Transportation Impact Study Guidelines

AS ADOPTED BY REGION OF WATERLOO COUNCIL
NOVEMBER 26, 2008 REPORT NO. P-08-102

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TRANSPORTATION IMPACT STUDY GUIDELINES

TRANSPORTATION IMPACT STUDY REPORT FORMAT & CONTENTS

INTRODUCTION

One of the Region of Waterloo's key strategies is to "provide high quality infrastructure and asset management to meet current needs and future growth". The main objectives of this strategy are to optimize the use of the existing transportation network and provide adequate infrastructure capacity to accommodate planned growth. The review and management of development generated trips is an integral part of these objectives. The Transportation Impact Study (TIS) guidelines outlined in this document have been established in support of these objectives.

The TIS is an important tool in the overall development planning process. It assists developers and public agencies in making land use decisions, and provides information that identifies the impacts of proposed development on the existing streets and circulation networks and recommends mitigation measures for the impacts identified.

RECOMMENDED THRESHOLD FOR STUDY

In general, a TIS will be requested whenever a proposed development will generate 100 or more new peak direction auto trips to or from the site during the adjacent roadway's peak hour or the development's peak hour (i.e. 100 new trips inbound/outbound). In some cases, although a development will generate fewer trips than the peak hour, peak direction threshold of 100 trips, a study may be requested due to localized safety or roadway/intersection capacity deficiencies.

A TIS will also be requested when two or more proposed developments will generate 100 or additional peak direction auto trips to or from the site during the adjacent roadway's peak hour.

QUALIFICATIONS TO CONDUCT TRANSPORTATION IMPACT STUDY

Transportation impact studies must be prepared under the supervision of a qualified, experienced and registered Professional Engineer in the Province of Ontario with specific training in traffic and transportation engineering and several years of experience related to preparing traffic studies for existing or proposed developments.

PROCESS

A schematic of the TIS process is provided in Appendix A.

Pre-Study Conference Preparation

The consultant/applicant is required to arrange for a pre-study conference with the

Region of Waterloo and other relevant reviewing agencies (e.g. Area Municipalities, Ministry of Transportation, etc.). In preparation for the pre-study conference, the consultant/applicant is required to prepare an estimate of the trip generation, prepare a preliminary growth rate based on review of the historic traffic counts and Regional Transportation Model, and propose the limits of the study area based on the anticipated impact of the development.

The consultant must obtain a pre-study conference form (Appendix B) and submit it with the required information in advance of the pre-study conference meeting.

Pre-Study Conference

The purpose of the pre-study conference is to ensure that the consultant/applicant is familiar with the TIS process and the relevant policies, procedures and approvals, and to agree on assumptions, as well as to facilitate discussions between the consultant/applicant, the Region of Waterloo, and other relevant reviewing agencies (e.g. Area Municipalities, Ministry of Transportation, etc.). Discussions may include but are not limited to the:

- TIS process, assumptions and reporting requirements
- Region of Waterloo policies, procedures and approvals
- Requirements of the other relevant reviewing agencies
- Characteristics of the proposed development
- Scope of the study
  - Horizon years
  - Study area limits
  - Other developments in study area
  - Specific concerns to be addressed
  - Level of detail
- Technical analysis needed
- Data requirements and their availability
- Public meeting requirements, if applicable. A public meeting might be held for large size projects (e.g. community plan, plan of subdivision) to allow public input to the scope and recommendations of the study. All costs associated with the public meetings (signs, room rental, notification mailing, etc.) shall be the responsibility of the developer/consultant.

Preliminary Review

The consultant/applicant is responsible for preparing minutes of the pre-study conference, outlining items agreed to during the pre-study conference, and distributing them to all appropriate parties for review/approval. The approved minutes must be included as an appendix in the TIS report.

Along with the minutes, the consultant must provide existing and background traffic analyses, trip generation, and trip distribution for review/approval.

Data Collection

The consultant/applicant is responsible for collecting, assembling, analyzing, and presenting all types of data required for the study.

The assembly of available data should be accompanied by a detailed investigation of the project site, area streets and the surrounding vicinity. This process should include recording all relevant characteristics needed for the analysis (e.g. land use type, intensity, and arrangement of the building, parking and access) plus observations of existing traffic conditions.

Current data should be collected to supplement the available data as necessary. Such data should be obtained through surveys consistent with procedures described in the current edition of the Manual of Traffic Engineering Studies published by the Institute of Transportation Engineers.

Traffic data may be obtained from the following Regional offices:

- Traffic growth rates, trip distribution, and transit data are available from:

  Transportation Planning Division
  E-mail: transportationplan@region.waterloo.on.ca
  Phone: 519-575-4036 Fax: 519-575-4449

- Traffic counts, collision data, traffic control signal timing plans, operational characteristics, capacity analysis input parameters, approved software program information, are available from

  Transportation Division
  E-mail: transportation@region.waterloo.on.ca
  Phone: 519-575-4558 Fax: 519-575-4453

- Collision data for local roads may be obtained from the relevant local municipality.

Any factors utilized in the transportation impact study that are not in concurrence with the recognized standards must be agreed upon with Regional Staff prior to submission of the final report.

Transportation impact Study Report Review

The TIS report must follow the format outlined in the following Report Format and Contents section of these guidelines. This format will facilitate review, discussion, and communication. Any variation from this format without prior consultation with the reviewing agency will result in delays to the processing of the application and in some cases the report may be denied and returned for revision.

