The Corporation of the City of Niagara Falls

Guidelines for the Preparation of

Transportation Impact Studies

and Site Plan Review

Revised

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Transportation Impact Study

The municipal road system serves as a network of routes for the safe and efficient movement of people and goods. It was constructed and is maintained at great public expense and forms an irreplaceable public asset. The City has a responsibility to effectively manage and maintain each roadway and intersection within its jurisdiction to preserve its safety, functional integrity and public purpose for present and future generations.

In order to manage and maintain existing and future roadway facilities, it is essential that the amount of new traffic entering the road system from adjacent developments be assessed, and the access and layout configuration of the developments be designed in such a manner that the safety and integrity of the roadway are maintained. Therefore, the goal of a transportation impact study is to assess the potential effects of traffic caused by a proposed development on local roadways and to identify the total roadway improvements needed to ensure that the roadway system will operate at an acceptable level upon completion of the proposed development.

Transportation impact studies are an important part of the development review and approval process to assist developers and public agencies in making land use decisions, such as Official Plan amendments, zoning amendments, subdivisions, site plans, planning approvals and other development reviews, where the proposal may have a significant impact on traffic and transportation operations.

Transportation impact studies benefit the municipality by:

- Providing decision makers with a basis on which to assess transportation implications of proposed development applications
- Providing a rational basis on which to evaluate if the scale of development is appropriate for a particular site and what improvements may be necessary, on and off the site, to provide safe and efficient access and traffic flow
- Providing a basis for determining existing or future transportation system deficiencies that should be addressed
- Addressing transportation related issues associated with development proposals that may be of concern to neighbouring residents, businesses and property owners
- Providing a basis for negotiations for improvements and funding participation in conjunction with a development or zoning application or petition

Transportation impact studies benefit the developer by:

- Ensuring that the adjacent road network is capable of accommodating the additional traffic demand
- Providing a consistent approach to development proposals throughout the city
- Potential safety issues are addressed and rectified through mitigating measures prior to development commencement
- Having a transportation engineer address site specific issues in the preliminary application stage and provide recommendations based on best practices

A transportation impact study may vary in scope and complexity depending on the type and size of the proposed development.

1.2 Study Justification

The City of Niagara Falls has prepared these guidelines in order to streamline the approval process and provide a standardized framework for consultants to follow when submitting transportation studies for review and should be complemented with good transportation engineering judgement.

1.3 Purpose of Guidelines

The purpose of these guidelines is to ensure that transportation impact studies prepared for the City meet the following criteria:

- Objective assessment - the study will evaluate the impacts of proposed new development in a rational manner
- Consistency - the study will utilize assumptions consistent with the City's accepted methodologies and parameters and thus be comparable to other traffic studies in the City
- Recognized by developers and consultants - the guidelines will provide a standard approach to be followed and will reduce confusion and delay in processing development proposals
- Promote understanding of process - the steps outlined in these guidelines will enable proponents, reviewers and elected officials to understand the process more effectively
- Ease of review by staff - a standardized set of guidelines will aid the efficiency of staff in reviewing transportation impact studies

1.4 Major Issues Addressed in the Transportation Impact Study

Transportation impact studies can respond to a wide variety of issues. These issues vary with the type of development, location of the proposed project, existing traffic and environmental conditions in the area, and with City policies. Questions addressed in this report include:

- When is a study required
- How much information is needed for a complete study
- What study area should be evaluated
- What should be the forecast year
- What peak hours should be analysed
- What technical procedures should be used (trip generation, trip assignment, levels of service calculations etc.)
- How to determine the transportation impacts that specifically result from development on a particular site
- Site plan review based on best practices
- How are appropriate improvements identified
- How should the findings and recommendations be documented

Given the unique nature of some developments and redevelopments that have occurred in Niagara Falls particularly related to the tourist sector, analysis on a particular aspect may be needed that has not been covered in this policy document. Staff reserves the right to request analysis or opinion on matters that may have an adverse effect on the transportation system over and above the standard requirements for a transportation impact study.

2.0 GENERAL TRANSPORTATION IMPACT STUDY REQUIREMENTS

2.1 Need for Transportation Impact Study

There are a number of criteria under which a transportation impact study may be required. In general, a transportation impact study should be conducted whenever a proposed development will generate more than 100 additional (new) peak hour, peak direction trips to or from the site during the adjacent roadway's peak hour or the development's peak hour.

A transportation impact study may also be required even if there are less than 100 peak hour, peak direction trips when one or more of the following conditions are anticipated or present:

- The development/redevelopment is located in an area of high roadway congestion and/or high expected rate of population or employment growth
- The development, its access or type of operation is not envisaged by local land use or transportation plans
- The development or redevelopment proposal requires amendment of the applicable Official Plan(s)
- As part of the proposed development, a new traffic control signal is proposed to be installed on a City roadway
- If, in the opinion of the City, the development/redevelopment has the potential to create unacceptable adverse operational and safety impacts on the City road network. Examples include the following:
  - Inadequate horizontal or vertical sight distances at access points
  - The proximity of the proposed access points to other existing driveways or intersections
  - Absence of a left or right turn lane(s) on the adjacent roadway at the proposed access point(s)
  - The vehicular traffic generated by the development/redevelopment would result in volume/capacity ratios at a signalized intersection becoming critical (i.e. greater than 0.85 overall or for a shared through/turning movement, or greater than 0.95 for an exclusive turning movement)

The City reserves the right to require the submission of a transportation impact study notwithstanding the criteria listed above.

2.2 Staff Consultation

It is imperative that prior to commencing a transportation impact study, representatives of the engineering consultant firm meet with City staff in order to review the level of detail and confirm the scope of the transportation impact study, arrange contacts with the various affected road jurisdictions and to determine data requirements and their availability. Staff will update the consultant on planned road improvement projects and provide information with respect to other developments or redevelopments in the general study vicinity that will need to be taken into account.

In addition to the City of Niagara Falls requirements, Regional, Provincial, Niagara Parks Commission authorities may require additional information or analysis to satisfy their requirements for a development or redevelopment proposal. The proponent should contact these roadway authorities, where applicable, to determine their requirements.

2.3 Study Updates

Generally, a transportation impact study will have a "shelf life" of five years. Major changes within the study area may reduce the "life" of the document if they were not considered in the impact assessment. Where the timing of subsequent development approvals exceeds five years, a new study will generally be required.

2.4 Qualifications to Conduct Transportation Impact Study

When the scale of the development/redevelopment warrants a transportation impact study, it is the proponent's responsibility to retain a qualified transportation consultant experienced in transportation planning and traffic engineering.

The consultant shall be registered as a professional Engineer in the Province of Ontario. The report must be dated and signed accordingly. The signing Engineer is verifying that appropriate assumptions and methodologies have been utilized in the completion of the transportation impact study and that "best practice" engineering standards in accordance with ITE, TAC and/or other approved documents have been incorporated in the decision making process and that they are the individuals who are taking corporate and professional responsibility for the work.

Alternatively, at the discretion of the Director of Municipal Works or his/her designate, the City may retain a consultant at the proponent's expense.

2.5 Documentation

During the course of data analysis, the consultant may refer to publications of various natures. Each reference shall indicate the name of the publication, author(s), date of publication, table or figure number and page number. Other information as appropriate shall also be included.

2.6 Assumptions

The consultant will detail any underlying assumptions made in the study that is not documented in a published manual. The assumption shall be reasonable, easily and readily observable, and be of sound engineering judgement.

2.7 Transportation Impact Study Review Time

City Staff will normally be allotted 4 weeks to review and prepare a response to a transportation impact study, although all attempts will be made to thoroughly complete the review as quickly as possible to expedite the application process. Review of additional requested information and addendums will generally take considerably less time to complete.

3.0 TRANSPORTATION IMPACT STUDY OUTLINE

The following sections outline the format and requirements of the transportation impact study. Regional, Provincial, and Niagara Parks Commission authorities may require additional information or analyses beyond the City requirements in these guidelines. The contents and extent of the transportation impact study generally depend on the location and size of the proposed development or redevelopment and the conditions prevailing in the surrounding area.

3.1 Description of the Proposal and the Study Area

A description of the development proposal, its location and the proposed transportation impact study area is required to permit staff to identify the site location, its anticipated operation and area of potential impact. In addition, this valuable information allows timely review of key study assumptions ranging from the study area limits and horizon years to the trip assignment assumptions.

3.1.1 General Description of the Development Proposal

Elements that should be included in the development description and study area are:

- identification of the applicant
- site location
    - municipal address
    - map(s) to show site in area content
- nature of application (Official Plan amendment, zoning amendment, site plan control application, etc.)
- A description of the proposed development in terms of
    - type of land use proposed
    - existing land uses or permitted uses provisions in a Official Plan, Official Plan Amendments, Zoning By-law etc.
    - size of individual land use components expressed in units related to transportation analysis (e.g. floor space of each type of use, employment number of parking spaces, etc). Special attention should be paid to gross versus net definitions
    - identification of phasing schemes with their associated land use and transportation components
    - expected dates of completion and full occupancy of the ultimate development and of interim phasing, if any
    - approximate hours of operation

- a site plan of a suitable scale (preferably 1:200 or 1:500) for consideration showing site specific information pertaining to:

    - building sizes and location
    - number of parking spaces, identifying those designated for the exclusive use by the disabled and by high-occupancy vehicles including a comparison of proposed parking supply with zoning standards
    - number, location and type of loading areas and location and operation of loading area access (e.g. deliveries, refuse pickup, tour buses)
    - on-site circulation for vehicles, pedestrians, bicycles and high-occupancy vehicles
    - proposed access points and type of access (full turns, right-in-right-out, turning movement restrictions etc.)
    - identification of site lines at proposed accesses (location of existing accesses across the road should also be included)

3.1.2 Study Area

A Scope Development Meeting with stakeholders must be arranged by the consultant to determine the study area. Stakeholders may include representatives from the City of Niagara Falls, Regional Municipality of Niagara, Niagara Parks Commission, Ministry of Transportation, and the Niagara Falls Bridge Commission depending on the development location. Regional, Provincial, Parks Commission, etc. staff may require additional information or analysis beyond the City of Niagara Falls requirements outlined in these guidelines. The City reserves the right to establish the study area as deemed appropriate.

A description of the existing transportation system in the study area, using a combination of maps and other documents should identify relevant information, such as the following;

- other developments in study area

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

- map(s), at a preferable scale of 1:200 or 1:500 to show the existing transportation system in the study area

    - existing roads, number of lanes and posted speeds
    - existing signalized intersections, lane configurations, lane widths
    - if appropriate, on-street parking spaces/standing/stopping restrictions in the vicinity of the development site and those which affect the operation of key intersections being analysed
    - other traffic controls and transportation facilities as appropriate
    - heavy vehicle restrictions including routes restricted to tour bus traffic
    - existing transit routes, stops and stations
    - other features of interest

3.2 Site Plan Review

The engineering consultant will undertake a thorough site plan review of the development proposal. Since site plan issues will inevitably affect the results of a transportation impact study, a careful analysis will ensure that problematic site plan issues are dealt with at the preliminary stage.

The goal of a parking and transportation assessment when reviewing site plans is to ensure that travel and parking demands are accommodated while the safety of all users within the proposed site is maximized. The site planning process integrates the building, site circulation, parking and access to the public roadway system.

References for site plan preparation can be obtained from:

- Geometric Design Manual for Canadian Roadways, published by the Transportation Association of Canada, 2000
- Promoting Sustainable Transportation Through Site Design, published by the Canadian Institute of Transportation Engineers
- City of Niagara Falls Zoning By-law 79-200
- City of Niagara Falls Official Plan

Other recognized transportation publications may be referred to where applicable.

Any design that is contrary to approved transportation guidelines must be rigorously justified by the consultant.

Strategies promoting the reduced dependence on the private automobile are taken into consideration during the site plan review. The development of the site should accommodate facilities that incorporate transportation demand management (TDM) initiatives as outlined in the Sustainable Transportation Master Plan Study, 2011. The initiatives include active transportation, transit, car sharing, employee participation and awareness.

It is not necessary to provide comments on each of the following, however, the site analysis should include an evaluation of, but not limited to the following (some items are expanded upon later in this policy document), where applicable:

3.2.1 Road Widening Requirements

- Road widenings, as per the Official Plan
- Daylighting triangles, as per the Official Plan

3.2.2 Accesses

- Location of access(es), their proximity to other accesses and intersections
- Access geometry (appropriate radius, driveway width, etc.) - Refer to Appendix B
- Curb return radii
- Proper curb returns must be contained entirely within the limits of the property
- Number of accesses. The need for multiple driveways/accesses will be based on level of service criteria as opposed to convenience

- Spacing between accesses
- Access type (full, restricted turns)
- Corner clearances in context with functional classification of roadway and adjacent intersections
- Existing and proposed abutting on-street parking control; removal or modification of parking areas
- Location of mechanical gates, sensors, booths, kiosks, and any other devices that restricts entry or exit
- Traffic control (existing traffic control signals, proposed traffic control signals, stop control, other)
- Visibility at accesses
- Proper driveway dimension - See Table 3.1

Table 3.1 Typical Driveway Dimensions

Dimension (m)	Land Use		
	Residential	Commercial	Industrial
width (W)			
• one-way	3.0[a] – 4.3	4.5[a] – 7.5	5.0[a] – 9.0
• two-way	3.0.[a] – 7.3	7.2[a] – 12.0[b]	9.0[a] – 15.0[b]
right-turn radius (R)	3.0 – 4.5	4.5 – 12.0	9.0 – 15.0

Notes: a. Minimum widths are normally used with radii at or near the upper end of the specified range.
b. Increased widths may be considered for capacity purposes; where up to 3 exit lanes and 2 entry lanes are employed, 17.0 m is the max. width, exclusive of any median.
c. Applicable to driveways only, not road intersections.

Source: Table 3.2.9.1, Geometric Design Guide, Transportation Association of Canada, 1999

3.2.3 Accessing the Site

- Passenger vehicles
- Delivery vehicles
- Service vehicles
- Shuttle buses and/or tour buses
- Transit buses
- Taxis
- Emergency vehicles
- Cyclists
- Pedestrians
- Site grading, terrain
- Drainage and snow considerations
- Building access(es)

3.2.4 Internal Road Network

- Aisle widths
- Design accommodates circulating traffic (no dead ends)
- Turning radius for emergency access and/or tour buses accommodated
- Auxiliary lanes
- On-site traffic calming (speed humps or bumps, other physical devices)
- Adequate widths for fire routes
- Pedestrian, cycling and transit friendly road network

3.2.5 Parking Area Design

- Throat length; queuing at accesses
- Corner clearances prior to first parking access opportunity
- Orient perpendicular to building access
- Consider winter maintenance functions (snow storage capability)

3.2.6 Parking Facilities

- Parking for passenger cars, buses, transit, taxi, bicycles, other vehicles
- Number of parking stalls required as per the Zoning by-law
- Number of parking stalls to be provided
- Stall and manoeuvring aisle dimensions
- One way or two way aisles
- If parking stall dimensions are according to the Zoning by-law
- End island treatments
- Reserve land for future parking expansion capabilities
- Designated parking stalls for disabled persons
- Preferential parking stalls for car pooling
- Preferential parking stalls for electric/green vehicles

3.2.7 Pedestrian & Cycling Facilities

- Separate vehicular and pedestrian traffic; minimize pedestrians walking through parking area
- Provide sidewalks and ensuring that sidewalks are not obstructed by overhang of vehicles
- Minimize crossing distances across internal roadways
- Signed and marked crossing areas provided
- Provide access from on-street facilities
- Bicycle storage areas
- Direct pedestrians and cyclists to where you want them to cross
- Safety and security considerations

3.2.8 Loading Areas - Delivery / Service / Tour Bus

- Vehicle manoeuvres required to access loading should be carried out entirely within the property. Use of the road allowance to carry out necessary turning movements are not acceptable.
- Locate delivery/service areas away from primary parking sites
- On-site storage space for an adequate number of vehicles provided, such as tour buses
- All manoeuvring takes place without using adjacent parking stalls
- Turning paths of all vehicles the size of a cube van and larger must be plotted using AutoTurn or other similar software. The vehicle type, code, dimensions and wheel base(s) must be noted.

3.2.9 Transit and Taxi Considerations

- For large developments, locate transit and taxi facilities on-site and close to entrances
- Provide sidewalks to existing on-street locations

3.2.10 Signs and Markings

- Conformity to Ontario Traffic Manuals
- Directional signs at accesses for one way movements (one way, do not enter, etc.)
- Directional arrows painted for one way movements
- Signs to direct motorists to external roadways/exits
- All signs must be installed within the limits of the property
- Site navigation (for larger or complex sites)

3.2.11 Visibility

- Ensure unobstructed visibility at accesses and pedestrian crossing locations
- Reduced visibility may be caused by the following:
  - signs
  - landscaping
  - street hardware - benches
    - transit shelters
    - mailboxes
    - newspaper vending boxes
    - pedestrian rails
  - garbage refuse
  - grade of property

3.2.12 Drive Through Facilities

- Location of pick up window(s)
- Ordering location(s)
- Distance and queuing space between pick up window and ordering kiosk
- Distance and queuing space between pick up window and street
- Distance and queuing space between entry and ordering kiosk
- Drive through lane width
- Turn radius, if applicable
- Design does not have pedestrians crossing drive through lane

3.2.13 Road Improvements

- Road widenings or narrowings
- Bus bays
- Cul-de-sac design
- Medians
- Existing and proposed turn lanes
- Realignment of existing sidewalk
- Construction of new sidewalk or extension of existing sidewalk
- Existing, new, proposed, extended and abandoned curb depressions

3.2.14 Site Amenities

- Waiting, drop off and pick up areas
- Transit shelters
- Bicycle racks
- Storage areas, lockers and change facilities
- Street furniture
- Landscaping

3.2.15 Utilities

- Water lines
- Sanitary sewer
- Storm sewer
- Gas
- Fire hydrants
- Electric, if overhead or underground
- Light poles and illumination
- Electrical, telephone, cable, or postal kiosks
- Manholes & sewer locations

3.3 Data Collection

The consultant will be responsible to obtain all information for analysis. The City of Niagara Falls may assist in providing such information if the information is readily available. The following is a cost breakdown for various services, as approved by Council and outlined in the Schedule of Fees for Services, June 2011. Prices may change without notice. Harmonized sales tax is extra.

Eight (8) hour manual intersection traffic count per location	$ 200.00
Twenty-four (24) hour automated traffic count (ATR) per location	$ 75.00
Manual radar spot speed study per location	$ 50.00
Twenty-four (24) hour automated speed study (ATR) per location	$ 100.00
Twenty-four (24) hour automated classification count (ATR) per location	$ 100.00
Motor vehicle collision summary report & diagram per location	$ 50.00
Traffic signal timing plan summary per location	$ 50.00
Lane configuration drawing per location	$ 50.00

Due to ongoing developments and natural traffic growth, traffic count data more than three (3) years old will not be suitable for analysis. The dates and times when the counts were conducted must be supplied.

The consultant will complete the form in Appendix A for the requested information. Upon receipt of the completed form, one (1) week is needed to compile the information. An invoice will follow addressed to the engineering consulting firm. Parking and traffic information for roads and/or intersections under the jurisdiction of the Regional Municipality of Niagara, Niagara Parks Commission, Ministry of Transportation or the Niagara Falls Bridge Commission shall be obtained from the respective road authorities.

No charge will be applied for information to firms undertaking a transportation impact study on behalf of the City of Niagara Falls or other governmental agency and commission.

3.3.1 Specialty Studies

In certain circumstances, additional studies may be required to substantiate field conditions related to, but not limited to the following:

- time travel
- pedestrian related studies
- weaving
- gap acceptance
- left turn
- saturation flow
- parking lot occupancy, peaks and usage
- queuing and blocking
- transit operations
- occupancy statistics

The consultant may be responsible in co-ordinating and carrying out the necessary studies to validate certain aspects to the transportation impact study.

3.4 Establishing a Context for the Transportation Impact Study

This section develops a suitable context to evaluate the impacts of the proposed development to baseline conditions. The projected impacts will later be compared with this summary of conditions.

3.4.1 Horizon Year

The horizon year for impact analysis should be ten (10) years from the date of the transportation impact study. Interim phases of the development to full build-out is required to be identified along with the improvements required for each phase.

3.4.2 Peak Period for Analysis

The critical time period for traffic generated by a given project is directly associated with the peaking characteristics of both the development related traffic and the transportation system traffic. Typically, the weekday morning and afternoon peak traffic period will constitute the "worst case" combination of site related and background traffic; however, in the case of retail, lodging, entertainment, religious, institutional and sports facility uses, analysis of Saturday, Sunday or other peak period may be required.

When selecting peak periods for analysis, consideration must be given to the peak traffic characteristics of the:

- proposed development
- adjacent land uses
- adjacent road and highway network

As part of the consultation process prior to commencing the study, the consultant should determine with City staff the selected time periods for analysis.

Table 3.2 Typical Peak Hours of Traffic for Selected Land Uses

Land Use	*Typical Peak Hours**	*Peak Direction*
Residential	Weekday: 7:00 - 9:00 a.m. Weekday: 4:00 - 6:00 p.m.	Outbound Inbound
Shopping	Weekday: 5:00 - 6:00 p.m. Saturday: 12:00 - 2:00 p.m. Saturday: 2:00 - 4:00 p.m.	Total** Inbound Outbound
Office	Weekday: 7:00 - 9:00 a.m. Weekday: 4:00 - 6:00 p.m.	Inbound Outbound

Land Use	*Typical Peak Hours**	*Peak Direction*
Lodging	Weekday: 11:00 - 3:00 p.m. Weekday: 4:00 - 6:00 p.m.	Inbound Outbound
Recreational	Varies with type of activity	
Industrial	Varies with shift schedule	

* hours may vary based on local conditions
** period of maximum traffic

3.5 Existing Traffic Conditions

To provide a representative picture of the existing traffic conditions, exhibits showing the existing traffic volumes and turning movements for roadways and intersections in the study area including pedestrian volumes and heavy vehicle movements (such as trucks, transit and tour buses, etc.) should be included.

