	10	125	0	154	206	186
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru		Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			28.7			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

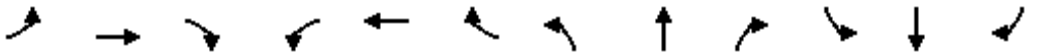
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	23.4	23.4	23.4	23.4	23.4	23.4	31.5	31.5		31.5	31.5	31.5
Actuated g/C Ratio	0.35	0.35	0.35	0.35	0.35	0.35	0.47	0.47		0.47	0.47	0.47
v/c Ratio	0.31	0.63	0.70	0.02	0.01	0.16	0.02	0.15		0.27	0.23	0.22
Control Delay	16.8	22.5	8.3	12.8	12.5	3.9	13.4	13.0		15.1	13.7	3.4
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	16.8	22.5	8.3	12.8	12.5	3.9	13.4	13.0		15.1	13.7	3.4
LOS	B	C	A	B	B	A	B	B		B	B	A
Approach Delay		14.2			4.5			13.0			10.5	
Approach LOS		B			A			B			B	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 67
Natural Cycle: 50
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.70
Intersection Signal Delay: 12.6 Intersection LOS: B
Intersection Capacity Utilization 66.6% ICU Level of Service C
Analysis Period (min) 60

Splits and Phases: 2: Off-ramp & Courtice Road



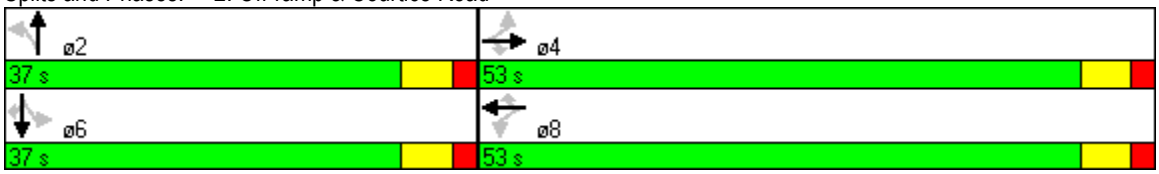


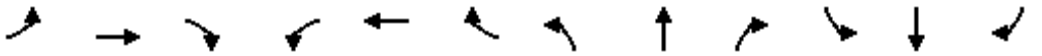
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	715	100	146	17	36	548	51	595	44	39	59	204
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	100.0		0.0	100.0		0.0	0.0		0.0	70.0		70.0
Storage Lanes	1		1	1		1	1		0	1		1
Taper Length (m)	2.5		2.5	2.5		2.5	2.5		2.5	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850		0.990				0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1690	1779	1512	1690	1779	1601	1690	1761	0	1706	1883	1601
Flt Permitted	0.734			0.692			0.719			0.129		
Satd. Flow (perm)	1306	1779	1512	1231	1779	1601	1279	1761	0	232	1883	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			146			111		5				204
Link Speed (k/h)		60			60			60			60	
Link Distance (m)		150.7			228.9			213.6			202.2	
Travel Time (s)		9.0			13.7			12.8			12.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	8%	8%	8%	8%	8%	2%	8%	8%	8%	7%	2%	2%
Adj. Flow (vph)	715	100	146	17	36	548	51	595	44	39	59	204
Shared Lane Traffic (%)												
Lane Group Flow (vph)	715	100	146	17	36	548	51	639	0	39	59	204
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		1.6			1.6			1.6			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Number of Detectors	1	2	1	1	2	1	1	2		1	2	1
Detector Template	Left	Thru	Right	Left	Thru	Right	Left			Left	Thru	Right
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	6.1	1.8		6.1	30.5	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	6.1	6.1	1.8	6.1	6.1	1.8		6.1	1.8	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Detector 2 Position(m)		28.7			28.7			0.0			28.7	
Detector 2 Size(m)		1.8			1.8			1.8			1.8	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	4	8	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	20.0	20.0	20.0	22.0	22.0		22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	53.0	53.0	37.0	37.0	0.0	37.0	37.0	37.0
Total Split (%)	58.9%	58.9%	58.9%	58.9%	58.9%	58.9%	41.1%	41.1%	0.0%	41.1%	41.1%	41.1%
Maximum Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	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	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0	6.0	6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	Max	Max		Max	Max	Max
Act Effct Green (s)	47.0	47.0	47.0	47.0	47.0	47.0	31.0	31.0		31.0	31.0	31.0
Actuated g/C Ratio	0.52	0.52	0.52	0.52	0.52	0.52	0.34	0.34		0.34	0.34	0.34
v/c Ratio	1.05	0.11	0.17	0.03	0.04	0.62	0.12	1.05		0.49	0.09	0.30
Control Delay	150.2	11.3	2.5	10.6	10.7	15.4	21.1	159.4		49.0	20.6	4.4
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	150.2	11.3	2.5	10.6	10.7	15.4	21.1	159.4		49.0	20.6	4.4
LOS	F	B	A	B	B	B	C	F		D	C	A
Approach Delay		113.3			15.0			149.2			13.3	
Approach LOS		F			B			F			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Natural Cycle: 130			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 1.05			
Intersection Signal Delay: 88.1		Intersection LOS: F	
Intersection Capacity Utilization 122.5%		ICU Level of Service H	
Analysis Period (min) 60			