The report should consist of a main document containing the text and exhibits

including summary tables, supplemented by technical appendices detailing the analysis.

All elements of the TIS report may not be requested depending on size and nature of development. This will be determined at the pre-study conference.

The report must be signed, dated and stamped by a professional engineer.

Three paper copies of the TIS report along with one electronic copy of all computer analyses on CD or DVD must be submitted to the Region of Waterloo for review. Additional copies, with supporting documentation, must be provided to the other relevant reviewing agencies as determined at the pre-study conference.

A preliminary review of the submitted TIS will occur after the receipt of the TIS and if the basic format or content are not to the standard outlined in the guideline, the study will be sent back to the consultant immediately for correction.

Any revision, supplementary analysis, or change to the original study, must be documented and a consolidated final version must be submitted to the Region of Waterloo.

Approval of the TIS does not constitute approval of the development application. Conditions imposed by other Regional reviewers must also be resolved.

TRANSPORTATION IMPACT STUDY
REPORT FORMAT & CONTENTS

1. TITLE PAGE

2. EXECUTIVE SUMMARY

Summary of key findings and recommendations of the transportation impact study should be provided.

3. TABLE OF CONTENTS

- List of Exhibits
- List of Appendices

4. INTRODUCTION

The introduction should include the identification of the applicant, site location, municipal address, site plan, the nature of the application (e.g. Official Plan Amendment, Zoning Amendment, Site Plan Control Application, etc.), study assumptions, and summary of key issues.

5. CONTEXT

Study Area

The study area must include all local, regional and provincial roads, expressways, intersections, interchanges, transit services, pedestrian and cycling facilities, etc. that will be affected by the proposed development. A map showing the study area should be provided.

In general, the study area and study intersections will be agreed upon during the pre-study conference. The study area might be revised as a result of the trip assignment analysis.

Proposed Land Use on Site

Type of land uses proposed and size of individual land use components expressed in units related to transportation analysis (e.g. floor area, number of residential units, population, employment, number of parking spaces, etc.) should be identified with special attention being paid to gross versus net definitions.

Identify any phasing schemes, along with their associated land use statistics.

Expected dates of completion and full occupancy of the ultimate development and of any interim phases, should be mentioned, if known.

Other Developments within Study Area

Identify other developments under construction, approved, or in the approval process within the study area, along with the type and size of development.

Map(s) and Text

Map(s) and text to show the existing transportation system in the study area should be provided; the following information must be included:

- existing roads, jurisdiction, number and widths of lanes, posted speeds;
- existing signalized intersections, lane configuration, restrictions on movements;
- other traffic controls, restrictions on movements;
- heavy vehicle (i.e. truck) restrictions;
- existing transit routes and service frequencies;
- existing transit stops and stations;
- existing cycling lanes/routes and facilities
- existing sidewalks and crosswalks
- other features of interest;
- anticipated nearby development; and
- if appropriate, on-street parking spaces, operation restrictions in the vicinity of the development site and those that would affect the operation of intersections subject to the analysis.

Transportation Network Improvements

Identify the nature and timing of planned transportation system improvements in the approved Regional, Provincial, and Area Municipal capital programs that are within the study area, and may affect transportation to/from the proposed development.

Transit, Cycling, and Walking Consideration

The existing and planned transit service, cycling and pedestrian facilities in the study area must be identified and the potential impact and possible changes in modal split should be evaluated.

6. TRAVEL DEMAND

Horizon Year

The horizon year will be agreed upon during the pre-study conference. In general, the horizon years will be established based on the development size and the date of full occupancy per the following:

- < 500 peak hour peak direction trips = 5 years from the date of TIS

submission;
- 500-1000 peak hour peak direction trips = 5 years after full occupancy; and
- >1000 peak hour peak direction trips = 5 years after full occupancy or Transportation Plan Horizon for large-scale projects.

Horizon years should also be identified for any interim phases of development.

For the purpose of a roundabout initial screening and an Intersection Control Study, a 10-year horizon is required for the functional design of each alternative traffic control.

Time Periods of Analysis

In general, the weekday morning and afternoon peak hours should be evaluated. The peak hours should be identified based on the "worst-case" combination of site-generated trips plus background traffic/transit volumes across the study area.

Other peak hours, such as Saturdays should be examined if they would result in a "worst-case" situation.

Examination of the seasonal variation in trip generation may be required for particular development applications.

Existing Traffic Conditions

The study should include map(s) to show existing traffic/transit volumes, turning movements for roadways and intersections, heavy truck movements, pedestrian and cyclist volumes in the study area. The traffic data for all modes must be based on the most recent traffic/transit counts available. The consultant should undertake additional traffic counts, where existing count data is more than two years old or where existing data appears to be inconsistent.

Transit counts should be based on the peak points of the routes involved. Particular care should be taken in conducting/reviewing traffic counts in congested situations to identify/account for distortions caused by capacity constraints.

Background Traffic and Transit Growth

Existing traffic/transit volumes should be factored to account for growth between the dates of the counts used and the horizon year(s).

The consultant should conduct historical traffic count analysis and may need to review or use the Regional Traffic Forecasting Model to determine the appropriate growth factors.

The growth forecasting technique to be used for the TIS will be agreed upon with Regional Transportation Planning staff prior to submission of the report. This component of background traffic growth will be deemed to represent travel

increases resulting from general growth outside the study area.