3.5.1 Establishing Base Year Traffic Volumes

Traffic volumes may be acquired from the City, Region or previous transportation impact studies undertaken in the study area. Traffic counts more than three (3) years old or counts that appear not to be reflecting existing conditions should be updated to ensure that they reflect current traffic levels. It may be necessary to factor up counts taken in previous years to represent the current year. A peak hour count at minimum should be undertaken to verify that traffic volumes through an intersection reflect actual demand and to determine the necessary adjustments to level-of-service calculation so that actual conditions are fairly represented. Developments proposed in the tourist area should use traffic volumes collected during the peak tourist season (July and/or August) and factored if necessary.

Traffic volumes for the road network in the study area must be balanced when there are significant discrepancies between adjacent intersection counts and there are no accesses or major traffic generators to account for the difference in volumes.

3.5.2 Field observations

It is recommended that the consultant make at least one visit to the site. This visit should be made after available information has been obtained from the City and other reviewing agencies. Any traffic count or field measurement information not available could be obtained at this time. Items to be checked when in the field include:

- posted speed limits
- prevailing operating speeds
- sight visibility to both the left and right for all proposed access points and adjacent intersections
- presence of curb, gutter and sidewalk
- drainage
- width of pavement and shoulders
- measurements, such as, but not limited to:
  - turn lane storage lengths
  - lane widths
  - crosswalk lengths/widths
  - link lengths
- vertical and lateral clearances
- curvatures
- grades
- presence of raised or painted medians
- turn restrictions at all intersections
- signal heads at signalized intersections
- marked pedestrian crossing areas
- location of access points to properties both adjacent to and on the opposite side of the road and permitted movements on each
- on-street parking regulations and availability
- current uses of adjacent sites
- street lighting
- bicycle lanes or bicycle travel on adjacent roads
- bus stops

- unopened road right-of-way allowances
- potential for linkages to other local roads or laneways
- potential for amalgamating site access with adjacent properties

In addition, photographs of the site can provide an office record of the site and its environment for both the traffic engineering consultant and the agencies reviewing the study and its recommendations.

3.6 Future Background Traffic (Future Traffic *Without* Proposed Development)

3.6.1 Future Background Traffic

The background growth projects future traffic without the proposed development. It includes at a minimum annual growth rates and future traffic from other proposed (approved) developments to be located within the vicinity of the site. The growth in traffic should be established in consultation with City staff through one of the following methods:

- estimation of roadway growth factors from a calibrated traffic forecast model
- regression analysis of historical traffic growth
- a growth rate based on area transportation studies

In absence of these methods, a growth rate of 2% per annum should be used.

3.6.2 Planned Roadway Improvements

Any planned roadway improvements to be completed within the study area should be identified and discussed within the report. These improvements shall be reflected in the *Future Background and the Future Total Traffic Condition.*

3.6.3 Other Developments Within the Study Area

All significant developments under construction, approved, or in the approval process and are likely to occur by the horizon years should be identified and discussed within the report. The trips that are expected to be generated by other developments should be combined with the trips of the subject development. Trip numbers should be separated. The land-use type and magnitude of the probable future developments in the horizon year should be identified through consultation with City and Regional staff.

3.7 Future Total Traffic (Future Traffic *With* Proposed Development)

All trip generation, trip distribution, trip assignment and modal split assumptions should be in accordance with standard/accepted techniques. Sources should be well documented and any assumptions which may be considered less than conservative should be rigorously justified.

3.7.1 Site Generated Traffic

Consultation with City Staff is recommended to ensure that appropriate trip generation rates are being employed in the transportation impact study. Available trip generation methods include, from most to least preferred:

- Trip generation surveys from similar development in the City which have similar operating characteristics as the proposed development. Tourist oriented developments must include surveys carried out during the peak tourist season. Modifications should be made to the trip generation rates to account for differences in the surveyed and proposed development sites. Field study background material must be provided and results prepard in tabular form.
- "First principles" calculations of anticipated trips to/from the site
- ITE Trip Generation rates provided that differences in the site nature and size are accounted for.

In addition to the basic requirements for establishing trip generation rates, the following key elements may also be considered for use:

- Pass-by trip percentages: Some land uses may not generate vehicle trips that are all new to the surrounding road network. A proportion of the site trips may be diverted from vehicle trips already passing by on nearby roads (i.e.; a driver may stop at a convenience store on the way home from work). If this store is located along the road the driver normally uses to get home, then the trip "generated by the store" is not a new trip added to the roadway. These trips are also called "Synergy" trips. It is important to note, however, that the trip generation rates at the accesses themselves will not be affected by pass-by trips. Only the estimated number of new trips on the surrounding road network will be affected. The total trip generation should be split up into volumes of new trips and volumes of pass-by trips based on survey results for the peak hour(s) being analysed.
- Internal "Synergy" trips: Represents trips which are shared between two or more uses on the same site (i.e.; a motorist visiting a retail store and a grocery store on the same site).
- Trips generated by the existing land use activities to be replaced by the proposed development. Unless otherwise accounted for, these trips will normally be subtracted from the trip generation estimates.
- Transportation Demand Management (TDM) strategies

All trip generation assumptions and adjustments assumed in the calculation of "new" vehicle trips should be documented and justified in terms of previous research or survey. Sensitivity analysis should be undertaken where trip generation parameters have the potential to vary considerably and most probable values cannot be readily identified.

A table should be provided in the study report identifying the categories and quantities of land uses, with the corresponding trip generation rates or equations and the resulting number of trips. For large

developments that will be phased in over time, the table should identify each significant phase separately. The method of determining the trip generation rates should be clearly identified.

If valet service is proposed and should these trips be diverted onto the road network, this volume will be included in the site generated traffic component. However, trip numbers should be separated to distinguish between patron and valet site generated traffic.

3.7.2 Trip Distribution

The directions from which traffic will approach and depart the site can vary depending on several location-specific factors including:

- type of proposed development
- size of proposed development
- surrounding and in some cases competing land uses, population and employment distribution
- prevailing conditions on the existing street system

The trip distribution assumptions should be supported by one or more of the following:

- Transportation Tomorrow Survey (TTS) data
- Origin-destination surveys
- Comprehensive travel surveys
- Existing/anticipated travel patterns
- Output from the City of Niagara Falls Paramics transportation planning model

Engineering judgement should be utilized to determine the most applicable of the above methodologies for each particular application.

3.7.3 Trip Assignments

Traffic assignments should consider logical routings, available and projected roadway capacities and travel times. Traffic assignments may be estimated using a transportation planning model or "hand assignment" based on knowledge of proposed/future road network in the study area. The City transportation model created using Paramics may be available and City staff can provide assistance upon request.

3.7.4 Summary of Traffic Demand Estimates

A summary of the future traffic demands (each combination of horizon year and peak period for both site generated and future total traffic conditions) should be provided in the form of exhibits. Appendix D illustrates a sample diagram for a small network under review. Pass-by traffic assumptions should be clearly identified and illustrated on an exhibit, which summarizes the reassignment of pass-by traffic.

3.8 Evaluation of Impacts of Site Generated Traffic

An evaluation of signalized and unsignalized intersections which will be affected by site generated traffic volumes for all relevant time periods and scenarios is required and summaries are to be provided in a tabular format.

The objective should be to ensure that no new problem movements are created by the development and that problem movement(s) which exist with the addition of site generated traffic are not worsened by this addition.

Documentation in an appendix to the transportation impact study of all assumptions used in the analysis concerning lane configuration/use, pedestrian activity, saturation flows, traffic signal cycle length, phasing and timing, utilization of the inter-green phase and other relevant parameters. Existing signal timings should be used for existing intersections and signal timing modifications may be considered as a measure to address capacity or level of service deficiencies.

Supplementary surveys or analyses may be needed to assess saturation flows, gap availability, weaving, projected queue lengths and possible blocking queues.

3.8.1 Capacity Analysis at Intersections

The summary should include the level-of-service including average vehicle delay, 95th percentile queue lengths and volume to capacity (v/c) ratios for overall intersection operations and individual critical movements, for all analysis periods and time horizons. Full documentation of the results of all level of service analysis should be provided in an appendix. The City accepts the Highway Capacity Manual (HCM) and Canadian Capacity Guide (CCG) methodologies of intersection analysis. Specific software packages include HCS Version 3.0 or higher CCG/CALC2, and Synchro 5.0 or higher or HCM/Cinema. Should a consultant wish to utilise a software package other than these listed above, prior approval from the City must be obtained. The analysis should incorporate adequate crossing time for pedestrians and should use conventional signal timing plans.

Studies confirm that a 1750 saturation flow rate is current standard to be used for analysis of intersections in Niagara Falls.

Lane arrangements will be coded in the analysis software as painted in the field.

Pedestrian times must be taken into consideration as worst case scenarios particularly where high pedestrian volumes exist or at locations where pedestrian pushbuttons are not present. City procedure for calculating pedestrian walk and 'don't walk' times is based on the following:

'Don't Walk' Time Calculation:

100% of the time required to cross the road minus the amber phase. The crossing time is calculated by dividing an average walking speed of 1.2 metres / second to the width of the crosswalk (in metres) measured along its midpoint from curb to curb (or edge of the pavement to edge of the pavement). This allows a pedestrian that has begun their crossing during the last second of the walk indication enough time to completely cross the road and indicates late arrivals not to begin crossing. In areas that experience high pedestrian volume,

is supervised by a school crossing guard or where the intersection is frequented by seniors, an average walking speed of 1.0 metres / second is used instead. The clearance interval must be set at this time length; it cannot be shortened or extended.

Walk Time Calculation:

50% of the 'Don't Walk' time, minimum of 7 seconds. For intersections that operate under a fixed time setting, the walk time is extended to equal the maximum green time for that phase.

Example:

Crossing Distance	=	25 metres, as measured along the midpoint of the crosswalk from curb to curb
Crossing Time	=	25 metres / 1.2 metres per second walking speed
	=	20.83 seconds OR 21 seconds (rounded)
Amber Time	=	3.3 seconds OR 3 seconds (rounded)
Don't Walk Time	=	21 seconds crossing time - 3 seconds amber clearance time
	=	**18 seconds**
Walk Time	=	50% of the Don't Walk time, minimum of 7 seconds
	=	**9 seconds** (*Note: if this intersection is operating as fixed time and the maximum green is set at 40 seconds, the walk time is then increased to 22 seconds)*

The analysis should include the identification of signalized intersections where one or more of the following is met:

- Volume to capacity (v/c) ratios for overall intersection operations, through movements, or shared through/turning movements increased to 0.85 or above
- v/c ratios for exclusive left turn or right turn movements increased to 0.95 or above
- 95th percentile queues for an individual movement are projected to exceed available turning lane storage. The analyst will recommend signal timing changes to mitigate vehicle spillovers.

Identification of unsignalized intersections where one or more of the following is met:

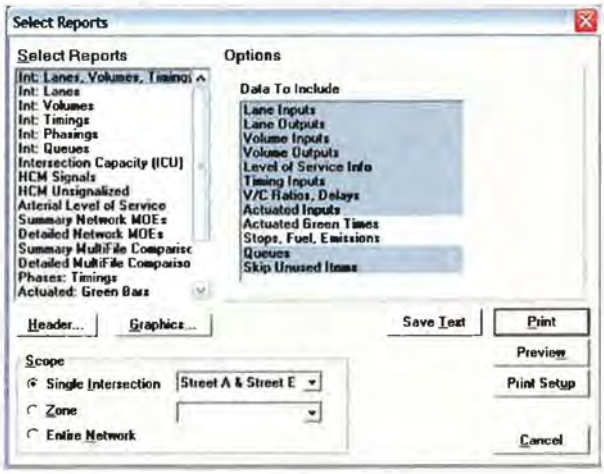
- Level of service (LOS), based on average delay per vehicle, on individual movements exceeds LOS "E"
- The estimated 95th percentile queue length for an individual movement exceeds the available queue storage

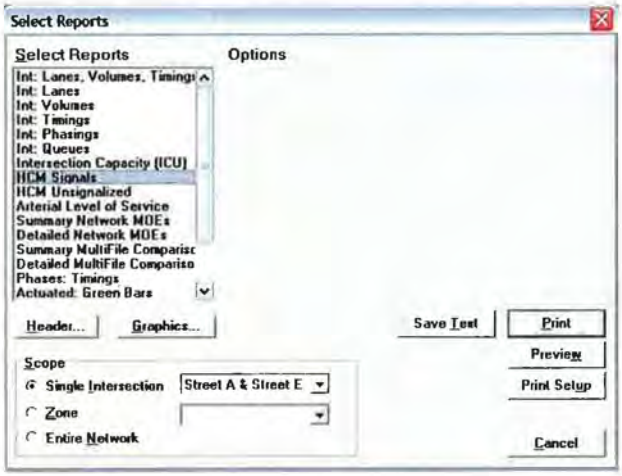
Conventional signal timing plans should be used and all proposed adjustments to traffic signal timing, phasing and cycle lengths should be evaluated in terms of pedestrian crossing time, effect on queue lengths, adequacy of existing storage and effects on the existing signal co-ordination.

For analyses carried out using the Synchro software package (version 5.0 and later), the intersection summary reports should be printed to show the following information:

3.8.1.1 Signalized Intersections

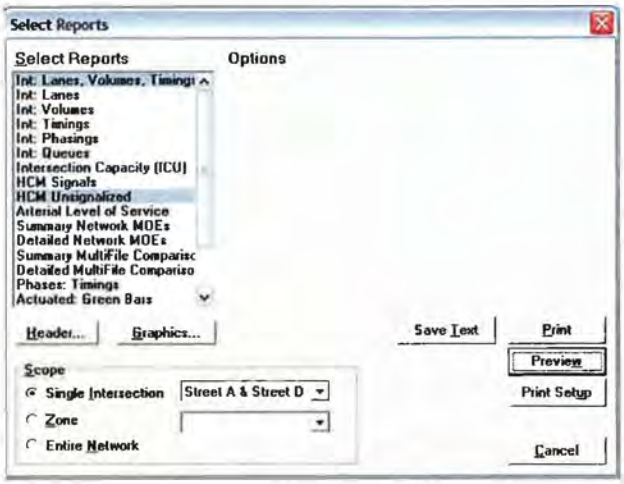
For each signalized intersection, select the following two reports with applicable highlighted data will be printed and inserted in the appendices for each analysis scenario.





3.8.1.2 Unsignalized Intersections

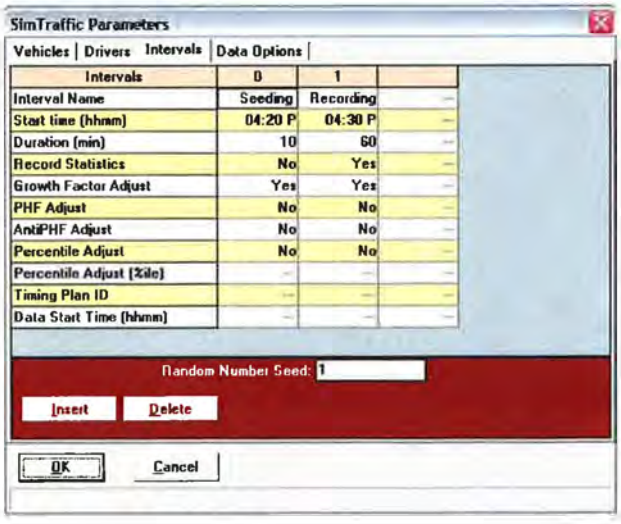
For each unsignalized intersection, the two highlighted reports, as shown to the right, will be printed and inserted in the appendices for each scenario.



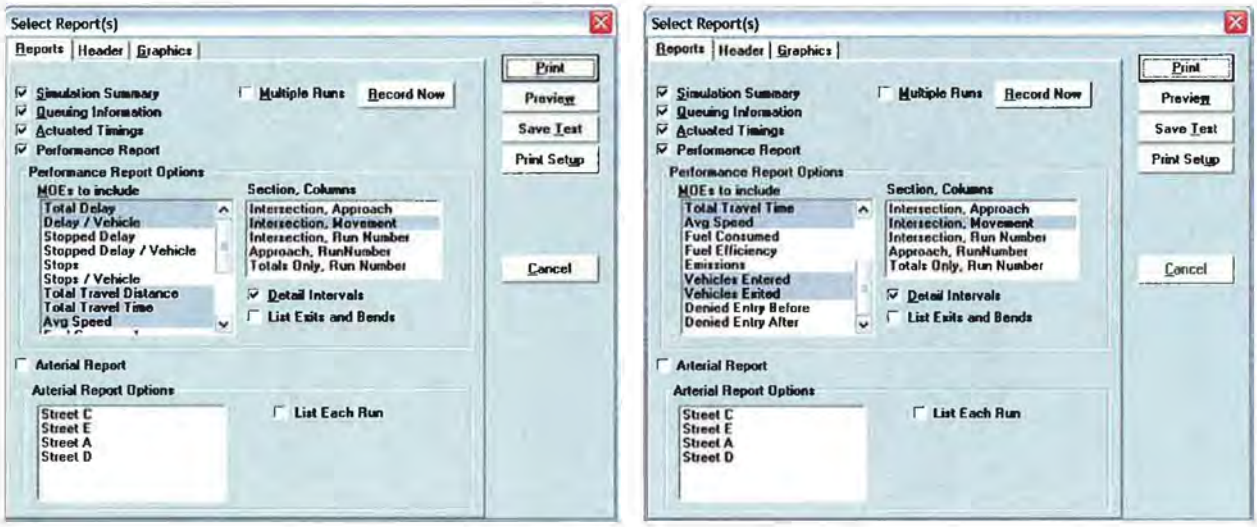
Sample reports for signalized and unsignalized intersections may be found in Appendix E and F respectively.

3.8.1.3 SimTraffic Reports

Synchro is a macroscopic model, which provides an analysis of each intersection independently. SimTraffic, on the other hand, provides an indication of how intersections operate while vehicles interact with each other. Results from the traffic simulation shall also be included in the appendices. The analyst shall first ensure that the seed time is set at a minimum of 10 minutes, while the recording session lasts 60 minutes in length, to coincide with the analysis period. These settings may be changed in the SimTraffic Parameters (Intervals) window as shown at right.



The following screen shots displays the report information requested from the SimTraffic analysis.



A sample SimTraffic report is contained in Appendix G.

3.8.1.4 Intersection Summary Reports

To facilitate easier comparison and discussion, the report should contain a table as shown in Appendix H that provides a summary of each intersections volume, delay, v/c ratio and level of service data. Additional pertinent information can be provided. This data grouping will assist decision makers in determining the need for improvements based on the total traffic (site generated volumes plus future background traffic) expected compared to anticipated base future background traffic. Any cell that exceeds tolerable limits should be highlighted.

3.8.2 Weaving Analysis

The engineer will provide the level of service results for various traffic volume levels and weaving distances for corridors where weaving operations need to be addressed. Mitigating measures to reduce weaving conflicts, if necessary, shall be discussed.

3.8.3 Pedestrian Analysis

In areas of high pedestrian activity, an analysis with respect to pedestrian level of service may be required to determine that the development will not adversely affect the operation of pedestrians on or adjacent to the property. The analysis should identify optimum sidewalk widths and clearances based on the prevailing pedestrian volumes and determine suitable pedestrian accesses and facilities to the development.

3.8.4 Traffic Infiltration

Development proposals should contain accesses that front onto major collector and arterial roads. However, depending on the configuration of the property or site, some proposals may contain auxiliary side or rear access(es) that disperses traffic onto minor collector or local streets with a primarily residential setting. In other cases, satellite parking lots may require valet service personnel to shuttle vehicles to these off-site locations, possibly through a residential area. Even if accesses are property located, the trip assignment to/from the development may utilize an undesirable route through residential areas should new traffic control signals be installed opposite of the main entrance to assist traffic on the minor approaches in clearing the intersection.

The option of shortcutting through the residential neighbourhood is undesirable. The consultant should investigate all other site design options first to minimize site-generated traffic in abutting residential areas. However, if a suitable design cannot be achieved, a discussion on mitigating measures to deter motorists that do not have either an origin or destination within a neighbourhood is required.

3.9 Access Analysis Requirements

3.9.1 Access Geometrics

The number and location of access points should be reviewed to ensure only the minimum number necessary is provided to serve the project without negatively impacting the flow of traffic along abutting streets. Access points should be located on minor roads where feasible and justification for more than one access must be based on capacity of site traffic and not design preference.

The locations should be adequately spaced from adjacent street and driveway intersections. The number of exit lanes, radii and vehicle storage should be appropriate to accommodate traffic demands placed on them. The throat length at the road should be sufficiently long to minimize conflicts with street traffic and within the site.

Access points should be evaluated in terms of capacity, safety and adequacy of queue storage capacity. Access points should be free of all encumbrances and provide appropriate sight triangles. Proposed 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 operations on City roads.

All accesses shall be designed to facilitate entry and exit of all vehicle types envisioned to access the site completely from and into abutting traffic lanes. Scaled drawings that illustrate the turning paths of various design vehicles using recognized software such as AutoTurn shall be provided in the appendices for review. Curb returns must be contained entirely within the limits of the property.

Access standards should be in conformance with those outlined in the "*Geometric Design Guide For Canadian Roads*", 1999 edition, as amended issued by the Transportation Association of Canada (TAC).