Splits and Phases: 2: Off-ramp & Courtice Road



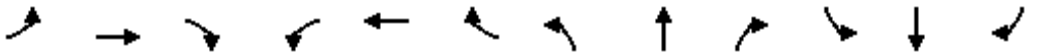


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	105	0	247	185	174	0	0	440	369
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1526	1521	1883	0	0	1779	1601
Flt Permitted				0.950			0.300					
Satd. Flow (perm)	0	0	0	1690	0	1526	480	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						247						369
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	0%	7%	20%	2%	0%	0%	8%	2%
Adj. Flow (vph)	0	0	0	105	0	247	185	174	0	0	440	369
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	105	0	247	185	174	0	0	440	369
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	30.0	0.0	30.0	20.0	60.0	0.0	0.0	40.0	40.0
Total Split (%)	0.0%	0.0%	0.0%	33.3%	0.0%	33.3%	22.2%	66.7%	0.0%	0.0%	44.4%	44.4%
Maximum Green (s)				24.0		24.0	17.0	54.0			34.0	34.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				24.0		24.0	57.0	54.0			34.0	34.0
Actuated g/C Ratio				0.27		0.27	0.63	0.60			0.38	0.38
v/c Ratio				0.23		0.42	0.37	0.15			0.65	0.44

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				27.5		6.0	9.2	8.4			28.9	4.0
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				27.5		6.0	9.2	8.4			28.9	4.0
LOS				C		A	A	A			C	A
Approach Delay								8.8			17.6	
Approach LOS								A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 55			
Control Type: Pretimed			
Maximum v/c Ratio: 0.65			
Intersection Signal Delay: 14.3		Intersection LOS: B	
Intersection Capacity Utilization 50.9%		ICU Level of Service A	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	32	0	250	936	924	0	0	270	161
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	100.0		0.0	0.0		76.2
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (m)	7.6		7.6	7.6		7.6	7.6		7.6	7.6		7.6
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1690	0	1601	1825	1883	0	0	1779	1601
Flt Permitted				0.950			0.336					
Satd. Flow (perm)	0	0	0	1690	0	1601	645	1883	0	0	1779	1601
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						182						161
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		391.7			461.0			202.2			260.3	
Travel Time (s)		29.4			34.6			15.2			19.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	8%	4%	2%	0%	2%	2%	0%	8%	2%
Adj. Flow (vph)	0	0	0	32	0	250	936	924	0	0	270	161
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	32	0	250	936	924	0	0	270	161
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.7			3.7			3.7			3.7	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.9			4.9			4.9			4.9	
Two way Left Turn Lane												
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Turn Type				custom		custom	pm+pt					Perm
Protected Phases							5	2			6	
Permitted Phases				8		8	2					6
Minimum Split (s)				22.0		22.0	8.0	22.0			22.0	22.0
Total Split (s)	0.0	0.0	0.0	23.0	0.0	23.0	42.0	67.0	0.0	0.0	25.0	25.0
Total Split (%)	0.0%	0.0%	0.0%	25.6%	0.0%	25.6%	46.7%	74.4%	0.0%	0.0%	27.8%	27.8%
Maximum Green (s)				17.0		17.0	39.0	61.0			19.0	19.0
Yellow Time (s)				4.0		4.0	3.0	4.0			4.0	4.0
All-Red Time (s)				2.0		2.0	0.0	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	0.0
Total Lost Time (s)	4.0	4.0	4.0	6.0	4.0	6.0	3.0	6.0	4.0	4.0	6.0	6.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Walk Time (s)				5.0		5.0		5.0			5.0	5.0
Flash Dont Walk (s)				11.0		11.0		11.0			11.0	11.0
Pedestrian Calls (#/hr)				0		0		0			0	0
Act Effct Green (s)				17.0		17.0	64.0	61.0			19.0	19.0
Actuated g/C Ratio				0.19		0.19	0.71	0.68			0.21	0.21
v/c Ratio				0.10		0.56	0.96	0.72			0.72	0.35

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Control Delay				31.2		15.5	48.9	13.5			46.0	7.4
Queue Delay				0.0		0.0	0.0	1.3			0.0	0.0
Total Delay				31.2		15.5	48.9	14.7			46.0	7.4
LOS				C		B	D	B			D	A
Approach Delay								31.9			31.6	
Approach LOS								C			C	

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Green			
Natural Cycle: 90			
Control Type: Pretimed			
Maximum v/c Ratio: 0.96			
Intersection Signal Delay: 30.2		Intersection LOS: C	
Intersection Capacity Utilization 81.1%		ICU Level of Service D	
Analysis Period (min) 60			

Splits and Phases: 3: On-ramp & Courtice Road