Other development projects included as part of the context for the TIS should be specifically accounted for.

Site-Generated Traffic and Transit Volumes

Trip generation, trip distribution, assignment and modal split assumptions must be in accordance with standard/accepted parameters and techniques or based on surveys or other local knowledge. Sources should be clearly documented and any assumptions that may be considered less-than-conservative should be rigorously justified. Any "soft" parameters where there is significant uncertainty or a range of possible values should be subjected to sensitivity analysis unless a demonstrated "worst-case" situation is assumed.

Assumed travel demand parameters for trip generation, distribution, modal split, etc. must be clearly summarized. Sample table formats for trip generation and trip distribution are attached as Appendices C and D. The trip distribution table should be accompanied by a trip distribution map.

Methods, sources and assumptions used for adjusting trip generation for site interaction rates for large commercial developments should be described in the report. Any significant differences between sums of single-use rates and proposed mixed-use estimates must be justified in the study report.

Only limited data are available to adjust the trip generation rates for pass-by trips. The information on pass-by trips included in the Institute of Transportation Engineers, Trip Generation Handbook should be reviewed. If pass-by trips are a major consideration for the land use in question, studies and interviews at similar land uses may be requested. The pass-by trips should not be discounted from the total generated trips. They can be subtracted from the through traffic on the adjacent roads, but need to be assigned to the specific accesses.

Estimation of Adjustments to Transportation Demand Management Initiatives

A Transportation Demand Management (TDM) Plan should be prepared to influence how, when, where, and why trips will be made to and from the site, thereby reducing single occupant auto use. The plan should include a description of the initiatives proposed and any consequent measures required to enhance alternatives to the single-occupant auto.

The effects of the proposed TDM Plan should be identified and evaluated. These measures may reduce trip generation, reduce the proportion of trips in the peak hour, and increase the modal share of trips by walking, cycling, and transit, and/or increase auto occupancy. The effects should be calculated as adjustments to the basic travel demand estimates.

The report should identify steps to be taken with respect to the proposed development or redevelopment to support walking, cycling, carpooling, telecommuting, and the use of transit.

Specific consideration should be given to the proposed developments adjacent to Rapid Transit stations. The impacts of the Rapid Transit on the proposed development should be identified and evaluated.

Map(s) to Summarize

Maps summarizing the following should be included for each time analysis period:

- existing traffic volumes including pedestrians and cyclists, and transit volumes and the date of the traffic counts;
- future background volumes (i.e. existing traffic volumes plus background growth);
- site trip distribution.
- any major transportation improvements, committed or planned, within the interim development phases or study horizon that may significantly affect the travel demand pattern associated with the development proposal should be considered. Scenarios with and without such improvements should be summarized as appropriate;
- site generated volumes;
- changes to traffic and transit volumes that are anticipated to result from TDM measures; and
- future total volumes (i.e. background plus site generated volumes) for each interim development phase and horizon year, and scenario.

7. EVALUATION OF IMPACTS

Impacts on streets and transit facilities will be evaluated for each time analysis period, taking into consideration the horizon year(s) for full development and interim phases. The evaluation will be undertaken for:

- existing conditions;
- existing plus background growth (i.e. future background traffic conditions);
- existing plus background growth plus site-generated travel (i.e. future total traffic conditions);
- scenarios with and without relevant major transportation system improvements as identified in the pre-study conference; and
- scenarios with different driveway/access locations if queuing or traffic operations become an issue.

Traffic Impact Analysis

All intersection capacity analyses must use electronic software and input parameters approved by the Region of Waterloo, which reflect the current

practice. Refer to the Region of Waterloo document Transportation Impact Studies, Requirements for Capacity Analysis, Roundabouts, and Turn Lanes.

- All **signalized** and major unsignalized intersections defined as critical intersections or that have critical movements in the study area must be evaluated;
- **Any street segment** deemed sensitive to traffic including pedestrians and cyclists such as weaving sections, ramps, internal site roadways, parking facility access points and reservoirs for vehicles queuing off site and on site must be evaluated;
- **Operational analysis** for signalized and unsignalized intersections must be conducted using software approved by the Region of Waterloo and supplemented if necessary by field studies of gap availability, possible queue, spillback, etc.;
- **All assumptions** concerning lane configuration/use, pedestrian activity, cycling activity, cycle length, phasing and signal timings, should be clearly documented. Existing signal timings should be used to analyze existing conditions. The consultant should confirm that any such assumptions, where applicable, conform with the standards/practice of the Region of Waterloo;
- **Future pedestrian activity** associated with the development and related implications for signal warrant calculations and signal timing requirements to provide adequate pedestrian road-crossing links should be evaluated and documented. Pedestrian connections to transit services are of particular interest;
- **Mid-block traffic** volume including pedestrians and cyclists should be documented and summarized in the body of the report. Pedestrian crosswalks and curb ramps should be evaluated taking into consideration the sight distance, existing on-road parking, the posted speed, and pedestrian demands;
- Traffic volumes, turning movement volumes, level of service, delay, queue, and volume/capacity ratios, must be documented in a clearly understandable table in an appendix for all signalized intersections (overall volume/capacity ratio) and for each individual traffic movement. A sample table format is attached as Appendix E;
- The criteria for identifying "**critical**" intersections are:
    - overall Level of Service E or F (i.e. average control delay per vehicle greater than 55 seconds) for signalized intersections; and
    - overall Level of Service E or F (i.e. average control delay per vehicle greater than 35 seconds) for unsignalized intersections.
- The criteria for identifying "**critical**" movements are:
    - the average control delay for individual movements is greater that 55 seconds;
    - estimated 95th percentile queue length for an exclusive movement exceeds the available storage space;
    - estimated 95th percentile queue length for an individual movement will block an existing access;

- exclusive turning lanes are inaccessible because of queue lengths in adjacent through lanes; and
- poor quality of service for non-auto modes (as per the assessment in 7.3 section).