3.9.2 Turn Lane Requirements

The requirements for left turn and right turn lanes should be examined. Adequate spacing between access points should be provided to avoid potential turn lane overlaps. Left turn lane determinations at unsignalized intersections is based on the Geometric Design Standards for Ontario Highways manual, published by the Ministry of Transportation of Ontario. Refer to Appendix C for warrant graphs excerpted from the manual.

3.10 Motor Vehicle Collision and Safety Analysis

The initial review of existing data within a study area should include recent (within 3 years) motor vehicle collision experience. A safety evaluation shall be undertaken for each intersection and access within the study area to identify locations where traffic safety should be given extra consideration. High accident locations (based on number, rate and severity) within the study area must be analyzed and measures to alleviate accident hazards must be considered.

Driveway/access design and roadway improvements should be analysed to ensure safe stopping, decision sight distances and intersection sight distances. Vehicle conflicts, accident potential locations, pedestrian, transit and bicycle activities are to be considered. Identification of potential safety of operational issues associated with the following, as applicable:

- high accident intersection or mid-block locations
- intersections in the study area which are in the top 10% in terms of collision rates
- conflicts between motor vehicles turning into or out of the site and pedestrians walking along sidewalks or cyclists on the street
- right turn, left turn and through movements onto and off of adjacent roads
- the geometry of the access and its impacts on entering and exiting vehicles
- the weaving distance of vehicles exiting the site
- location of bus stops in proximity to a new access or intersection
- on-street parking provisions
- traffic infiltration or shortcutting through residential areas
- heavy vehicle movement conflicts

3.11 Sight Distance Evaluation

Analysis for access design and roadway improvements should ensure:

- safe stopping sight distance
- decision sight distances
- intersection sight distances

At each access and at each intersection where a new road is proposed, the sight distance requirements should be examined based on appropriate standards (TAC Manual), and the availability of sight distance determined from actual field measurements.

3.12 Parking Provision Evaluation

A description of the parking and loading facilities proposed in conjunction with the proposed development is required. The parking supply should be rationalized with the modal split assumptions used in the calculation of travel demand, with local policies and standards. Special attention should be given for developments attracting high-occupancy vehicles to ensure that not only adequate storage is available, but the safe manoeuvring of the vehicle within the parking lot is taken into consideration. The provision of bicycle parking or storage and for vehicles operated by or those with mobility limitations should also be addressed.

3.13 Transportation System Mitigation Measures

This section outlines the process of identification of operational transportation system improvements and other measures required to ensure that acceptable operation of the transportation system is maintained. The improvements must incorporate recommendations and standards outlined in previous City transportation studies or improvement projects.

3.13.1 Off-Site Improvements

The physical and operational road network deficiencies that have been identified in the transportation impact study must be addressed and solutions provided that are feasible and economic to implement.

Functional design plans or detailed design drawings may be required for identified physical improvements to ensure their feasibility.

The improvements could include but are not limited to the following:

- widening of the surrounding road network
- addition of left turn or right turn lanes at intersections and/or accesses
- restriction or relocation of existing accesses
- change of traffic control at an intersection
- upgrading of traffic control signal through additional phasing and/or improved timing
- co-ordination of traffic control signals
- relocation or closure of existing public street roads or intersections
- installation or removal of a median barrier or other median treatments

3.13.2 On-Site Improvements

On-site improvements that should be investigated as means of reducing the impacts of the proposed development could include but are not limited to:

- redesign of existing or proposed parking lot layout
- vehicular circulation improvement
- access points on minor roads
- turn restrictions at the access point
- relocation of existing or proposed access points
- combination of existing nearby accesses to reduce or eliminate the number or density of accesses
- addition of on-site left and right turn channelization
- accessible loading areas and refuse collection with adequate turning paths and clearances
- bus loading/unloading areas and parking zones with adequate turning paths and clearances

The consultant shall provide a preliminary assessment of the overall site design elements compared with "best practices." Appropriate recommendations should be provided to enhance the overall operation and aesthetics of the site. Section 3.2 provides a breakdown of key site plan components that should be addressed.

Drive through service facilities shall be designed as to have available space for ten (10) vehicles to queue entirely within the site and preferably without blocking internal access to aisle ways or parking areas. Targeted wait times at different stages in the drive through should be provided. These should be comparable with studies conducted at similar franchises.

3.13.3 Required Traffic Signal Improvement(s)

Any traffic signal operational deficiencies that have been identified in the transportation impact study must be addressed and solutions provided that are feasible to implement.

3.13.4 Right-of-Way Requirements

The consultant is to identify property availability and requirements to implement improvements.

3.13.5 Preliminary Cost Estimate

A preliminary cost estimate must be provided for all identified infrastructure and traffic control signal improvements.

4.0 CONCLUSIONS AND RECOMMENDATIONS

It is important to structure recommendations for improvements within appropriate time perspectives. Recommendations should be sensitive to the following issues:

- Timing of short-range and long-range network improvements that are already planned and scheduled
- Anticipated time schedule of adjacent developments
- Size and timing of individual phases of the proposed development
- Logical sequencing of various improvements or segments
- Right-of-way requirements and the availability of additional right-of-way within the appropriate time frames
- Local priorities for transportation improvements and funding
- Cost-effectiveness of implementing improvements at a given stage of development
- Necessary lead-time for additional design and construction

Since improvements can often be implemented in more than one order, the recommendation should address an implementation sequence that would provide maximum compatibility with the overall roadway system configuration network effectiveness.

5.0 DOCUMENTATION AND REPORTING

The structure and format of the transportation impact study should follow the guidelines outlined in this document, as applicable. The following is a suggested study structure:

- Executive summary
- Development description with a suitable site plan
- Study area map identifying the study area and site
- Existing traffic conditions in the study area
- Anticipated nearby developments (tabular summaries)
- Identification of all assumptions
  - Analysis period
  - Trip generation rates for each land use
  - Trip distribution
  - Synergy trips
  - Trip assignment
  - Modal split
- Existing traffic demand (exhibit required)
- Site generated traffic assignment (exhibit required)
- Traffic demand (future background without development, exhibit required)
- Total traffic demand (future total background with development, exhibit required)
- Improvement alternatives required to mitigate transportation impacts off-site and on-site
- Transportation impacts for future background and total traffic with and without mitigation measures (tabular summaries)
- Access considerations including visibility requirements
- Safety considerations including collision summaries (collision diagrams, tabular summary)
- Parking considerations including disabled parking and high occupancy provisions
- On-site circulation for high occupancy vehicles, delivery vehicles, refuse pickup
- Summary of findings
- Property assessment
- Preliminary cost estimates
- Conclusions and recommendations

This format will facilitate review, discussion and communication. Relevant maps, graphs and tables should be placed adjacent to the relevant text.

The transportation impact study should consist of a main document, supplemented by technical appendices containing detailed analyses as required. A site plan of a suitable scale (1:200 or 1:500 is preferred) complete with dimensions should also accompany the study documents.

A checklist is provided in Appendix I to identify all the requirements of the traffic impact study. This form is to be completed and submitted with the document.

Five (5) copies of the final transportation impact study complete with supporting documentation must be submitted to City staff (2 - Planning & Development, 2 - Traffic & Parking Services, 1 - Municipal Works - Engineering) for review. All electronic Synchro and SimTraffic files must be provided on one (1) compact disc upon the submission of the reports. The files shall be named appropriately to easily identify their targeted analysis period.

All information submitted to City staff in connection with any transportation impact study will be considered to be in the public domain.

6.0 BIBLIOGRAPHY

Guidelines for the Preparation of Traffic Impact Studies - Regional Municipality of Halton, August 2001

Guidelines for the Preparation of Transportation Impact Studies - Metro Planning, September 1996

Guidelines for the Evaluation of Traffic Impact Studies for Development Proposals/Applications, Region of Peel

Site Impact Analysis Requirements Manual - Ministry of Transportation and Highways, British Columbia, January 1997

Traffic Access and Impact Studies for Site Development, A Recommended Practice, Institute of Transportation Engineers, 1991

APPENDIX A

Traffic Information Request Form

TRAFFIC INFORMATION REQUEST FORM

Date: _____

Firm: _____

Contact Person: _____

Address: _____

Telephone: _____ Facsimile: _____

E-mail Address: _____

Purpose of Information: _____

Description *	Qty.	Price	Total
• Eight (8) hour intersection traffic count per location	_____	* $200.00 =	_____
• Twenty-four (24) hour automated traffic count (ATR) per location	_____	* $75.00 =	_____
• Manual radar spot speed study per location	_____	* $50.00 =	_____
• Twenty-four (24) hour automated speed study (ATR) per location	_____	* $100.00 =	_____
• Twenty-four (24) hour automated classification count (ATR) per location	_____	* $100.00 =	_____
• Motor vehicle collision summary report & diagram per location	_____	* $50.00 =	_____
Time Period: _____ to _____			
• Traffic signal timing plan summary per location	_____	* $50.00 =	_____
• Lane configuration drawing per location	_____	* $50.00 =	_____

*** Only if information is available**

SUBTOTAL = _____

HST (13%) = _____

TOTAL = _____

Please specify requested locations on separate sheet

THIS IS NOT AN INVOICE. For Information Purposes Only

You will be invoiced for this data from our Finance Department

APPENDIX B

Driveway Design

Refer to Chapter 3.2 of the

Geometric Design Guide for Canadian Roads

Transportation Association of Canada

September 1999

or as amended

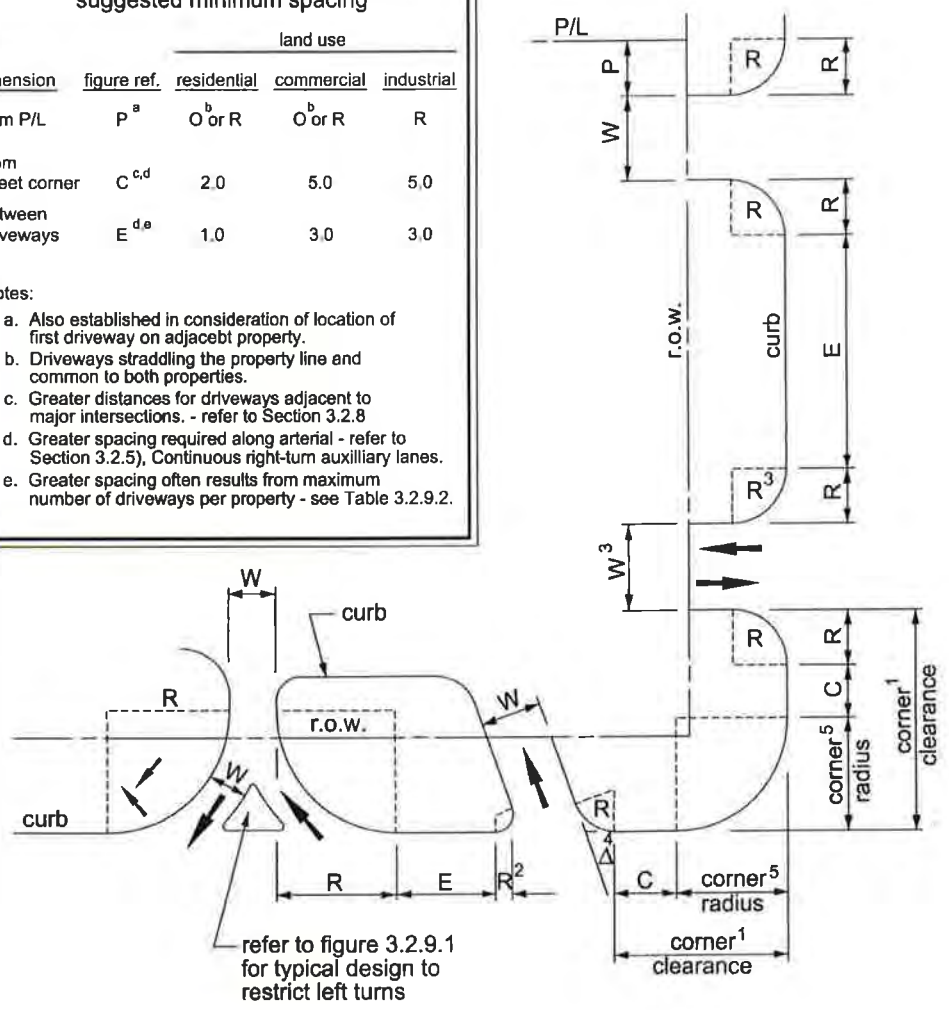
Figure 3.2.9.3 Driveway Spacing Guidelines - Locals and Collectors

suggested minimum spacing

dimension	figure ref.	land use: residential	commercial	industrial
from P/L	P [a]	O [b] or R	O [b] or R	R
from street corner	C [c,d]	2.0	5.0	5.0
between driveways	E [d,e]	1.0	3.0	3.0

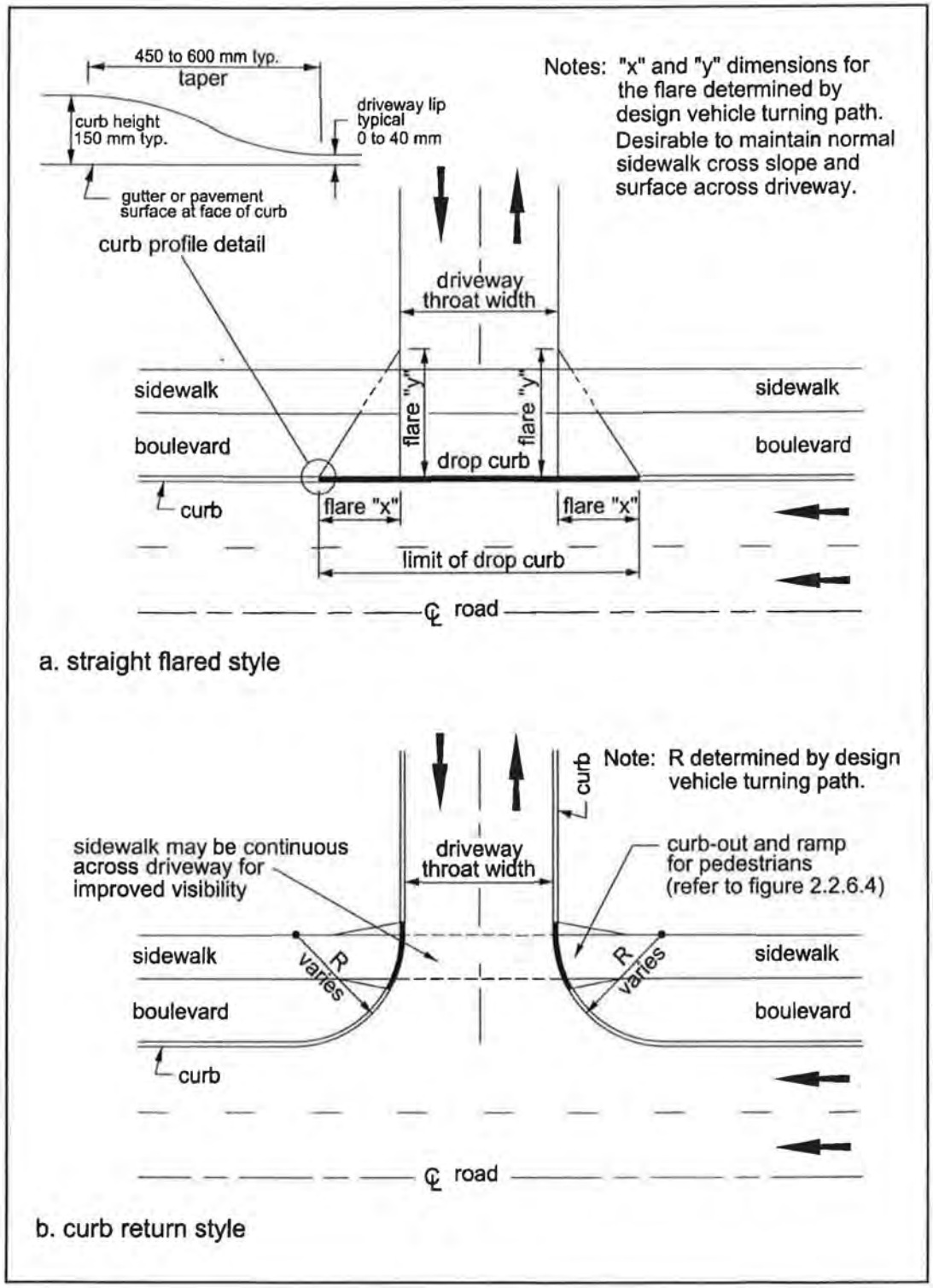
Notes:

a. Also established in consideration of location of first driveway on adjacebt property.
b. Driveways straddling the property line and common to both properties.
c. Greater distances for driveways adjacent to major intersections. - refer to Section 3.2.8
d. Greater spacing required along arterial - refer to Section 3.2.5), Continuous right-turn auxilliary lanes.
e. Greater spacing often results from maximum number of driveways per property - see Table 3.2.9.2.



Notes:
1. For suggested minimum corner clearance at major intersections, see Figure 3.2.8.2
2. Where turns are not permitted, R=1.5 m assists in discouraging wrong-way movements.
3. For typical R and W dimensions, refer to Table 3.2.9.1
4. Minimum angle of 70° desirable where pedestrians routinely cross driveway, 45° minimum otherwise.

Figure 3.2.9.2 Driveway Types



APPENDIX C

Left Turn Storage Lanes for Two Lane Highways

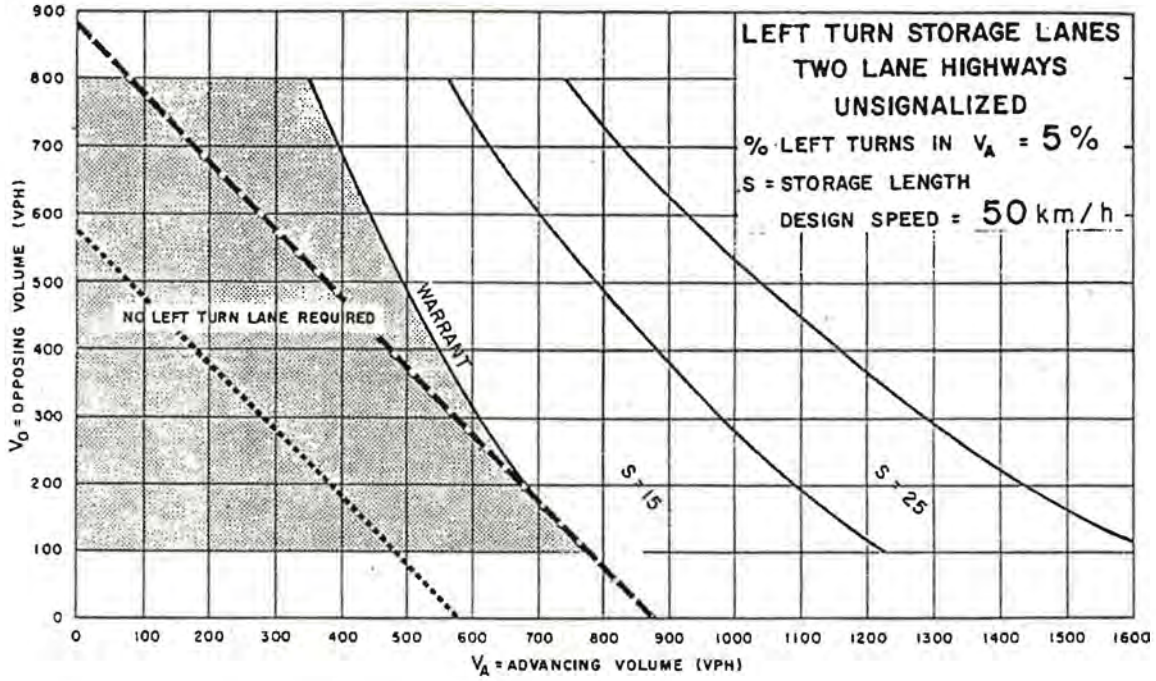
Refer to Figures EA-2 through EC-1 of the

Geometric Design Standards for Ontario Highways

Ministry of Transportation

1985

or as amended



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

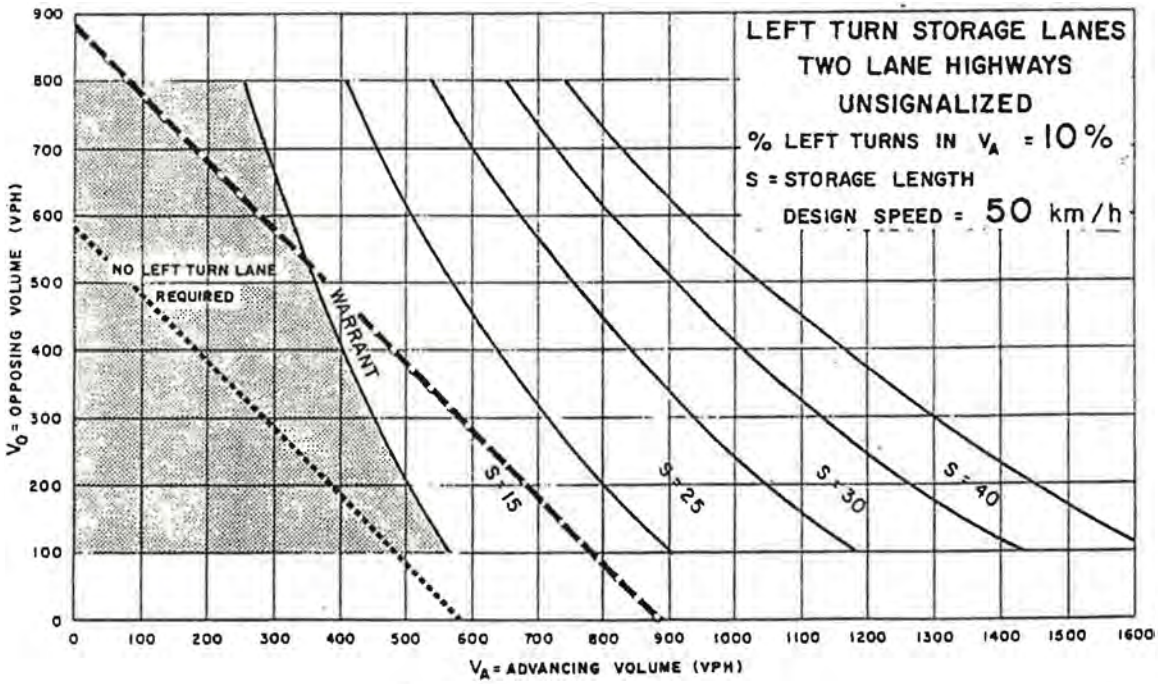
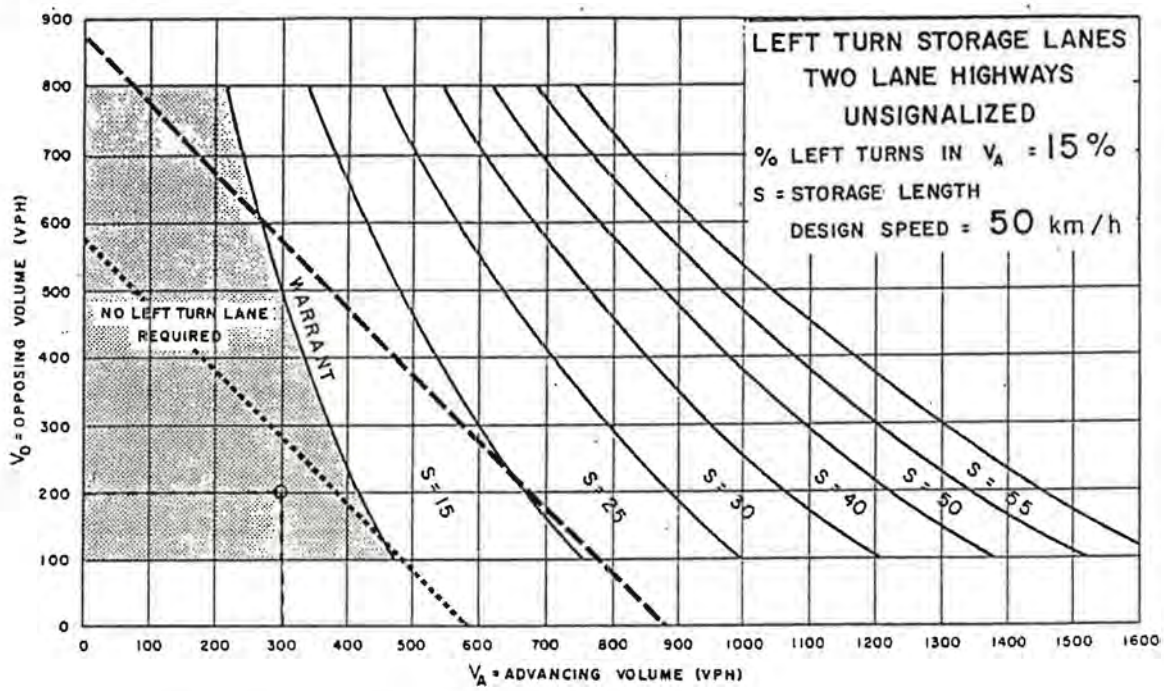


Figure EA-2



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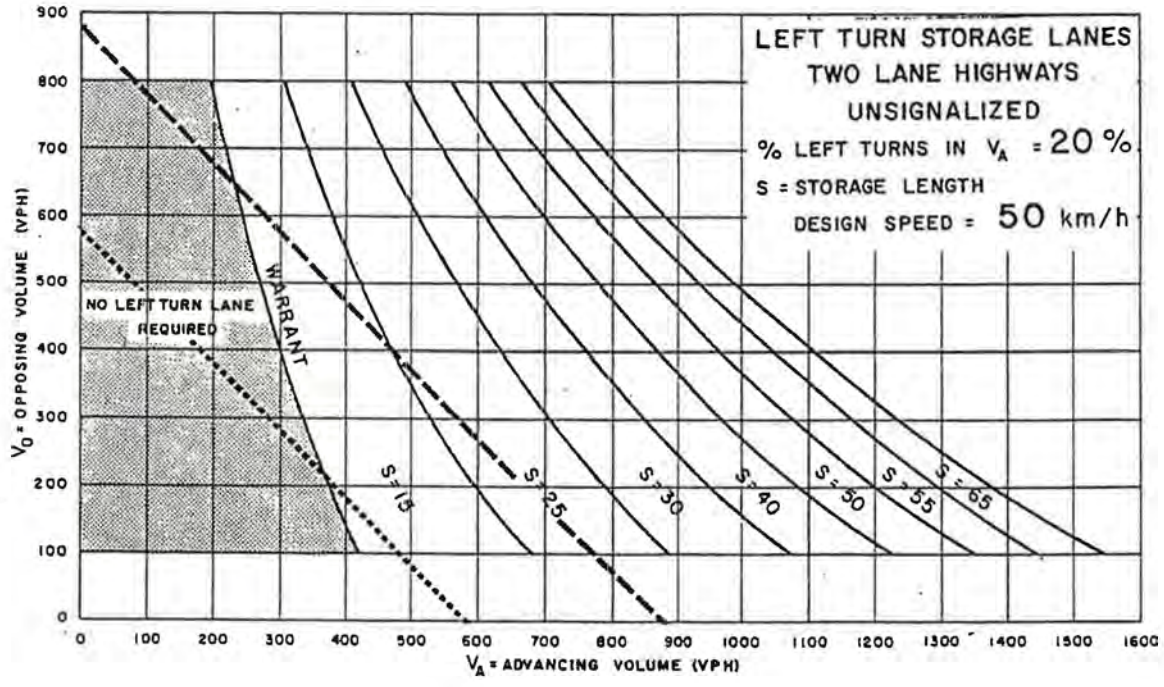
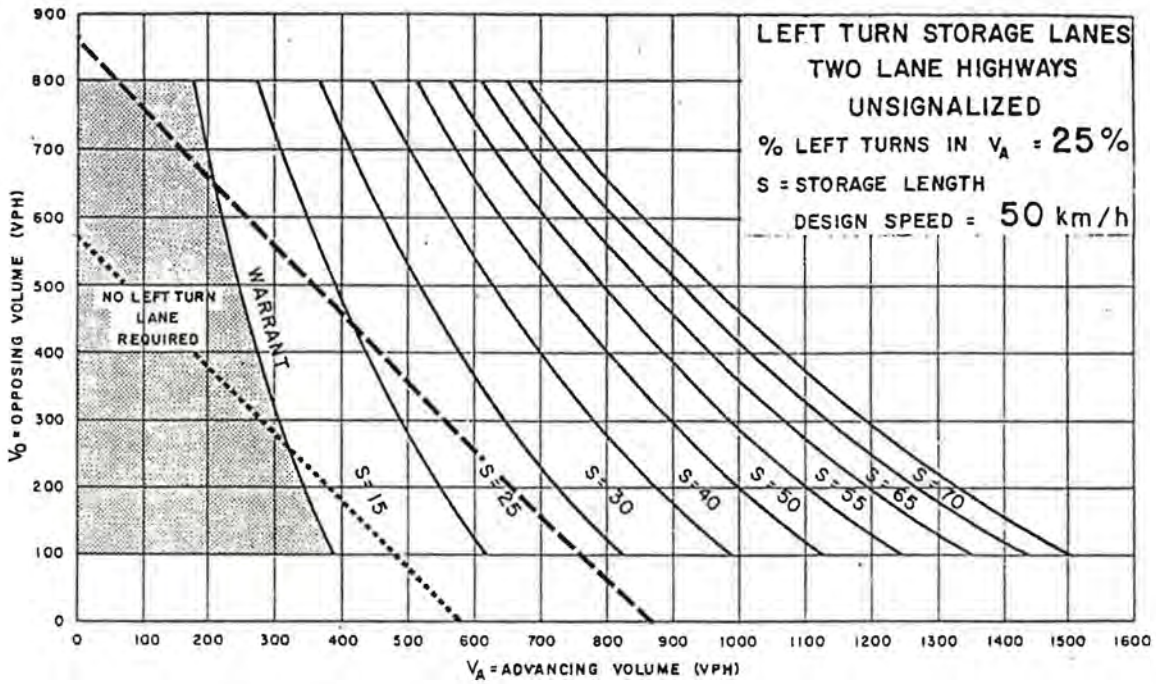


Figure EA-3



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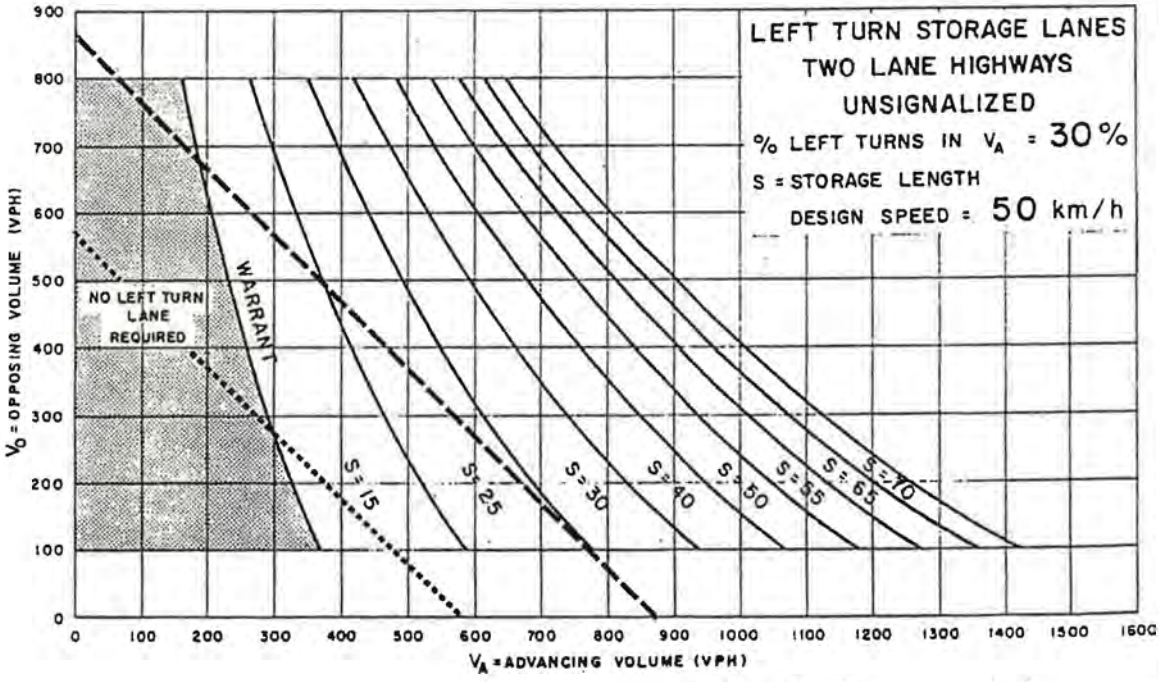
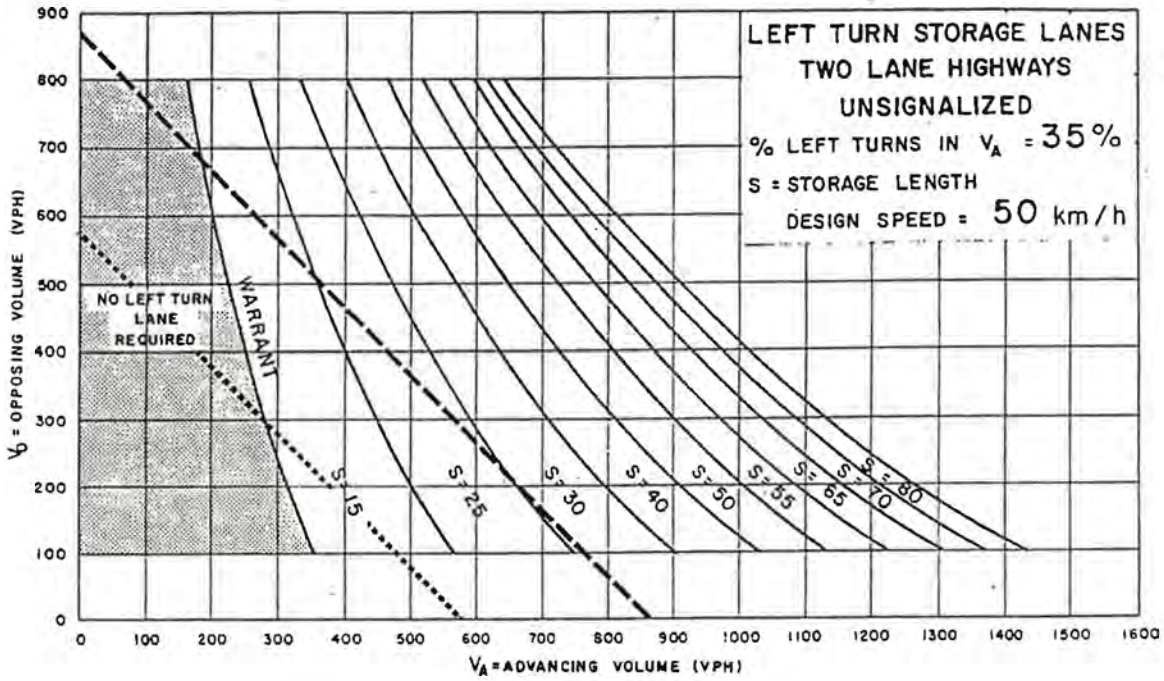


Figure EA-4



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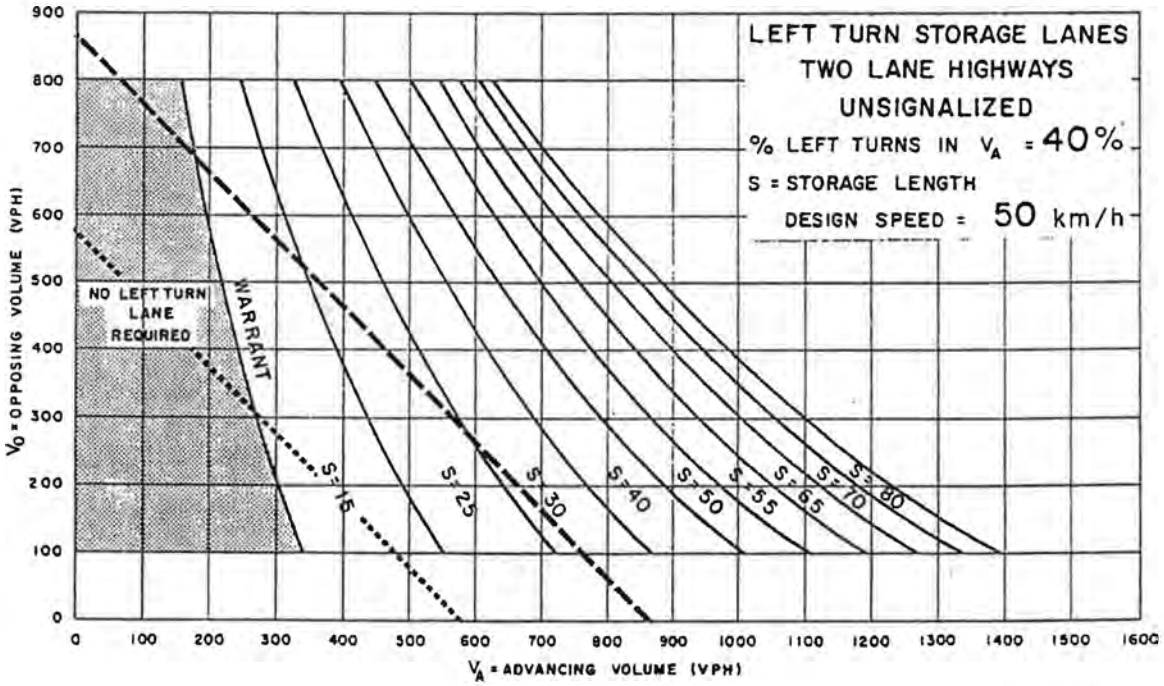
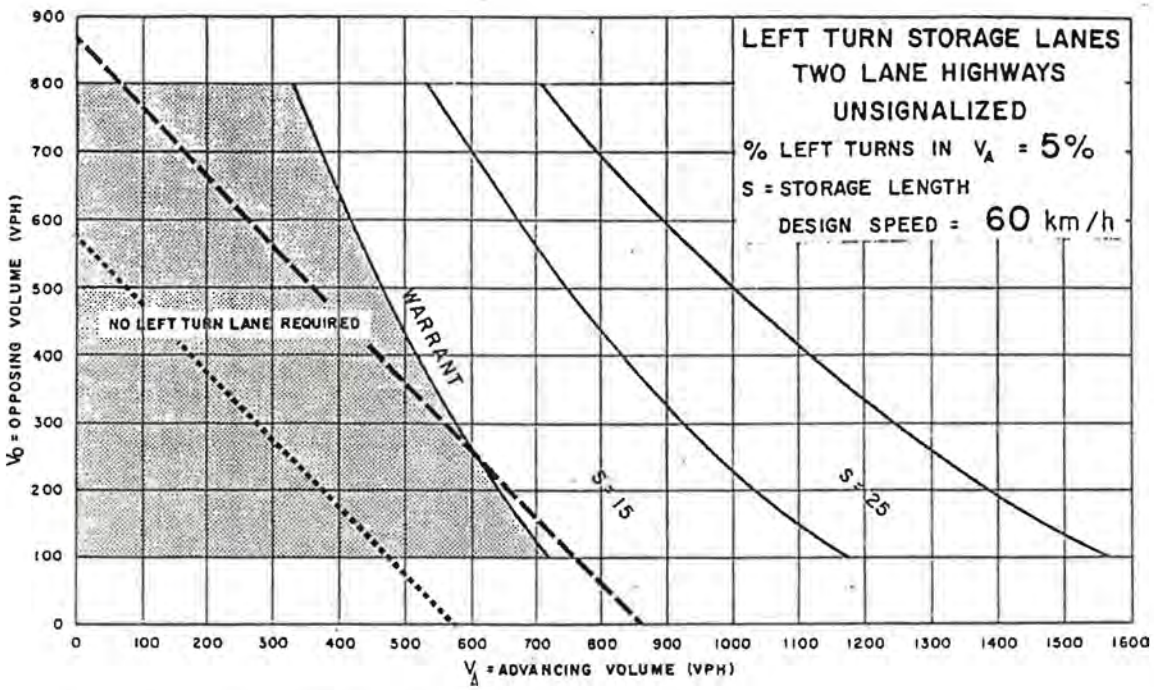


Figure EA-5



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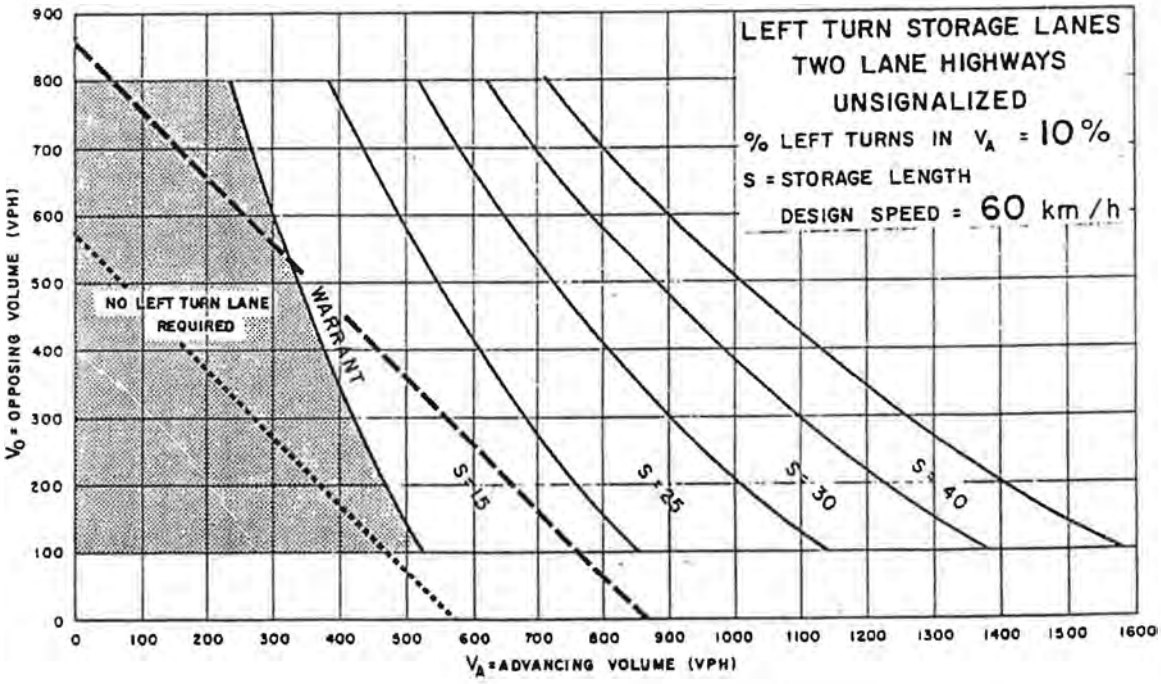
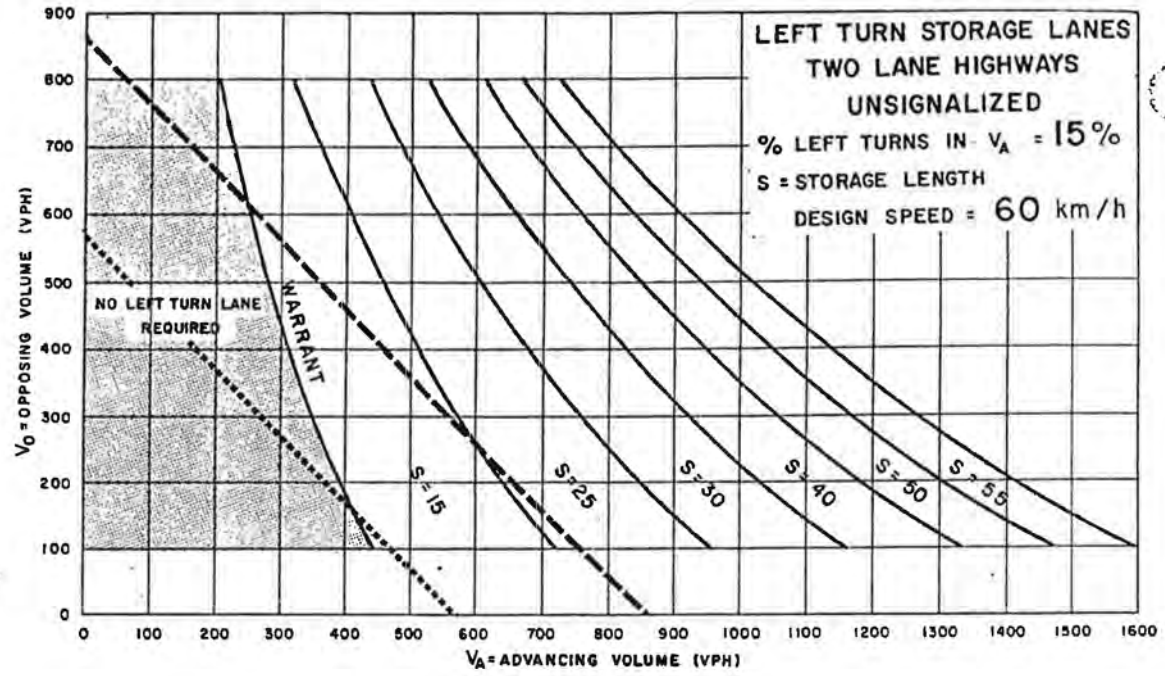