Operational analysis for all "critical" intersections/individual movements in those peak hours that meet the criteria noted above, must be summarized in a table in the body of the report. This table should include traffic volumes, volume/capacity ratios, levels of service, delay, and back of queue for the existing conditions, future background conditions, and future total conditions for scenarios with and without relevant major transportation system improvements.

- **All queuing analysis** of existing and future traffic volumes should be presented in a clear format where available storage and required storage for all movements are clearly recognized. A sample figure format is attached as Appendix F.
- All **level of service** analysis of existing traffic volumes/movements at major signalized intersections where delays will exceed 55 seconds may need to be supplemented by field evaluation of average delays and queue lengths. Evaluation of future scenarios should be supplemented by estimates of these parameters as available from the capacity analysis technique utilized;
- **All intersections/individual movements** identified above as "critical" should be discussed in terms of contribution of the development proposal to the situation, possible remedial measures, a recommended solution, and the effectiveness of the solution towards resolving the situation. In general, the objective should be to ensure that no new “critical” movement is created by the development and that “critical” movements that exist are not worsened by addition of site-generated traffic;
- All **exclusive turning lanes** used by site-generated traffic must be examined to ensure adequate queue storage space. Adequate storage lengths will be designed for 95th percentile back of queue;
- **Left turn lane warrant** analysis for unsignalized intersections should be conducted using the MTO Geometric Design Guidelines. Based on level of service and operating conditions at unsignalized intersections, **right turn** lanes should be considered;
- All **proposed adjustments** to signal phasing, signal timing and new signals should be evaluated in terms of pedestrian crossing time, effect on queue lengths and adequacy of existing storage, and effects on existing signal co-ordination;
- **Supplementary analysis** of traffic signal system/network operations may be required to assess impacts on traffic signal co-ordination;
- All **proposed new traffic signals** should be evaluated according to the current signal warrant practice of the Region of Waterloo;
- **Other alternatives** to the proposed traffic control modes, including traffic signals should be considered where possible; a roundabout must be considered as an alternative means of traffic control whenever traffic signals

are warranted and proposed or whenever road improvements (e.g. additional dedicated turning lanes or additional through lanes) are being considered to address a safety or a capacity deficiency;
- For the purpose of these guidelines, an **Intersection Control Study** is a study that determines the feasibility of implementing a roundabout at particular locations by comparing the roundabout to other forms of traffic control such as traffic signals.
- The **roundabout option** must be investigated based on various factors including capacity, safety performance, and site conditions.

Roundabout Feasibility

Prior to the undertaking of a detailed Intersection Control Study to determine the feasibility of a roundabout, an Initial Screening must be done. The **Initial Screening** shall involve the following:

- determine the scope of intersection improvements to implement the traffic signals and other turning lanes and scope of work to implement a roundabout;
- complete a Traffic Flow worksheet and preliminary lane configuration for the proposed roundabout ;
- develop a preliminary cost estimate to implement each of the traffic control alternatives (roundabouts and signals);
- develop a 20-year injury collision cost for each of the alternatives, adjusted to Present Value; and
- compare the sum of injury collision costs and implementation costs for each alternative.

The Initial Screening tool and Traffic Flow worksheet forms can be obtained from the Region of Waterloo.

Should the total cost for the roundabout be significantly more than the total cost of the signals, the roundabout would not be considered feasible unless other issues warrant additional consideration of a roundabout; otherwise, a more detailed Intersection Control Study will be required to determine the feasibility of a roundabout.

A detailed **Intersection Control Study** will involve the following:

- functional design of both the roundabout and other alternative road improvement such as a signalized intersection
- preliminary cost estimate of each alternative including:
    - property acquisition
    - utility relocations
    - construction
    - signing and marking
    - engineering

    - contingency
- a comparative evaluation of each alternative using the following criteria
    - safety for all users
    - traffic operations
    - property impacts
    - fuel consumption and emissions
    - pedestrian and cyclist issues
    - persons with disabilities
    - compatibility with area land use, accesses and corridor traffic signal timings
    - aesthetic value
    - 20-year life cycle costs

A functional design of the proposed roundabout and alternative road improvement indicating dimensions, required pedestrian and cyclist facilities and other significant characteristics, should be included in an Intersection Control Study report.

All methodologies and assumptions should be documented as to source and their use should be justified.

The functional design of the roundabout should:

- be adequately sized to provide the required capacity to accommodate the 10-year traffic volume;
- be adequately sized to accommodate the appropriate design vehicle;
- include adequate deflection to achieve the required speed reduction;
- consider nearby accesses, property and utility impacts; and
- include necessary facilities for transit, cyclists and pedestrians.

Please refer to Appendix G for parameters and assumptions to be used for the Intersection Control Study.

The horizon year to be used for any Intersection Control Study is to be 10 years from the date of the traffic impact study; however, a sensitivity analysis is also required to determine when the proposed design based on the 10-year horizon starts to operate at a poor level of service (i.e. Level of Service E or worse).

Intersection Control Studies must be prepared under the supervision of a qualified, experienced and registered Professional Engineer in the Province of Ontario with specific training in traffic and transportation engineering and several years of experience related to roundabout feasibility and design.

Non-Auto Modes, Transit, Pedestrians, Bicycles

The study should analyze and evaluate the roadway’s performance with regard to accommodating transit, pedestrians, and cyclists in the study area using the

Highway Capacity Manual and any other generally acceptable guidelines.

The assessment considerations for transit include but are not limited to:

- frequency and hours of service
- presence of bus stops
- reliability of service
- passenger loads
- travel time

The assessment considerations for pedestrians may include but are not limited to:

- presence, connectivity, and width of sidewalks
- barriers and buffers from traffic
- crossing opportunities at signalized and unsignalized intersections
- delay at intersections
- number of driveways and traffic volumes at the driveways
- presence of illumination

The assessment considerations for bicycles may include but are not limited to:

- presence of a dedicated facility
- network connectivity
- number and width of travel lanes adjacent to the route
- volume and speed of traffic
- percentage of trucks and buses encountered
- pavement condition
- presence of parking /showers/change rooms in the study area

The recommended measures to improve walking, cycling, and transit environment in the study area must comply with Region of Waterloo policies and practices including the most recent Bus Stop Zones guidelines.

Safety Analysis

The study should include a safety impact analysis to identify the effects of the development on the collision risk of the site and the adjacent road system. The study should recommend countermeasures where warranted and modifications to the site plan and the road system to enhance the level of safety for motorists, cyclists and pedestrians.

Designs and recommendations should comply with the Ministry of Transportation of Ontario (MTO) Geometric Design Standards for Ontario Highways, the Ontario Traffic Manuals, and the Transportation Association of Canada Geometric Design Guide for Canadian Roads, as well as Region of Waterloo policies and practices.

The safety impact analysis should include but is not limited to:

- A road safety review as per current Region of Waterloo practice. A check list is available from the Region of Waterloo;
- An estimate of the impacts that the development will have on collision patterns; and
- In particular, any new access should be designed to restrict the inbound and outbound left turns if they conflict with an expected queue on the main road.

8. SITE ACCESS AND CIRCULATION

The access points should be located on minor roads where possible. The number and location of access points should be reviewed to ensure that only the minimum number necessary are provided to serve the development adequately without negatively affecting the flow of traffic along the road network abutting the development; justification for more than one access should be based on traffic capacity and safety and not design preference.

- All site access points on Regional roads should be evaluated in terms of capacity, safety and adequacy of queue storage. The evaluation should be similar in scope to that for signalized/unsignalized intersections described previously;
- Proposed access points should be evaluated with respect to possible mutual interference with other access points, including those of other sites, on-street weaving problems, need for acceleration/deceleration lanes, and safety for all modes of transportation, etc.;
- On site parking/circulation systems should be evaluated to demonstrate a high safety factor with respect to the possibility of queues backing on Regional roads, the need for vehicles to reverse onto Regional roads, etc.;
- Sight distance should be evaluated to ensure safe conditions in accordance with Transportation Association of Canada-Geometric Design Guide for Canadian Roads;
- Proposed truck/courier loading facilities and access to these facilities should be evaluated to ensure that they are adequately sized, designed, and provided with suitable access so that they will not adversely affect traffic and transit operations on Regional roads;
- Any required turning restrictions or other restrictions should be identified;
- All accesses should be designed with sufficient on-site queuing storage in accordance with the Region of Waterloo Policy and Procedures for Access onto Regional Roads;
- Adequate access for emergency vehicles should be provided; and
- Adequate access for garbage/recycling services and delivery/moving should be provided.

9. REMEDIAL MEASURES

- All transportation system improvements identified as necessary or desirable to serve the proposed development or to accommodate the background traffic

should be listed and the timing of their implementation should be identified;
- All street improvements should be shown on a functional sketch indicating dimensions, required pavement widening, required right-of-way widening, traffic control and other significant characteristics including the location of all driveways/intersections/points of access opposite the property being developed. In some cases a detailed design and cost estimates may be required;
- When improvements to an intersection are proposed, the design plans should show all legs of the intersection so that turning paths and lane continuity can be reviewed;
- All "critical" traffic movements or other traffic (including pedestrians and cyclists) /transit impacts that cannot be successfully mitigated should be identified;
- A table should be prepared, similar to that shown in Appendix E, to show the volume/capacity ratios, levels of service, delays, and back of queue of intersections/individual movements as affected by the recommended remedial measures;
- Once the traffic analysis has been accepted, approval of the Transportation Impact Study will be granted conditional upon the feasibility of the recommended plan;
- A sufficient amount of design should be undertaken to ensure all recommended improvements could be physically constructed. In some cases where new roads or road widening are recommended a public meeting may be required; and
- Cost estimates must be provided for all recommended improvements.
- The approved transportation impact study is valid for one year from the original submission date. If a transportation impact study is older than one year, it will be reviewed by Region of Waterloo staff and based on the review, the consultant/developer may be required to provide an update.

10. CONCLUSIONS AND RECOMMENDATIONS

- Summary of key study conclusions with respect to the transportation and safety impact of the proposed development; and
- Summary of recommended improvements and unresolved problems/issues.