Figure EA-6



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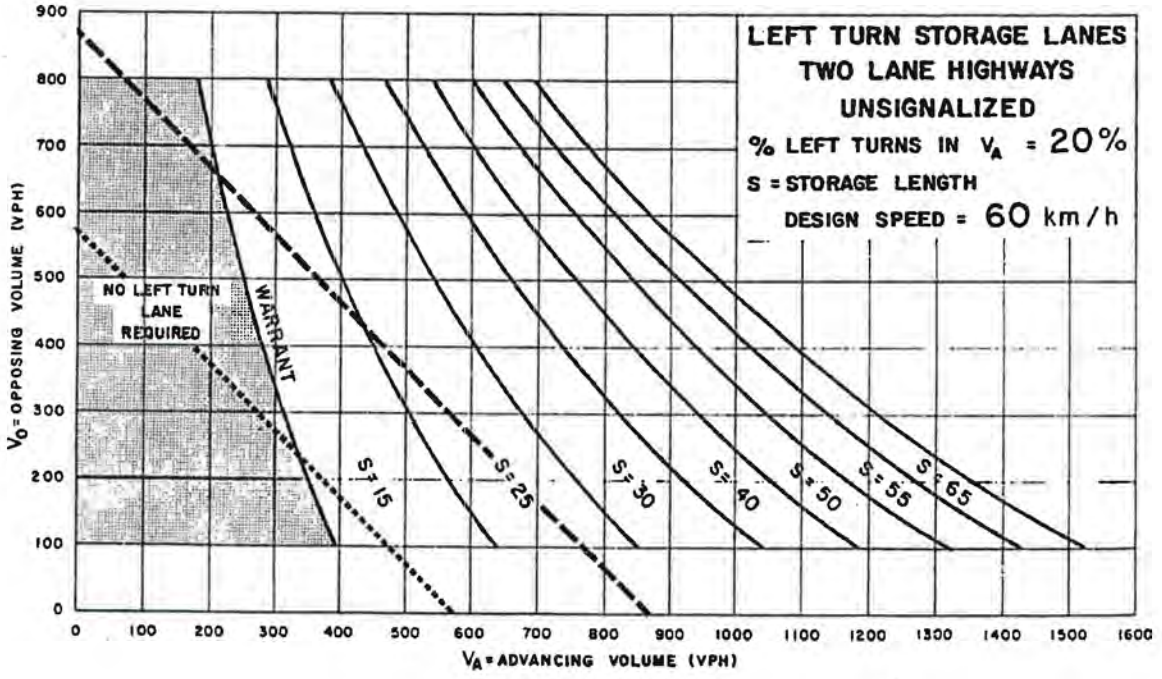
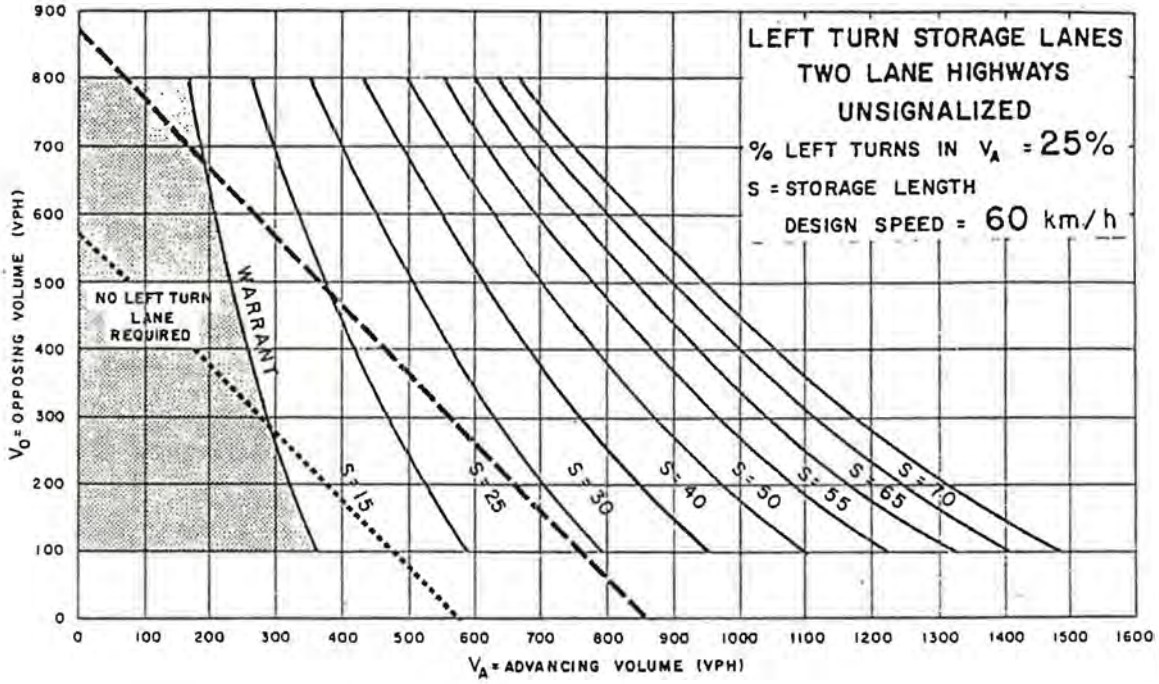


Figure EA-7



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

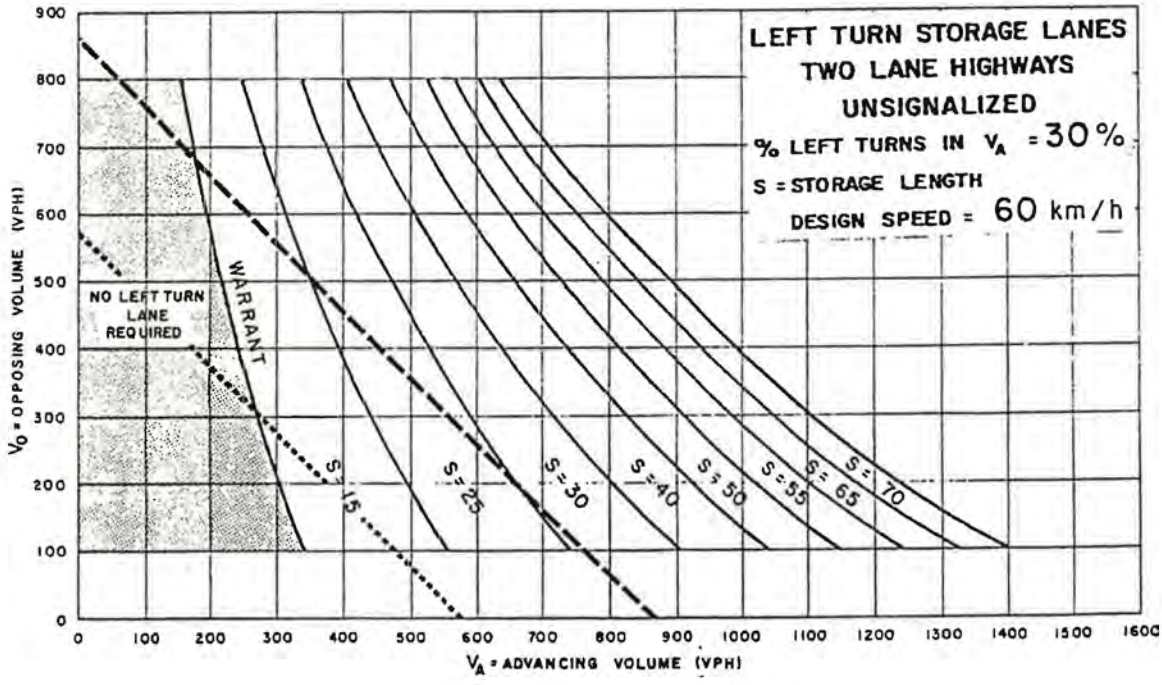
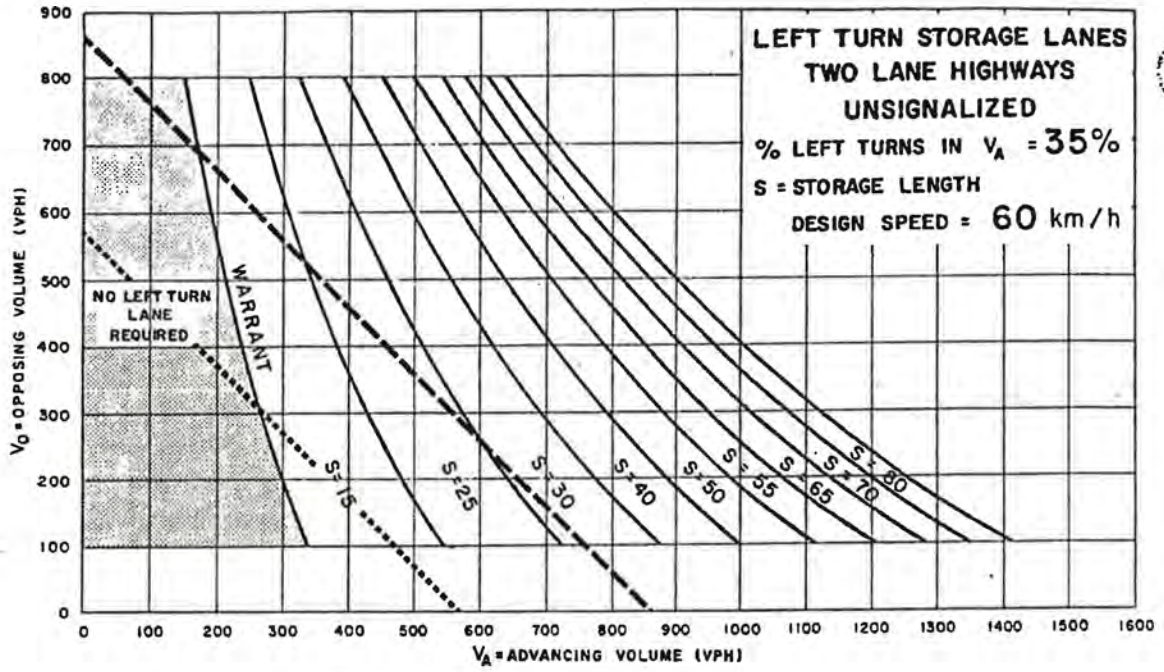


Figure EA-8



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

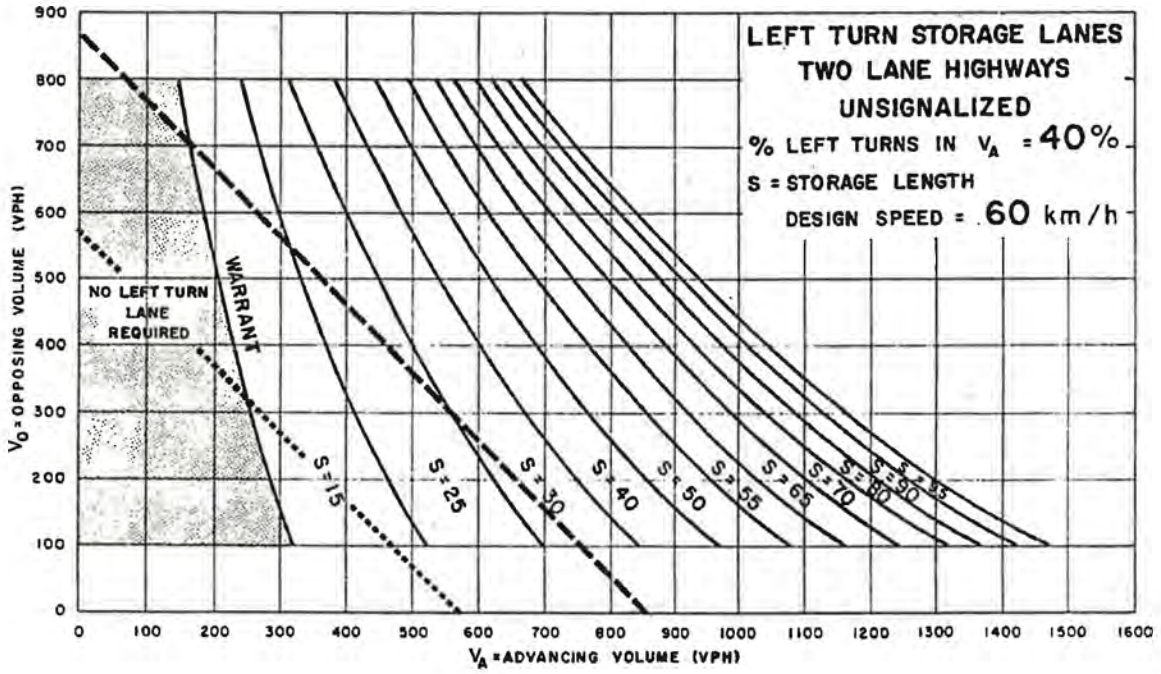
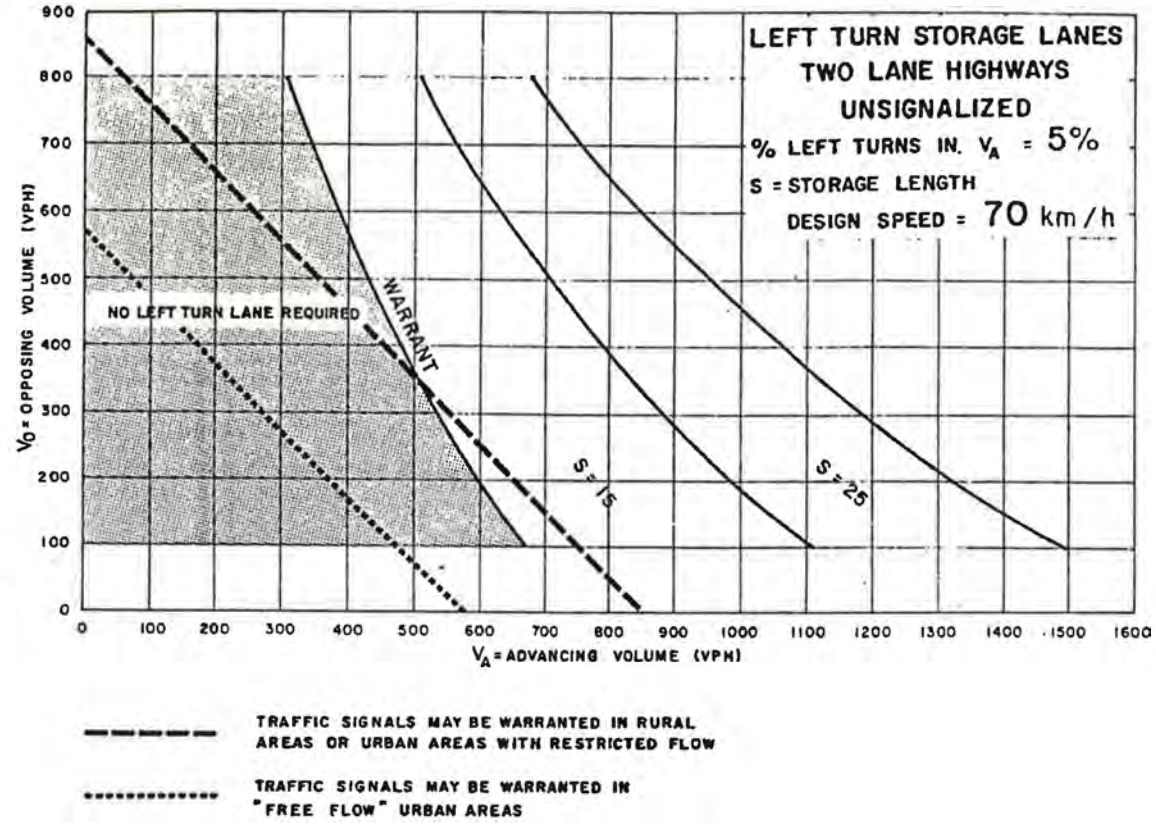


Figure EA-9


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 5%
S = STORAGE LENGTH
DESIGN SPEED = 70 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S=15
S=25
V_O = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
0 100 200 300 400 500 600 700 800 900
TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW
TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

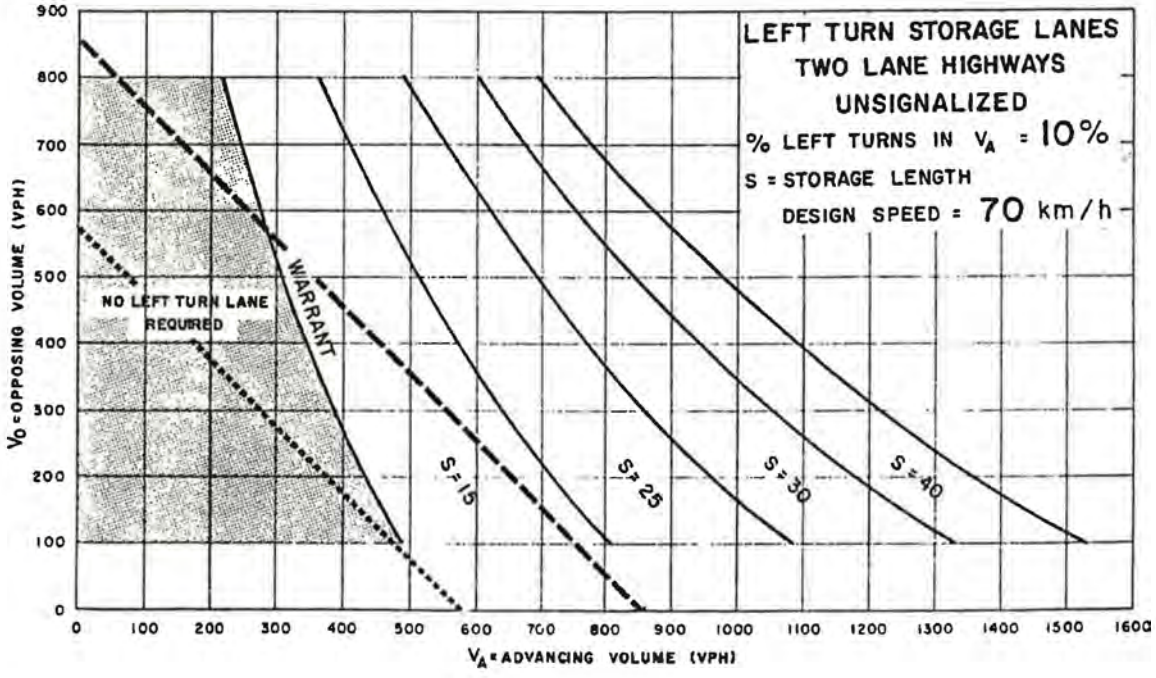
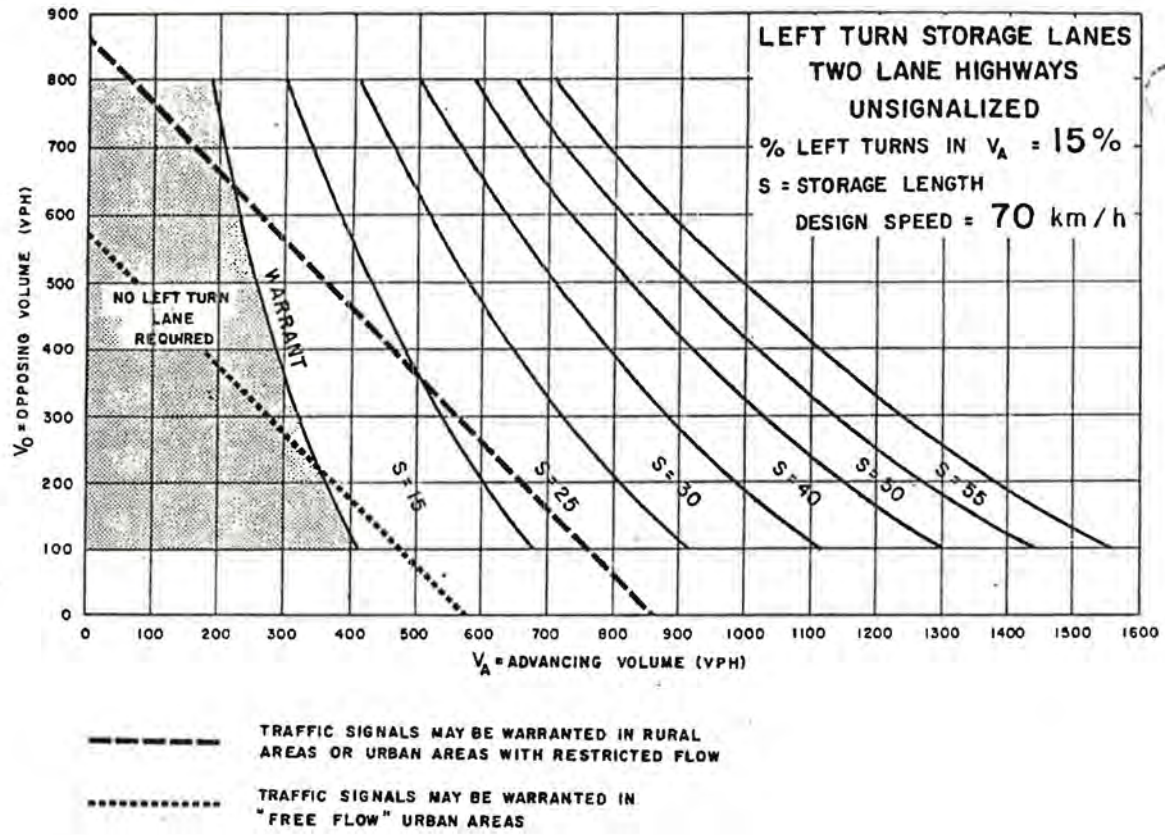

LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 10%
S = STORAGE LENGTH
DESIGN SPEED = 70 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S=15
S=25
S=30
S=40
V_O = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600

Figure EA-10



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

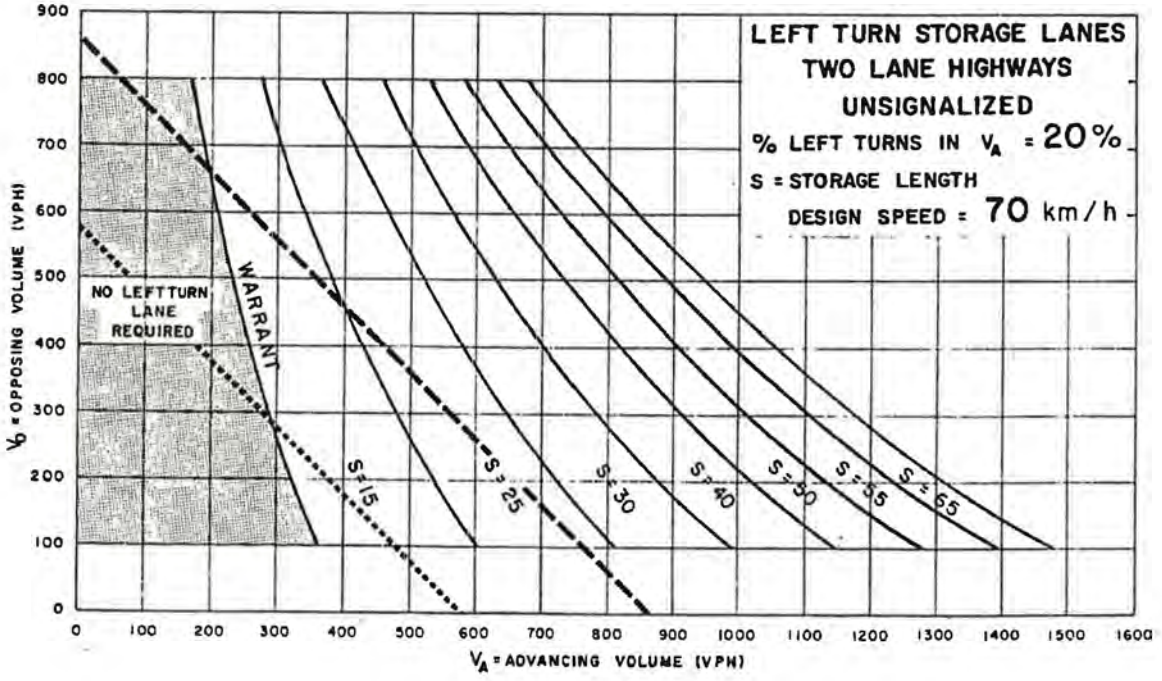
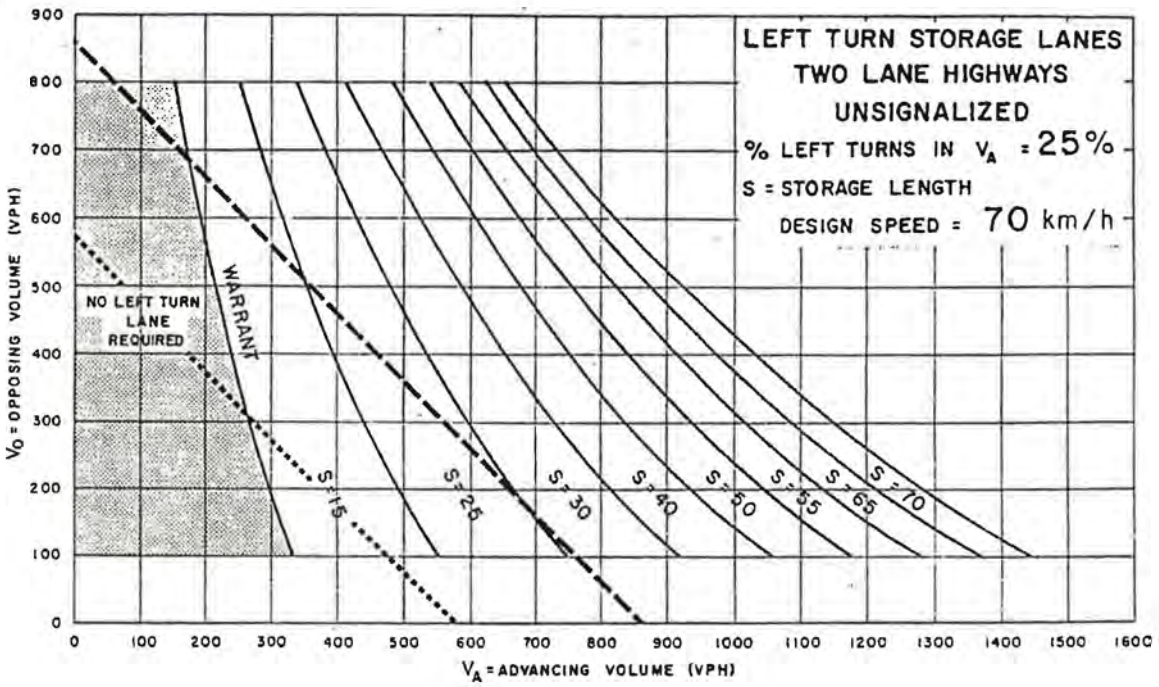


Figure EA-11



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

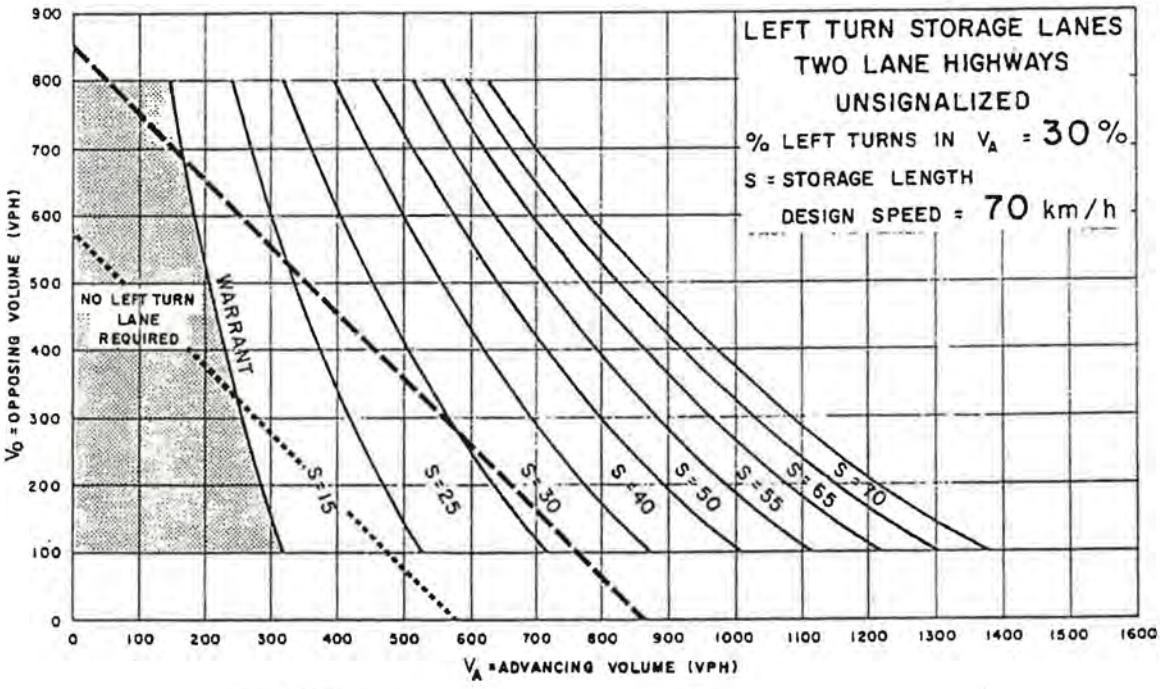
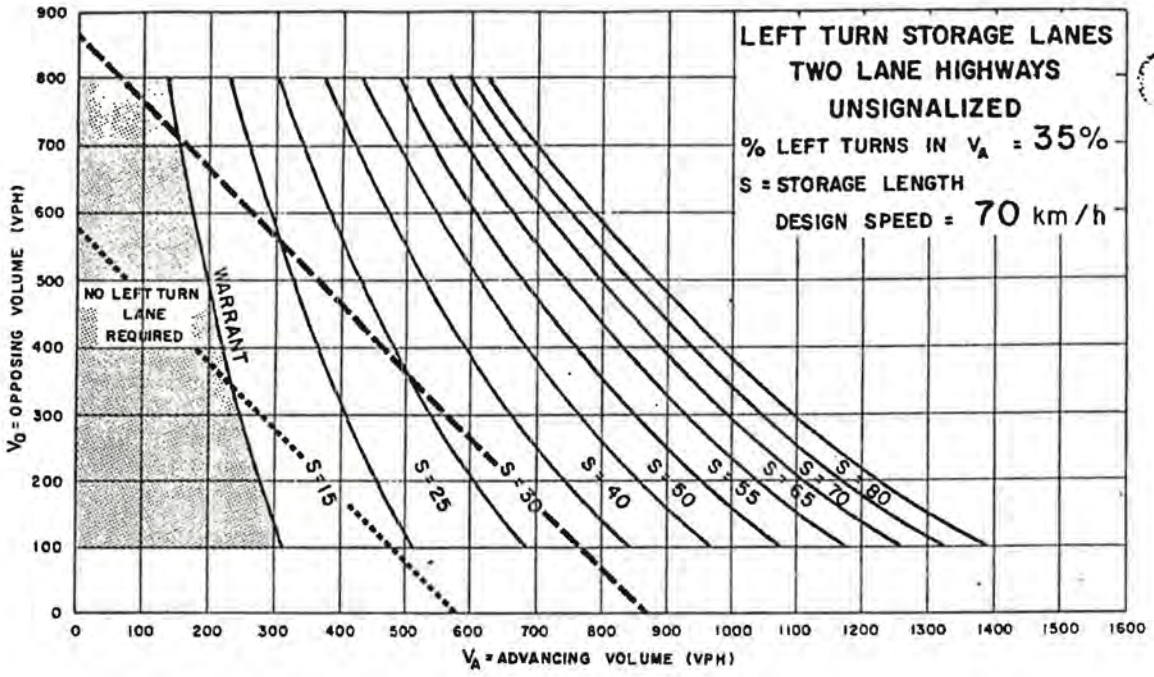


Figure EA-12



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

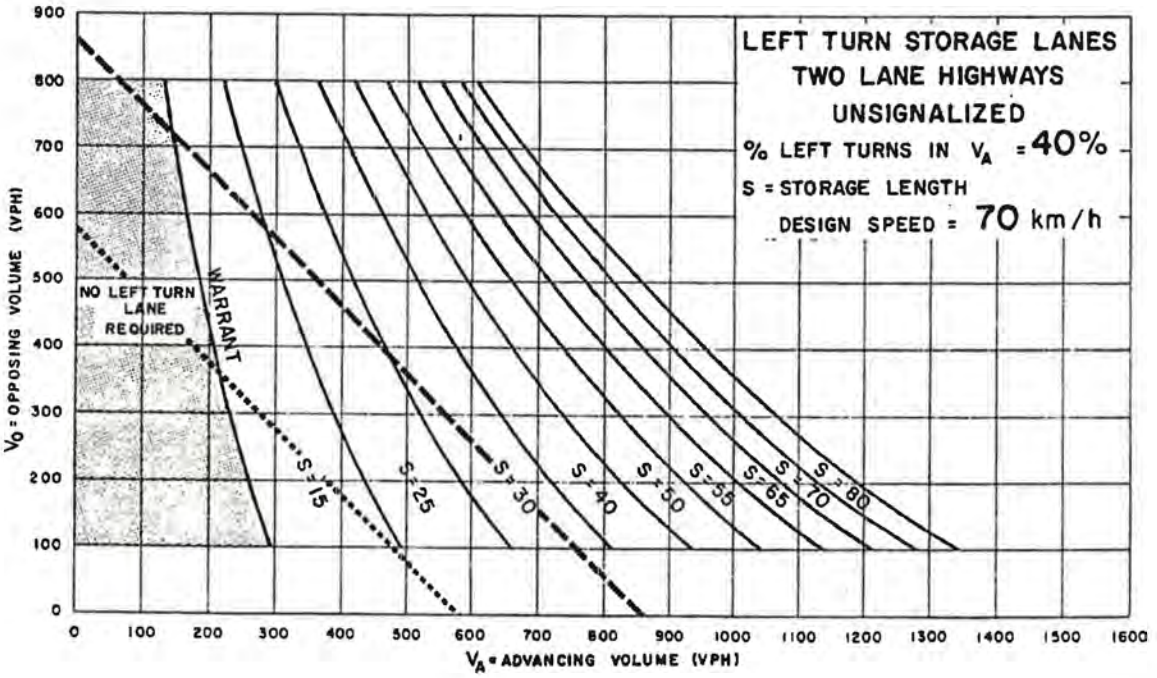
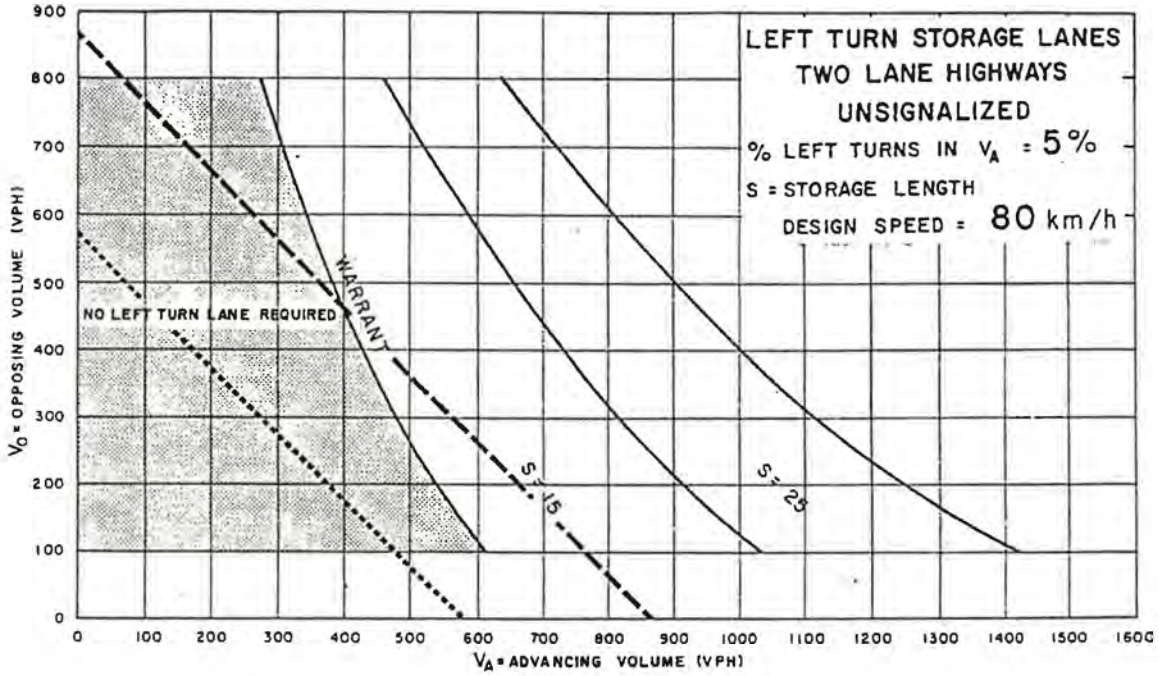


Figure EA-13



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

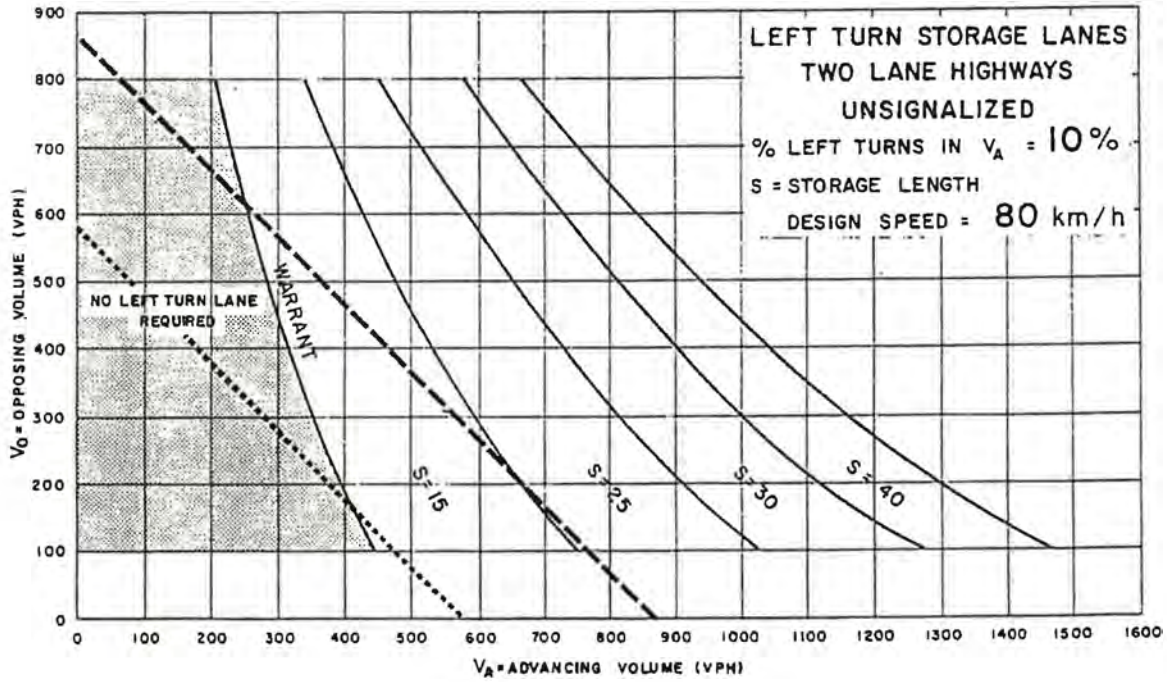
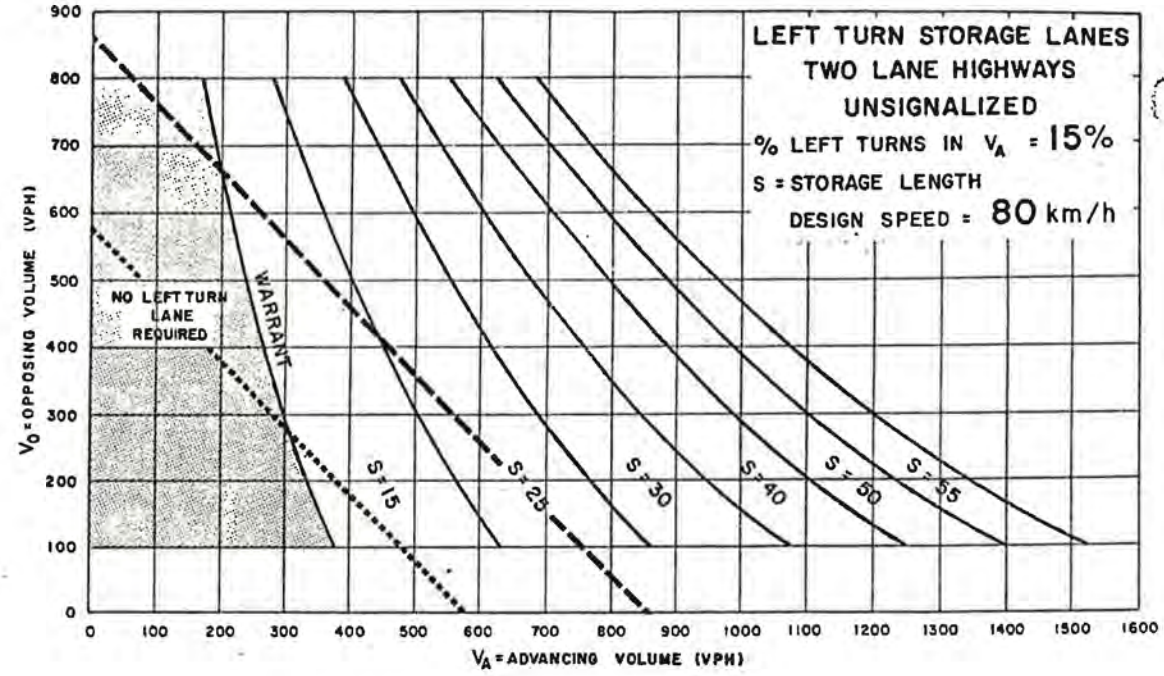