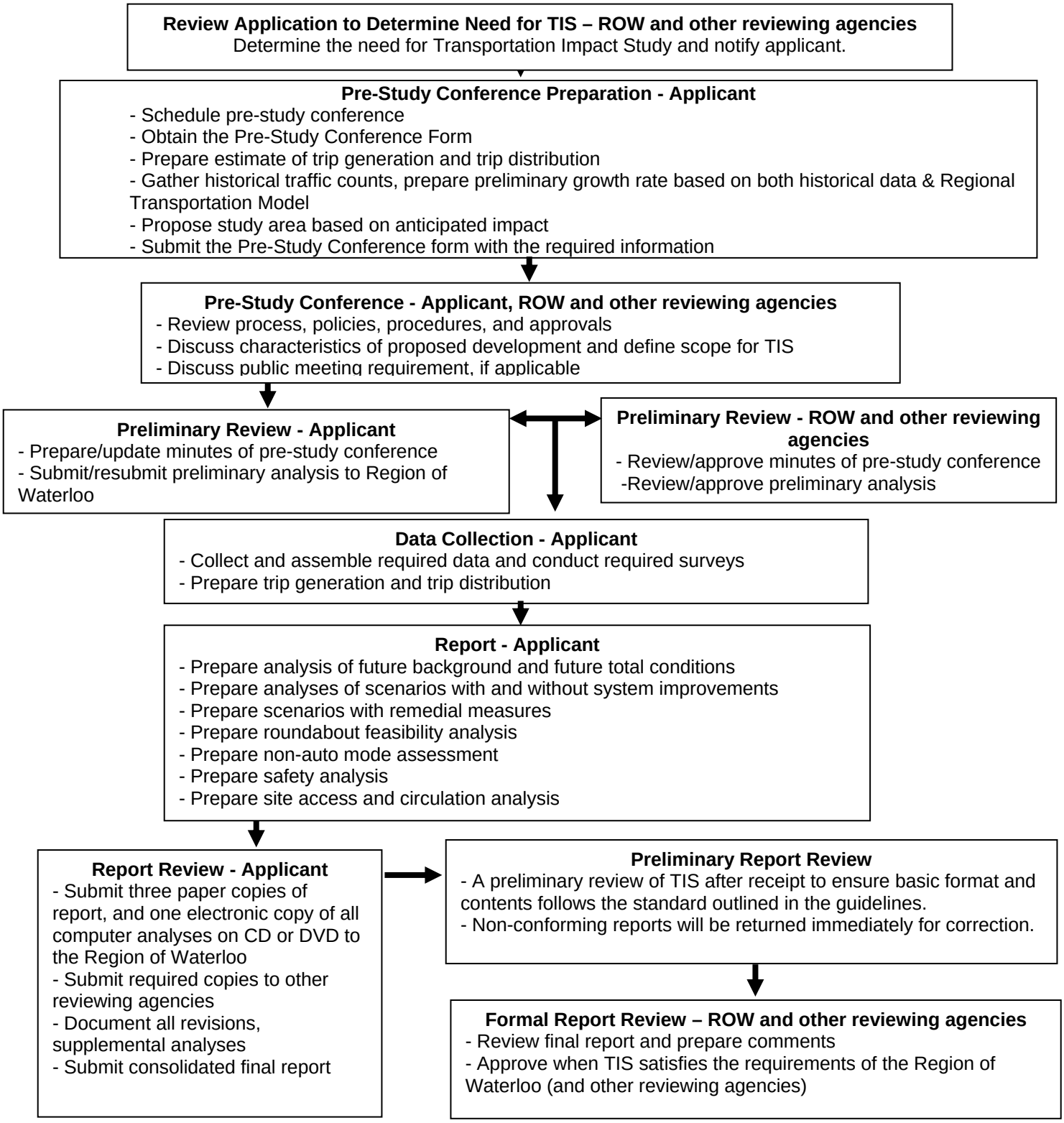
11. APPENDICES

- Approved minutes of the pre-study conference;
- A list of the traffic counts, collision data, and traffic signal timings that were used in the study, including the dates and sources of the counts/data;
- Calculations for intersection and roundabout capacity analyses, using software approved by the Region of Waterloo including all input parameters and full printouts detailing the traffic volumes, turning movement volumes, level of service, volume/capacity ratios, delays, and queues;
- Calculations for any auxiliary lane warrants;

- Calculations for any traffic control warrants;
- Calculations for any roundabout Initial Screening; and
- Calculations for any Intersection Control Study.