Figure EA-14



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

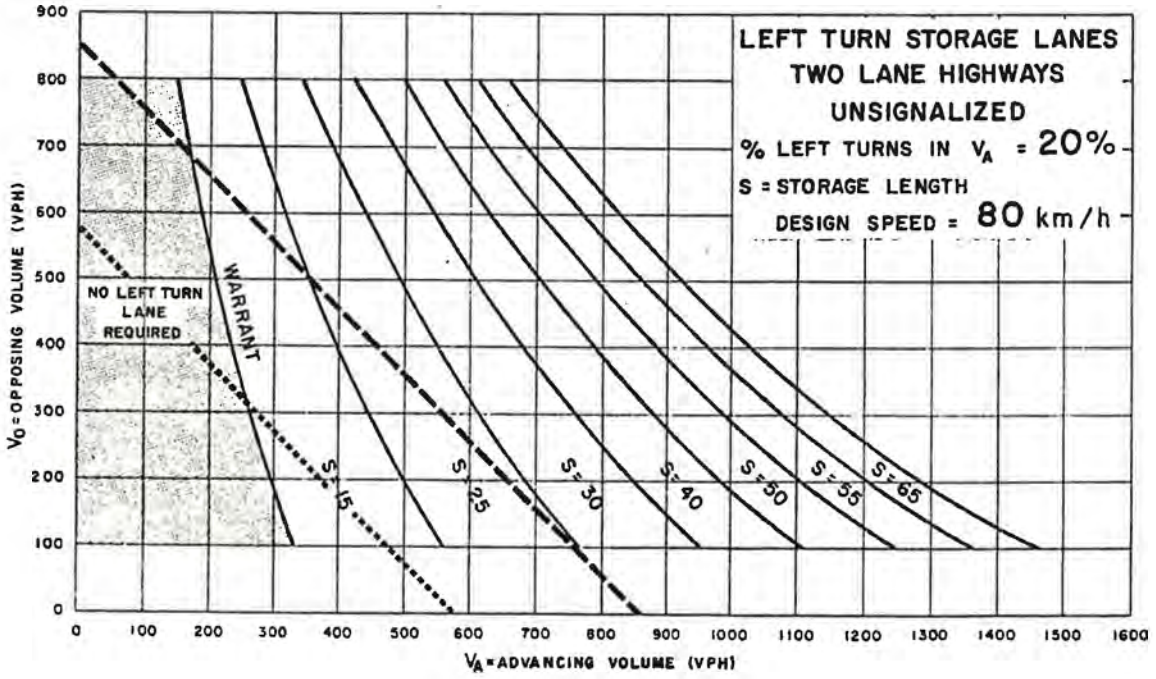
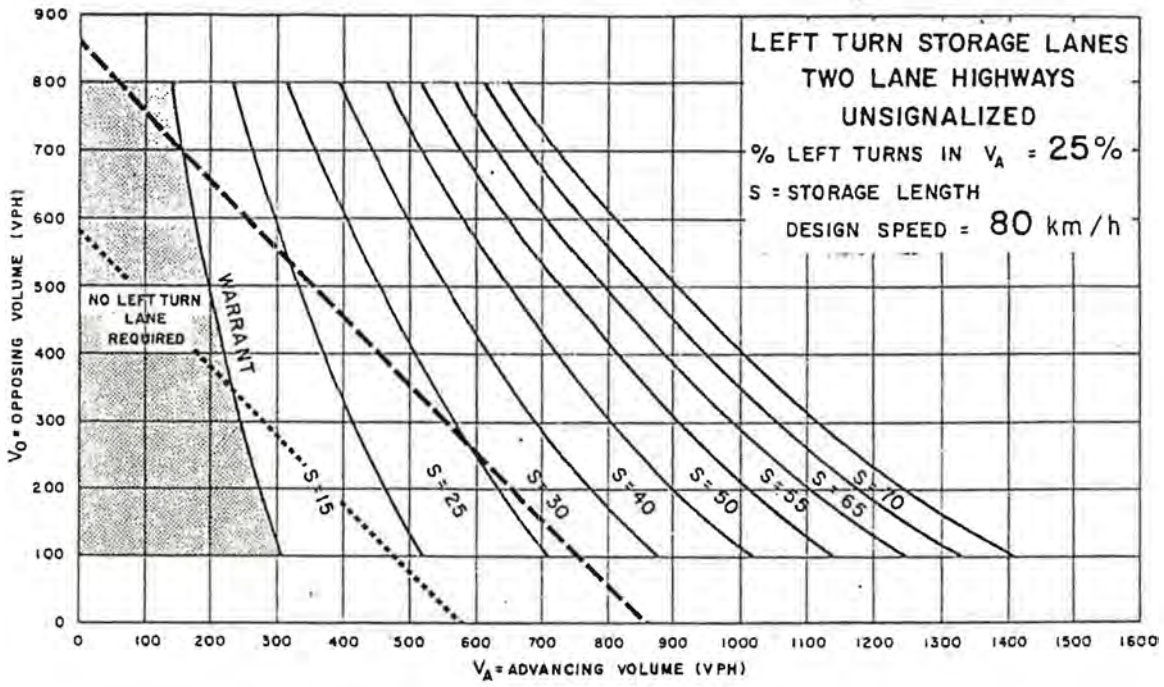


Figure EA-15



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

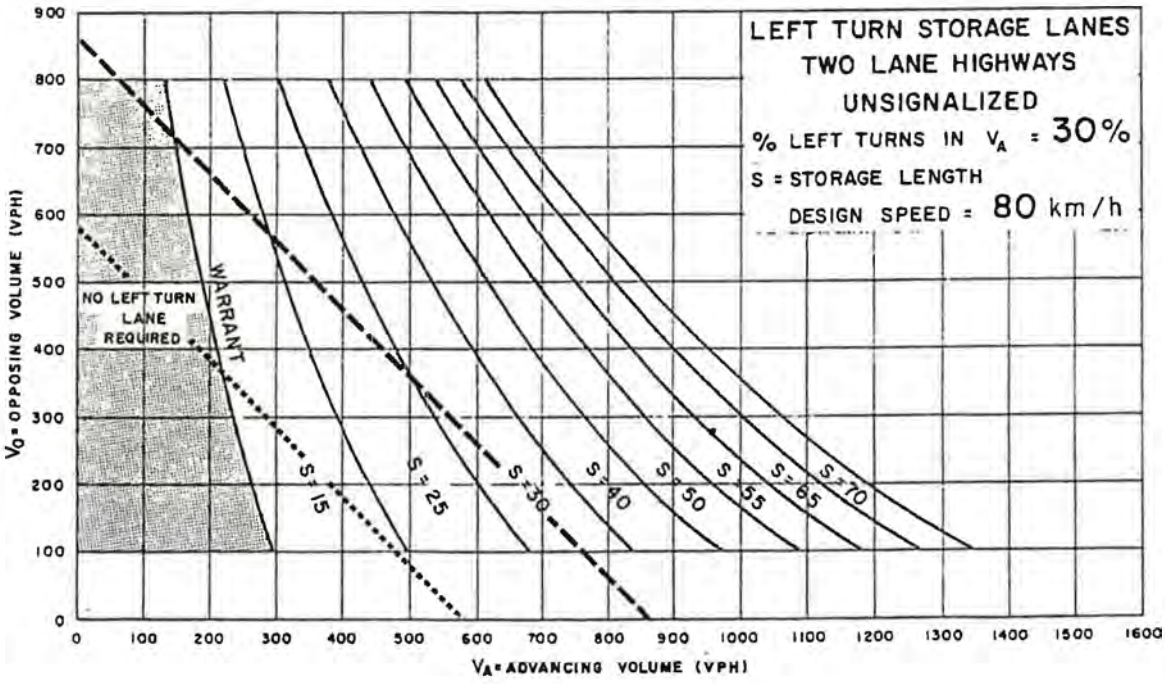
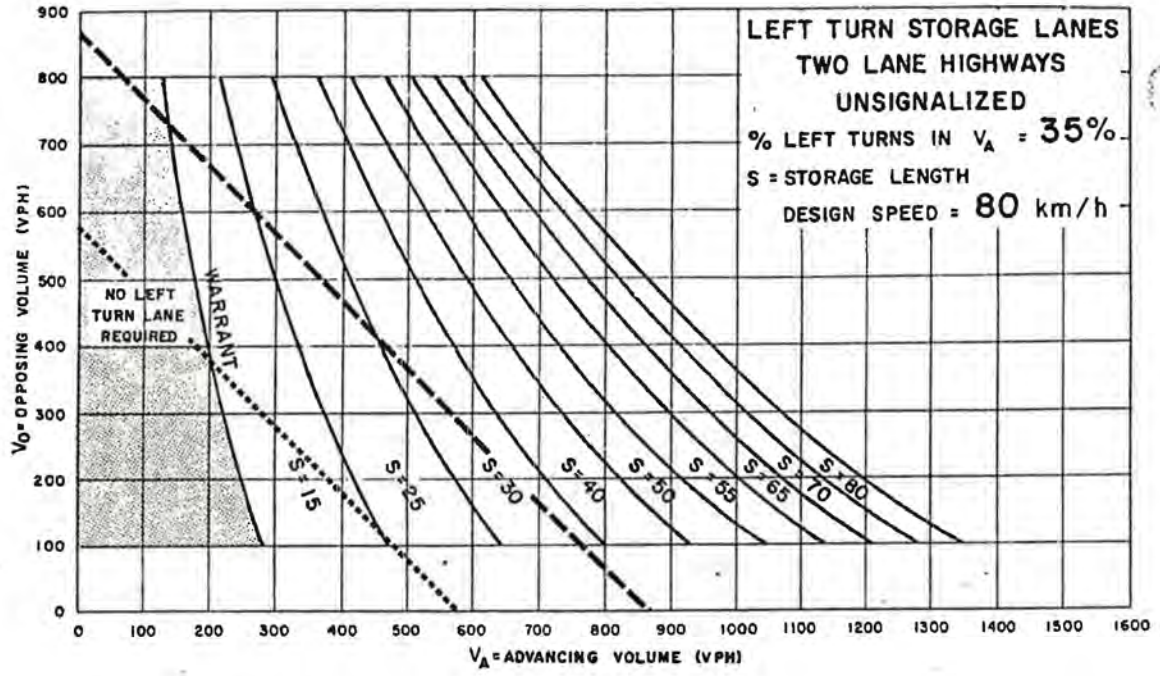


Figure EA-16



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

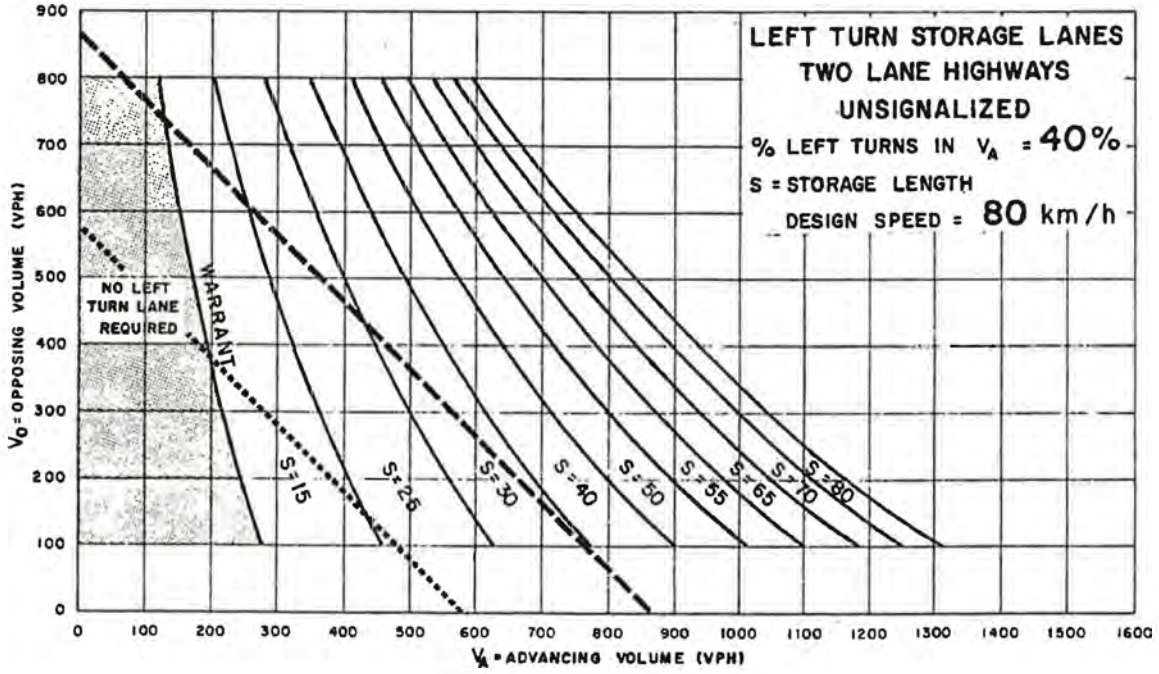
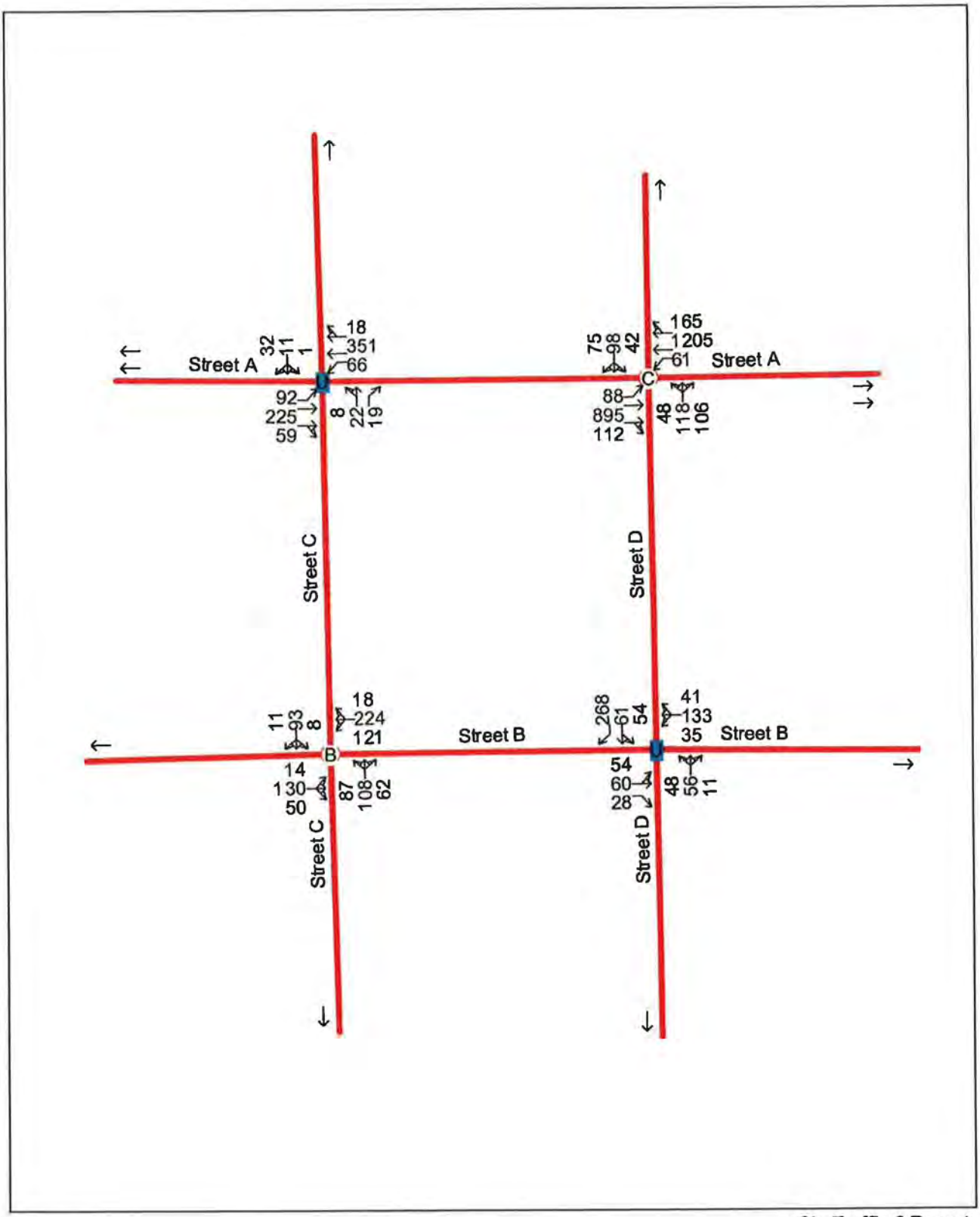


Figure EA-17

APPENDIX D

Synchro Base Map Sample Printout


Street A
Street A
Street B
Street B
Street C
Street C
Street D
Street D
B
C
32 11 1
18 351 66
92 225 59
8 22 19
75 98 42
165 1205 61
88 895 112
48 118 106
11 93 8
18 224 121
14 130 50
87 108 62
268 61 54
41 133 35
54 60 28
48 56 11

APPENDIX E

Synchro Signalized Intersection Sample Printout

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Storage Length (m)	45.0		0.0	45.0		0.0	0.0		15.0	0.0		0.0
Storage Lanes	1		0	1		0	0		0	0		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor		0.93		0.91	0.93			0.89			0.89	
Frt		0.983			0.982			0.947			0.953	
Flt Protected	0.950			0.950				0.991			0.990	
Satd. Flow (prot)	1612	2962	0	1612	2959	0	0	1446	0	0	1454	0
Flt Permitted	0.106			0.205				0.901			0.866	
Satd. Flow (perm)	180	2962	0	317	2959	0	0	1285	0	0	1249	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		28			31			22			16	
Headway Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		173.2			121.9			195.3			107.1	
Travel Time (s)		13.0			9.1			14.6			8.0	
Volume (vph)	88	895	112	61	1205	165	48	118	106	42	98	75
Confl. Peds. (#/hr)	295		395	395		295	142		127	127		142
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	96	973	122	66	1310	179	52	128	115	46	107	82
Lane Group Flow (vph)	96	1095	0	66	1489	0	0	295	0	0	235	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Minimum Split (s)	25.5	25.5		25.5	25.5		22.2	22.2		21.5	21.5	
Total Split (s)	60.0	60.0	0.0	60.0	60.0	0.0	30.0	30.0	0.0	30.0	30.0	0.0
Total Split (%)	66.7%	66.7%	0.0%	66.7%	66.7%	0.0%	33.3%	33.3%	0.0%	33.3%	33.3%	0.0%
Maximum Green (s)	54.7	54.7		54.7	54.7		24.7	24.7		24.7	24.7	
Yellow Time (s)	3.3	3.3		3.3	3.3		3.3	3.3		3.3	3.3	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Walk Time (s)	8.0	8.0		8.0	8.0		6.0	6.0		6.0	6.0	
Flash Dont Walk (s)	12.0	12.0		12.0	12.0		9.0	9.0		9.0	9.0	
Pedestrian Calls (#/hr)	25	25		25	25		25	25		25	25	
Act Effct Green (s)	56.0	56.0		56.0	56.0			26.0			26.0	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.29			0.29	
v/c Ratio	0.86	0.59		0.34	0.80			0.76			0.63	
Control Delay	75.1	11.5		14.0	16.9			41.7			34.7	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	75.1	11.5		14.0	16.9			41.7			34.7	
LOS	E	B		B	B			D			C	
Approach Delay		16.6			16.8			41.7			34.7	
Approach LOS		B			B			D			C	
Queue Length 50th (m)	12.2	52.4		4.9	91.0			43.0			32.8	
Queue Length 95th (m)	#44.3	69.7		14.1	121.9			#82.2			57.7	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Internal **Link Dist** (m)		149.2			97.9			171.3			83.1	
Turn Bay Length (m)	45.0			45.0								
Base Capacity (vph)	**112**	**1854**		**197**	**1853**			**387**			**372**	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	**0**	**0**		**0**	**0**			**0**			**0**	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	**0.86**	**0.59**		**0.34**	**0.80**			**0.76**			**0.63**	