Appendices

APPENDIX A : TRANSPORTATION IMPACT STUDY – PROCESS



APPENDIX B
PRE-STUDY CONFERENCE FORM

Item	Description	Details
INTRODUCTION		
1	Nature of application (Attach a drawing)	o Official Plan Amendment o Zoning Amendment o Site Plan Control Application o Plan of Subdivision o Community Plan o Other
2	TIS process, and relevant policies, procedures and approvals	o Guidelines for the preparation of Transportation Impact Studies in Support of Development Applications o Transportation Impact Studies Requirements for Capacity Analysis, Roundabouts, Turn Lanes o Safety Analysis Checklist o Policy and Procedures for Access onto Regional Roads
3	Public Meeting	o Required o Not Required
CONTEXT		
4	Study intersections (Intersections to be analyzed) Note: the consultant is responsible to identify any further intersections impacted as the study progresses.	o o o o o o o o o o o
5	Size and number of phases of development	o Phase 1: o Phase 2: o Phase 3: o Phase 4: o Phase 5:
6	Approved and pending approval development applications	o o o o
7	Planned transportation system improvements	o o o o

Item	Description	Details
TRAVEL DEMAND		
8	Horizon years	o 5 years from date of TIS o 5 years after full occupancy o Transportation Plan horizon for large scale projects o Interim years o Other…
9	Peak hour determination	o AM weekday peak hour of adjacent roadway o PM weekday peak hour of adjacent roadway o Saturday peak of adjacent roadway o AM weekday peak hour of development o PM weekday peak hour of development o Saturday peak of development o Other…
10	Background	o Historical traffic/transit counts o ROW travel demand forecasts o Approved and pending approval development applications o Other…
11	Trip generation	o ITE average rates o ITE fitted equation o Rates published elsewhere o Observed rates for similar areas o Observed rates for similar developments in the local area o Other…
12	Trip reductions (TDM, internal, pass-by)	o Published Travel Demand Management reductions o Observed Travel Demand Management reductions o ITE internal capture reductions for mixed-use developments o Observed internal capture reductions for mixed-use developments o ITE pass-by reductions o Observed pass-by reductions for similar developments o Other…
13	Trip distribution	o ITE trip distribution IN/OUT split o Regional travel demand o Population and employment distribution o Market analysis of catchment area o Other…
14	Trip assignment	o Local traffic pattern o Site layout and access design o Existing turning movements o Other…

Item	Description	Details
EVALUATION OF IMPACTS		
15	Traffic impact analysis (Use approved software)	o Unsignalized intersections o left turn warrant analysis o signal warrant analysis o Signalized intersections o LOS, v/c, delay, queuing o ROW saturation flow rates o Existing signal timings for existing conditions o Optimize signal timings for future conditions o Queuing analysis o Roundabouts o Other…
16	Roundabout feasibility (Use approved software)	o Initial screening o Intersection control study (10 year horizon)
17	Transit assessment	o Frequency and hours of service o Presence of bus stops o Reliability of service o Passenger loads o Travel time o Other
18	Pedestrian assessment	o Presence, connectivity, and width of sidewalks o Barriers and buffers from traffic o Crossing opportunities at intersections o Delay at intersections o Number of driveways and traffic volumes at the driveways o Presence of illumination o Other
19	Cycling assessment	o Presence of a dedicated facility o Network connectivity o Number and width of travel lanes adjacent to the route o Volume and speed of traffic o Percentage of trucks and buses encountered o Pavement condition o Presence of parking /showers/change rooms o Other
20	Safety analysis	o Road safety review o Collision risk analysis o Access conflict evaluation
21	Site access and circulation	o Review sight distances at all new access points o Internal traffic controls o Loading facilities and access o Service/maintenance vehicle access o Emergency vehicle access

APPENDIX C
FORMAT FOR TRIP GENERATION TABLES

Land Use	ITE Code	Size	AM Peak Hour				PM Peak Hour			
			Rate/Equation	In	Out	Total	Rate/Equation	In	Out	Total

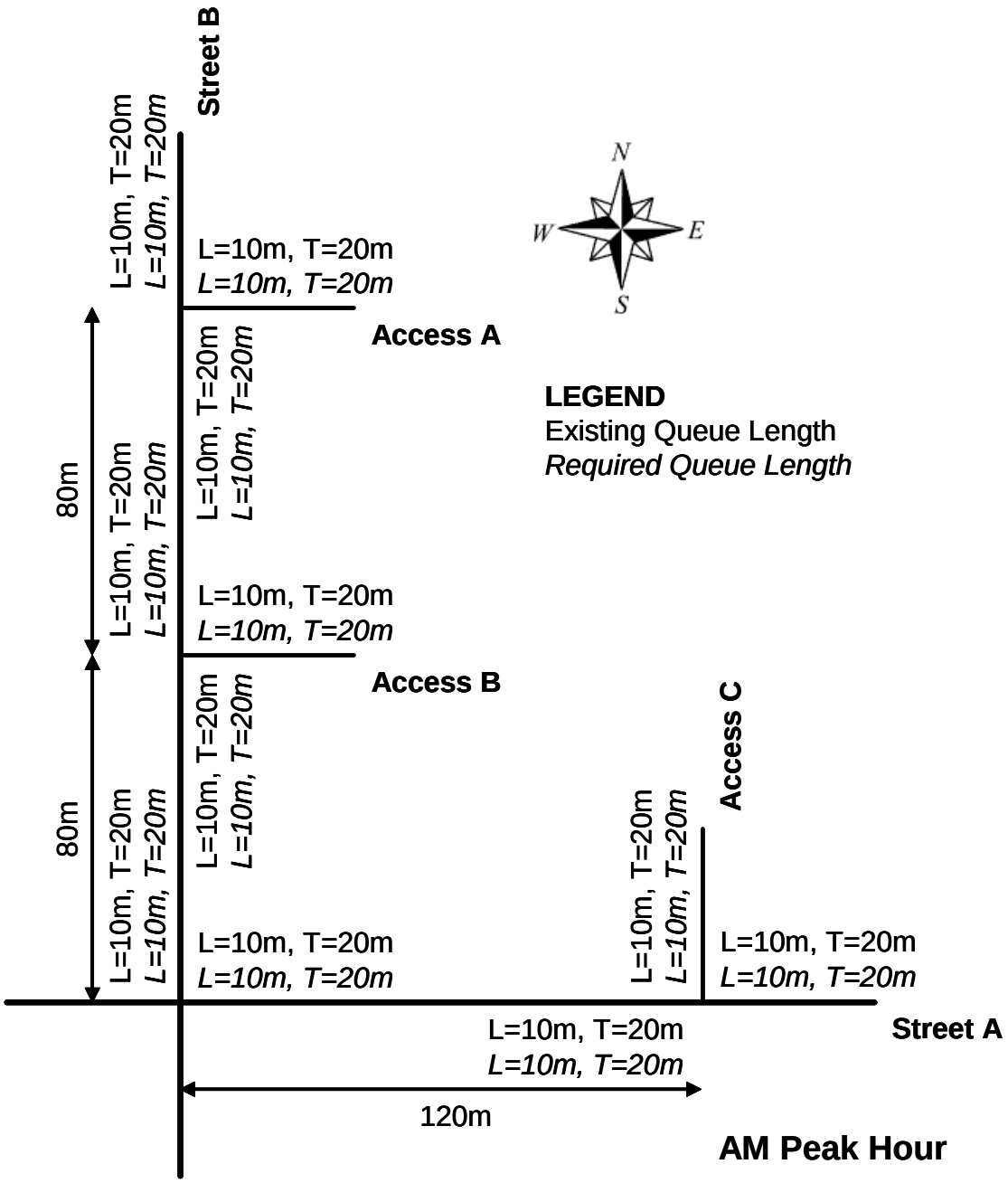
APPENDIX D
FORMAT FOR TRIP DISTRIBUTION TABLES

Origin / Destination	Percent Distribution			
	AM Peak Hour		PM Peak Hour	
To / From the North:	In	Out	In	Out
Via Via Street A				
Via Via Street B				
Via Via Street C etc…				
To / From the South:				
Via Via Street A				
Via Via Street B				
Via Via Street C etc…				
To / From the East:				
Via Via Street A				
Via Via Street B				
Via Via Street C etc…				
To / From West:				
Via Via Street A				
Via Via Street B				
Via Via Street C etc…				

APPENDIX E
TABULAR FORMAT FOR ANALYSIS AND IMPACT SUMMARIES

Analysis Period	Intersection	Control Type	MOE		Direction/Movement/Approach																
					OVERALL	EB-LEFT	EB-THOUGH	EB-RIGHT	EB-APPROACH	WB-LEFT	WB-THOUGH	WB-RIGHT	WB-APPROACH	NB-LEFT	NB-THROUGH	NB-RIGHT	NB-APPROACH	SB-LEFT	SB-THROUGH	SB-RIGHT	SB-APPROACH
AM Peak Hour	St. A @ St. B		Los																		
			Del																		
			v/c																		
			Q	Required																	
				Existing																	
				Available																	
	St. C @ St. D		Los																		
			Del																		
			v/c																		
			Q	Required																	
				Existing																	
				Available																	
PM Peak Hour	St. A @ St. B		Los																		
			Del																		
			v/c																		
			Q	Required																	
				Existing																	
				Available																	
	St. C @ St. D		Los																		
			Del																		
			v/c																		
			Q	Required																	
				Existing																	
				Available																	

APPENDIX F
QUEUING ANALYSIS FORMAT



APPENDIX G
ROUNDABOUT / INITIAL SCREENING AND TRAFFIC CONTROL STUDY CRITERIA

Horizon Year	10 years with sensitivity analysis of when 10 year design will start to perform at a LOS D or worse
Capacity Analysis	Use Region of Waterloo approved software
Cost Assumptions	o Cost of traffic signals to include all road widening to provide required turning lanes and in the case of a project identified for widening in the Region's 10 Year Capital Program cost of the ultimate widening is to be included. o For illumination, the cost of the implementation, operation, and maintenance of both traffic signals and roundabout should be calculated as per current Region of Waterloo practice. A check list is available. o For the operation of traffic signals use the most recent estimation. Check the list available from the Region of Waterloo o For traffic signals, assume full equipment replacement after15 years
Present Value Calculations	Use the most recent calculated value of the discount rate, and the injury collision cost as per current Region of Waterloo estimation. The Region of Waterloo will provide a list for the most recent values.
RODEL Confidence Level	o use 50% confidence level for capacity analysis and concept development o use 85% confidence level for sensitivity analysis o use 95% confidence level for estimating queue length
ARCADY Parameters	o use 100% capacity for initial analysis and concept development o use Y-intercept adjustment to 85% capacity for sensitivity analysis
Collision Rates	The Region of Waterloo will supply expected collision rates for the signals. Expected collision rates for the roundabout are assumed to be 50% or less of the signalized rate.
Design Vehicle	WB-20

Please refer to the following link for more information regarding the Roundabout Control Study and sample of the preliminary design. "Roundabout Workshop Guide":

www.region.waterloo.on.ca
Living Here-Transportation-Other Transportation and Related Projects-Transportation Impact Study Guidelines-Roundabout Workshop-May7, 2009.

http://www.region.waterloo.on.ca/web/region.nsf/97dfc347666efede85256e590071a3d4/f97a7c3f47dc74128525750f00512b13!OpenDocument