Intersection Summary

Area Type: **Other**
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 75
Control Type: Pretimed
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 20.2 Intersection LOS: C
Intersection Capacity Utilization 82.4% **ICU Level of Service E**
Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Street A & Street D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	0.93		1.00	0.93			0.91			0.91	
Flpb, ped/bikes	1.00	1.00		0.91	1.00			0.98			0.98	
Frt	1.00	0.98		1.00	0.98			0.95			0.95	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.99	
Satd. Flow (prot)	1612	2963		1469	2959			1414			1428	
Flt Permitted	0.11	1.00		0.20	1.00			0.90			0.87	
Satd. Flow (perm)	179	2963		317	2959			1285			1248	
Volume (vph)	88	895	112	61	1205	165	48	118	106	42	98	75
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	96	973	122	66	1310	179	52	128	115	46	107	82
RTOR Reduction (vph)	0	11	0	0	12	0	0	16	0	0	11	0
Lane Group Flow (vph)	96	1084	0	66	1477	0	0	279	0	0	224	0
Confl. Peds. (#/hr)	295		395	395		295	142		127	127		142
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	54.7	54.7		54.7	54.7			24.7			24.7	
Effective Green, g (s)	56.0	56.0		56.0	56.0			26.0			26.0	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.29			0.29	
Clearance Time (s)	5.3	5.3		5.3	5.3			5.3			5.3	
Lane Grp Cap (vph)	111	1844		197	1841			371			361	
v/s Ratio Prot		0.37			0.50							
v/s Ratio Perm	c0.53			0.21				c0.22			0.18	
v/c Ratio	0.86	0.59		0.34	0.80			0.75			0.62	
Uniform Delay, d1	13.9	10.1		8.1	12.8			29.1			27.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	54.7	1.4		4.5	3.8			13.2			7.8	
Delay (s)	68.6	11.5		12.6	16.6			42.3			35.5	
Level of Service	E	B		B	B			D			D	
Approach Delay (s)		16.1			16.5			42.3			35.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	20.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX F

Synchro Unsignalized Intersection Sample Printout

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Storage Length (m)	45.0		0.0	45.0		0.0	0.0		15.0	0.0		0.0
Storage Lanes	1		0	1		0	0		1	0		0
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.969			0.993				0.850		0.902	
Flt Protected	0.950			0.950				0.987			0.999	
Satd. Flow (prot)	1612	3124	0	1612	3201	0	0	1675	1442	0	1529	0
Flt Permitted	0.950			0.950				0.987			0.999	
Satd. Flow (perm)	1612	3124	0	1612	3201	0	0	1675	1442	0	1529	0
Headway Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Link Speed (k/h)		48			48			48			48	
Link Distance (m)		108.9			173.2			196.1			130.0	
Travel Time (s)		8.2			13.0			14.7			9.8	
Volume (vph)	92	225	59	66	351	18	8	22	19	1	11	32
Confl. Peds. (#/hr)	150		200	200		150						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	100	245	64	72	382	20	9	24	21	1	12	35
Lane Group Flow (vph)	100	309	0	72	402	0	0	33	21	0	48	0
Sign Control		Free			Free			Stop			Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	35.1%	**ICU Level of Service**	A
Analysis Period (min)	15		

7: Street A & Street C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		**Free**			**Free**			**Stop**			**Stop**	
Grade		0%			0%			0%			0%	
Volume (veh/h)	**92**	**225**	**59**	**66**	**351**	**18**	**8**	**22**	**19**	**1**	**11**	**32**
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	**100**	**245**	**64**	**72**	**382**	**20**	**9**	**24**	**21**	**1**	**12**	**35**
Pedestrians								200			150	
Lane Width (m)								**3.5**			**3.5**	
Walking Speed (m/s)								1.2			1.2	
Percent Blockage								**16**			**12**	
Right turn flare (veh)									2			
Median type								**None**			**None**	
Median storage veh)												
Upstream signal (m)					**173**							
pX, platoon unblocked												
vC, conflicting volume	**551**			**509**			**1052**	**1371**	**354**	**1019**	**1393**	**351**
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	551			509			1052	1371	354	1019	1393	351
tC, single (s)	**4.1**			**4.1**			**7.5**	**6.5**	**6.9**	**7.5**	**6.5**	**6.9**
tC, 2 stage (s)												
tF (s)	**2.2**			**2.2**			**3.5**	**4.0**	**3.3**	**3.5**	**4.0**	**3.3**
p0 queue free %	89			92			90	73	96	99	86	94
cM capacity (veh/h)	**892**			**882**			**88**	**87**	**538**	**89**	**84**	**567**

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	**100**	**163**	**146**	**72**	**254**	**147**	**53**	**48**
Volume Left	100	0	0	72	0	0	9	1
Volume Right	**0**	**0**	**64**	**0**	**0**	**20**	**21**	**35**
cSH	892	1700	1700	882	1700	1700	143	222
Volume to Capacity	**0.11**	**0.10**	**0.09**	**0.08**	**0.15**	**0.09**	**0.37**	**0.22**
Queue Length 95th (m)	2.9	0.0	0.0	2.0	0.0	0.0	11.9	6.0
Control Delay (s)	**9.5**	**0.0**	**0.0**	**9.4**	**0.0**	**0.0**	**46.9**	**25.6**
Lane LOS	A			A			E	D
Approach Delay (s)	**2.3**			**1.4**			**46.9**	**25.6**
Approach LOS							E	D

Intersection Summary				
Average Delay	5.4			
Intersection Capacity Utilization	**35.1%**	**ICU Level of Service**	**A**	
Analysis Period (min)	15			

APPENDIX G

SimTraffic Sample Printout

Summary of All Intervals

Start Time	4:20
End Time	5:30
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intvls	1
Vehs Entered	3886
Vehs Exited	3867
Starting Vehs	44
Ending Vehs	63
Denied Entry Before	1
Denied Entry After	1
Travel Distance (km)	1182
Travel Time (hr)	54.8
Total Delay (hr)	24.9
Total Stops	3194
Fuel Used (l)	391.3

Interval #0 Information Seeding

Start Time	4:20
End Time	4:30
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	4:30
End Time	5:30
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	3886
Vehs Exited	3867
Starting Vehs	44
Ending Vehs	63
Denied Entry Before	1
Denied Entry After	1
Travel Distance (km)	1182
Travel Time (hr)	54.8
Total Delay (hr)	24.9
Total Stops	3194
Fuel Used (l)	391.3

3: Street B & Street D Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.2	0.8
Delay / Veh (s)	**3.9**	**1.4**	**2.5**	**2.3**	**1.2**	**0.8**	**8.2**	**10.5**	**3.8**	**11.8**	**12.0**	**11.0**
Travel Dist (km)	9.8	13.3	5.9	4.3	18.8	5.0	7.1	7.5	1.7	6.9	9.0	43.5
Travel Time (hr)	**0.3**	**0.4**	**0.2**	**0.1**	**0.5**	**0.2**	**0.3**	**0.3**	**0.1**	**0.3**	**0.4**	**2.1**
Avg Speed (kph)	31	37	31	31	36	31	23	22	26	23	23	22
Vehicles Entered	**58**	**108**	**35**	**33**	**143**	**38**	**50**	**53**	**12**	**41**	**54**	**265**
Vehicles Exited	57	107	35	32	143	38	52	53	12	40	56	264
Hourly Exit Rate	**57**	**107**	**35**	**32**	**143**	**38**	**52**	**53**	**12**	**40**	**56**	**264**

3: Street B & Street D Performance by movement

Movement	All
Total Delay (hr)	1.6
Delay / Veh (s)	**6.5**
Travel Dist (km)	132.8
Travel Time (hr)	**5.2**
Avg Speed (kph)	26
Vehicles Entered	**890**
Vehicles Exited	889
Hourly Exit Rate	**889**

4: Street A & Street D Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	1.1	2.7	0.3	0.6	4.6	0.6	0.7	2.5	2.0	0.6	1.5	1.0
Delay / Veh (s)	**53.7**	**11.3**	**9.2**	**34.4**	**13.6**	**12.8**	**72.3**	**69.6**	**66.2**	**48.5**	**57.5**	**43.5**
Travel Dist (km)	7.5	86.5	11.2	7.3	139.1	18.0	5.4	18.0	15.7	4.0	8.7	7.7
Travel Time (hr)	**1.3**	**5.0**	**0.7**	**0.8**	**8.3**	**1.2**	**0.9**	**2.9**	**2.5**	**0.7**	**1.7**	**1.3**
Avg Speed (kph)	6	18	18	10	17	16	6	6	6	6	5	6
Vehicles Entered	**76**	**866**	**116**	**64**	**1221**	**158**	**38**	**127**	**109**	**43**	**94**	**83**
Vehicles Exited	75	864	116	64	1219	158	37	128	108	41	91	81
Hourly Exit Rate	**75**	**864**	**116**	**64**	**1219**	**158**	**37**	**128**	**108**	**41**	**91**	**81**

4: Street A & Street D Performance by movement

Movement	All
Total Delay (hr)	18.2
Delay / Veh (s)	**21.9**
Travel Dist (km)	328.9
Travel Time (hr)	**27.2**
Avg Speed (kph)	12
Vehicles Entered	**2995**
Vehicles Exited	2982
Hourly Exit Rate	**2982**

7: Street A & Street C Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBT	SBR	All
Total Delay (hr)	0.2	0.0	0.0	0.1	0.5	0.0	0.0	0.1	0.1	0.0	0.0	1.2
Delay / Veh (s)	**7.9**	**0.7**	**0.9**	**5.3**	**1.5**	**1.5**	**17.6**	**5.1**	**9.8**	**15.0**	**4.9**	**2.3**
Travel Dist (km)	9.2	23.4	6.6	13.3	139.1	3.8	2.1	12.4	4.0	0.9	3.5	218.3
Travel Time (hr)	**0.5**	**0.7**	**0.2**	**0.4**	**3.6**	**0.1**	**0.1**	**0.4**	**0.2**	**0.1**	**0.2**	**6.4**
Avg Speed (kph)	25	37	28	30	39	35	21	30	24	16	23	35
Vehicles Entered	**92**	**233**	**65**	**78**	**1237**	**22**	**11**	**99**	**21**	**8**	**31**	**1897**
Vehicles Exited	92	231	64	78	1239	22	10	99	21	8	30	1894
Hourly Exit Rate	**92**	**231**	**64**	**78**	**1239**	**22**	**10**	**99**	**21**	**8**	**30**	**1894**

8: Street B & Street C Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.0	0.3	0.0	0.6	0.9	0.0	0.3	0.4	0.1	0.0	0.2	0.0
Delay / Veh (s)	**12.8**	**9.0**	**3.9**	**16.1**	**10.3**	**9.0**	**14.0**	**13.6**	**7.4**	**7.4**	**6.2**	**6.7**
Travel Dist (km)	1.5	15.4	5.2	22.4	44.5	2.1	12.0	14.4	9.3	0.6	23.1	1.7
Travel Time (hr)	**0.1**	**0.7**	**0.2**	**1.2**	**2.0**	**0.1**	**0.7**	**0.8**	**0.4**	**0.0**	**0.8**	**0.1**
Avg Speed (kph)	17	21	25	18	22	22	18	19	22	27	28	27
Vehicles Entered	**13**	**129**	**43**	**134**	**312**	**13**	**87**	**105**	**67**	**3**	**138**	**9**
Vehicles Exited	13	130	43	134	311	13	87	105	68	3	137	9
Hourly Exit Rate	**13**	**130**	**43**	**134**	**311**	**13**	**87**	**105**	**68**	**3**	**137**	**9**

8: Street B & Street C Performance by movement

Movement	All
Total Delay (hr)	3.1
Delay / Veh (s)	**10.5**
Travel Dist (km)	152.2
Travel Time (hr)	**7.1**
Avg Speed (kph)	21
Vehicles Entered	**1053**
Vehicles Exited	1053
Hourly Exit Rate	**1053**

Total Network Performance

Total Delay (hr)	24.9
Delay / Veh (s)	**23.1**
Travel Dist (km)	1181.6
Travel Time (hr)	**54.8**
Avg Speed (kph)	22
Vehicles Entered	**3886**
Vehicles Exited	3867
Hourly Exit Rate	**3867**

Intersection: 3: Street B & Street D

Movement	EB	EB	WB	NB	SB	SB
Directions Served	LT	R	LTR	LTR	LT	R
Maximum Queue (m)	**7.7**	**12.0**	**14.0**	**24.9**	**51.7**	**28.5**
Average Queue (m)	3.3	0.8	1.9	9.5	14.4	16.7
95th Queue (m)	**9.0**	**5.0**	**8.5**	**17.0**	**31.0**	**25.6**
Link Distance (m)	152.4		130.8	139.0	173.4	
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (m)		**15.0**				**15.0**
Storage Blk Time (%)		0.00			0.02	0.14
Queuing Penalty (veh)		**0**			**5**	**16**

Intersection: 4: Street A & Street D

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (m)	**40.7**	**78.6**	**81.0**	**51.9**	**109.4**	**96.8**	**102.0**	**89.6**
Average Queue (m)	17.3	44.0	42.9	14.8	66.6	64.1	60.2	42.3
95th Queue (m)	**33.7**	**66.7**	**68.3**	**35.5**	**102.6**	**97.1**	**94.1**	**75.5**
Link Distance (m)		152.8	152.8		113.5	113.5	173.4	93.5
Upstream Blk Time (%)					**0.00**			**0.00**
Queuing Penalty (veh)					0			0
Storage Bay Dist (m)	**45.0**			**45.0**				
Storage Blk Time (%)	0.00	0.03			0.12			
Queuing Penalty (veh)	**0**	**3**			**7**			

Intersection: 7: Street A & Street C

Movement	EB	EB	WB	NB	NB	SB
Directions Served	L	TR	L	LT	R	LTR
Maximum Queue (m)	**14.7**	**20.8**	**14.1**	**16.3**	**14.9**	**15.6**
Average Queue (m)	6.2	2.3	6.2	8.5	4.5	7.2
95th Queue (m)	**13.2**	**10.1**	**13.5**	**16.3**	**12.4**	**14.3**
Link Distance (m)		100.1		174.2		116.1
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (m)	**45.0**		**45.0**		**15.0**	
Storage Blk Time (%)				0.02	0.00	
Queuing Penalty (veh)				**0**	**0**	

Intersection: 8: Street B & Street C

Movement	EB	WB	NB	SB
Directions Served	LTR	LTR	LTR	LTR
Maximum Queue (m)	28.7	59.6	66.3	28.4
Average Queue (m)	16.1	33.3	23.1	10.4
95th Queue (m)	27.4	49.1	44.0	21.1
Link Distance (m)	120.2	152.4	137.8	174.2
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (m)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Nework Summary

Network wide Queuing Penalty: 32

Intersection: 8: Street B & Street C

Phase	2	4	6	8
Movement(s) Served	NBTL	EBTL	SBTL	WBTL
Maximum Green (s)	**20.0**	**20.0**	**20.0**	**20.0**
Minimum Green (s)	4.0	4.0	4.0	4.0
Recall	**Min**	**None**	**Min**	**None**
Avg. Green (s)	17.0	17.3	17.0	17.3
g/C Ratio	**0.38**	**0.38**	**0.38**	**0.38**
Cycles Skipped (%)	0	0	0	0
Cycles @ Minimum (%)	**0**	**0**	**0**	**0**
Cycles Maxed Out (%)	34	60	34	60
Cycles with Peds (%)	**29**	**26**	**28**	**19**

Controller Summary

Average Cycle Length (s): 44.9

Number of Complete Cycles : 79

APPENDIX H

Comparison Table of Future Traffic Conditions

Future Background Traffic Summary Data Year:
Future Traffic *Without* Proposed Development

Intersection 1: Street A & Street C													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 2: Street A & Street D													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 3: Street B & Street C													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 4: Street B & Street D													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Future Background Traffic Summary Data Year:
Future Traffic *With* Proposed Development
No Infrastructure Improvements or Signal Timing Adjustments

Intersection 1: Street A & Street C													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 2: Street A & Street D													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 3: Street B & Street C													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 4: Street B & Street D													
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Future Background Traffic Summary Data Year:

Future Traffic *Without* Proposed Development

Intersection 1: Street A & Street C	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 2: Street A & Street D	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 3: Street B & Street C	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 4: Street B & Street D	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Future Background Traffic Summary Data Year:

Future Traffic *With* Proposed Development

With Recommended Infrastructure Improvements and/or Signal Timing Adjustments

Intersection 1: Street A & Street C	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 2: Street A & Street D	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 3: Street B & Street C	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

Intersection 4: Street B & Street D	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Intersection
Volume													
v/c Ratio													
LOS													
95th Queue (m)													
Delay (s)													

APPENDIX I

Transportation Impact Study Checklist

This checklist can be used to identify the specific elements to be included in a transportation impact study in the context of discussions with City staff. The consultant will return the completed checklist with the impact study.

1. MISCELLANEOUS

- a. Preliminary staff consultation (2.2) ☐
- b. Consultation with other jurisdictions (2.2)
  - i. Region of Niagara (2.2) ☐
  - ii. Ministry of Transportation (2.2) ☐
  - iii. Niagara Parks Commission (2.2) ☐
  - iv. Niagara Falls Bridge Commission (2.2) ☐
- c. Approval of study area (2.2) ☐
- d. All assumptions documented (2.6) ☐
- e. All references documented (2.5) ☐
- f. Dates applied to all data used in the analysis (3.3) ☐
- g. Report is dated and signed by the Engineer (2.4) ☐
- h. Five (5) coil-bound reports with supporting documentation provided (5.0) ☐
- i. Submission of analysis on disk (5.0) ☐

2. DESCRIPTION OF THE DEVELOPMENT PROPOSAL AND THE STUDY AREA

- a. Name of applicant, identification and type of application (3.1.1) ☐
- b. Identification of site location (3.1.1) ☐
- c. Description of proposed application (3.1.1) ☐
- d. Definition of study area boundary (3.1.2) ☐

3. SITE PLAN REVIEW

- a. Road Widening Requirements (3.2.1) ☐
- b. Accesses (3.2.2) ☐
- c. Accessing the Site (3.2.3) ☐
- d. Internal Road Network (3.2.4) ☐
- e. Parking Area Design (3.2.5) ☐
- f. Parking Facilities (3.2.6) ☐
- g. Pedestrian & Cycling Facilities (3.2.7) ☐
- h. Loading Areas - Delivery / Service / Tour Bus (3.2.8) ☐
- i. Transit and Taxi Considerations (3.2.9) ☐

j. Signs and Markings (3.2.10) ☐
k. Visibility (3.2.11) ☐
l. Drive Through Facilities (3.2.12) ☐
m. Road Improvements (3.2.13) ☐
n. Site Amenities (3.2.14) ☐
o. Utilities (3.2.15) ☐

4. ESTABLISHING A TRANSPORTATION CONTEXT FOR THE ANALYSIS HORIZON YEAR AND TIME PERIODS FOR ANALYSIS

a. Base Year Established (3.4.1) ☐
b. Horizon Year Established (3.4.1) ☐
c. Description of existing and future planned study area transportation system (3.1.2) ☐
d. Existing Traffic Conditions
   i. Base Year Traffic Volumes (3.5.1) ☐
   ii. Field observations (3.5.2) ☐
e. Future Background Changes in Traffic Conditions
   i. Appropriate growth rate factor used (3.6.1) ☐
   ii. Adjustments for existing development (3.5.1) ☐
   iii. Other approved developments in study area (2.2 & 3.6.3) ☐
   iv. Planned transportation system improvements in study area (2.2 & 3.6.2) ☐

5. ESTIMATION OF TRAVEL THAT WILL BE GENERATED BY THE DEVELOPMENT PROPOSAL AND DEVELOPMENT OF A TDM PLAN

a. Estimation of Basic Travel Demand
   i. Summary of travel demand assumptions and methodologies (3.7.1) ☐
   ii. Identification of peak period(s) used in analyses (3.4.2) ☐
   iii. Trip distribution (3.4.2) ☐
   iv. Trip assignment (3.4.3) ☐
   v. Pass-by trips, internal (synergy) trips (3.7.1) ☐
   vi. Summary diagrams (3.7.4) ☐

6. EVALUATION OF TRANSPORTATION IMPACTS AND IDENTIFICATION OF TRANSPORTATION SYSTEM IMPROVEMENTS NEEDED TO MITIGATE THESE IMPACTS

a. Evaluation of Impacts of Site-Generated Traffic Demand

- i. Evaluation of signalized and unsignalized intersections (3.8.1) ☐
- ii. Saturation flow rate of 1750 used (3.8.1) ☐
- iii. Pedestrian volumes, calls and crossing times used in analysis (3.8.1) ☐
- iv. Results of supplementary surveys or analyses (3.3.1) ☐
- v. Identification of critical intersections (3.8.1) ☐
- vi. Documentation of level-of-service analysis results (3.8.1.1, 3.8.1.2, 3.8.1.3, 3.8.1.4) ☐
- vii. Identification of transportation system improvements required to mitigate the impacts of the proposed development (3.13.1) ☐

b. Safety Analysis

- i. Motor Vehicle Collision Analysis (3.10) ☐
- ii. Sight Distance Evaluation (3.11) ☐
- iii. Weaving Analysis (3.8.2) ☐
- iv. Pedestrian Analysis (3.8.3) ☐
- v. Traffic Infiltration (3.8.4) ☐
- vi. Corner Clearances (3.9.1) ☐
- vii. Need for turning lanes, other auxiliary lanes (3.9.2) ☐

7. SUMMARY OF FINDINGS

a. Comparison summary tables provided (3.8.1.4) ☐

b. Property assessment (3.13.4) ☐

c. Identification of network improvements and preliminary cost estimates (3.13.5) ☐

d. Summary of findings listed in point form (5.0) ☐

e. Conclusions and Recommendations (4.0) ☐