

Request for Decision

Pedestrian Crossing Policy and Recommendations

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Recommendation

That the Operations Committee adopt the Pedestrian Crossing Policy prepared by HDR Corporation dated February 2012, and;

That the recommendations contained in the Pedestrian Traffic Study – Crossing Review prepared by HDR Corporation dated February 2012 with respect to the pedestrian crossing on Elm Street between the Transit Depot and the Rainbow Value Centre be approved, and;

That the recommendations contained in the Pedestrian Traffic Study – Crossing Review prepared by HDR Corporation dated February 2012 with respect to the pedestrian crossing on Brady Street at Shaughnessy Street be approved, and;

That HDR Corporation complete the development of an educational brochure and that Staff undertake an educational campaign regarding pedestrian crossings all in accordance with the report from the General Manager of Infrastructure Services dated February 22, 2012.

Signed By

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Background

The City's Roads and Transportation Services Division retained HDR Corporation to develop a Pedestrian Crossing Policy to assist the City in determining how and when to implement pedestrian crossings (**see Exhibit A**).

HDR Corporation was also asked to undertake an assessment of three (3) specific pedestrian crossings in downtown Sudbury. The pedestrian crossing locations included as part of the assessment are:

1. Ste. Anne Road crossing at the Radisson Inn
2. Elm Street crossing at the Rainbow Value Centre
3. Brady Street crossing at Shaughnessy Street

The results of the assessments are contained in **Exhibit B, Pedestrian Traffic Study – Crossing Review**.

Pedestrian Crossing Policy

The Pedestrian Crossing Policy has been developed in light of the benefits of improving both driver and pedestrian awareness and understanding of rules of right of way. Research into the development of the policy has included a review of the practices of other jurisdictions, generally accepted and published best practices in Ontario, original research into traffic safety, and legislative references such as the Ontario Highway Traffic Act. However, as this is a City of Greater Sudbury Policy, it has been developed in recognition of the specific roadway environment in the City of Greater Sudbury, existing pedestrian crossing features, and existing driver expectancy with the City.

Some of the key recommendations contained in the policy include the following:

1. Continue to follow the Ontario Traffic Manual Warrants and Methodologies for implementing protected pedestrian crossings using traffic control signals, mid-block pedestrian signals and intersection pedestrian signals.
2. Consider pedestrian grade separation within the context of potential benefits and costs at locations where other forms of protected crossings are warranted, but cannot be reasonably, economically and practically implemented.
3. With the exception of supervised school crosswalks, marked crosswalks will be discouraged.
4. Utilize warning signs, pedestrian refuge islands and other measures such as reflective delineator posts at unprotected crossings to draw driver's attention to the possible presence of pedestrians.
5. Consider removing crosswalk markings at unprotected crossings on high speed or high volume multi-lane roads.
6. Proactively address pedestrian safety needs and establish a program for reviewing pedestrian crossings.

Pedestrian Traffic Study – Crossing Review

The City of Greater Sudbury has been responsive to the need to better accommodate the safety and security of pedestrians in the roadway environment. To this end, the City initiated a pedestrian crossing policy study and reviews of pedestrian safety and accommodation of “in-service roads”. This study is an assessment of these specific pedestrian crossings in downtown Sudbury.

It was the objective of the study to assess the appropriateness of the existing forms of pedestrian crossings. The study provides an inventory of existing conditions and identifies opportunities to improve pedestrian crossing safety. For the recommended measures, an implementation strategy is also identified.

It should be noted that this study commenced in 2006. Since then, some of the recommendations identified in the draft report have been implemented. Other changes that have occurred at the study sites since 2006 have also been noted in report.

The following is a summary of the major findings and recommendations for the three (3) existing pedestrian crossing locations:

1. Ste. Anne Road Crossing at the Radisson Inn

It was concluded that the presence of senior and student crossings at this unprotected marked crossing adjacent to a horizontal curve is not desirable. It was also noted that based on current counts that pedestrian and vehicle volumes approach Ontario Traffic Manual warrants for signals at the crossing and that warrants would likely be met during high volume (spring time) conditions. On this basis, it was recommended that traffic control signals be implemented in the vicinity of the existing crosswalk, coordinated with the adjacent driveways.

The pedestrian signals were installed in 2010.

2. Elm Street Crossing at the Rainbow Value Centre

It is concluded that the pedestrian demand of the current crossing is a function of existing land use (Rainbow Value Centre and the Transit terminal) and that there is no simple solution to change pedestrian desire lines. The location of existing signals does not permit a protected (signalized) crossing with adequate sight distance.

It is recommended that the existing unprotected pedestrian crossing point be retained. The zebra markings offer greater benefit in terms of driver awareness of crossing pedestrians than any existing confusion it may represent in terms of pedestrian and driver right of way. Existing pedestrian signage, which addresses the need to alert pedestrians of the fact that they do not have the right of way and encourages caution, should also remain.

It is also recommended that an educational campaign be implemented to remind drivers and pedestrians of the rules of right of way.

3. Brady Street Crossing at Shaughnessy Street

Considering the high pedestrian volumes that cross Brady Street throughout the day, and the strong pedestrian desire line between the numerous pedestrian generators along Shaughnessy Street and City Hall and the Police station, it is recommended that the existing unprotected mid-block crossing be maintained and enhanced to accommodate this desire line. Recommended crossing enhancements to the mid-block crossing include the application of Zebra style pavement markings similar to those used along Elm Street, as well as the addition of "Yield to Traffic" signs at both ends of the crossing.

In order to eliminate jay-walking at random locations across Brady Street, it is recommended that median enhancements be installed along Brady Street to discourage jay-walking and funnel pedestrians to the enhanced pedestrian crossing. Median enhancements can include the installation of a fence and / or planters similar to the median enhancements applied along Elm Street at the Elm Street crossing.

Educational Campaign

As part of the HDR Corporation's assignment, they will develop an educational brochure regarding pedestrian crossings. In addition to the publication and distribution of the educational brochure it is recommended that Staff, with the support of the Corporate Communications Section, undertake an educational campaign on the rules of right of way. Staff will work with groups such as the Sustainability Mobility Advisory Panel in the promotion of pedestrian safety.

February 2012

Pedestrian Crossing Policy Report

City of Greater Sudbury



Final Report





EXECUTIVE SUMMARY

A. Introduction

The City of Greater Sudbury has been responsive to the need to better accommodate the safety and security of pedestrians in the roadway environment. To this end, the City initiated a pedestrian crossing policy study and reviews of pedestrian safety on “in-service roads”. The study was carried out by HDR | iTRANS in association with Tranplan. This report provides a summary of best practices in pedestrian crossings and policy development for pedestrian crossing facilities in the City of Greater Sudbury.

The pedestrian crossing policies have been developed in light of the benefits of improving driver and pedestrian awareness and understanding of rules of right of way. Research into the development of the policies have included a review of the practices of other jurisdictions, generally accepted and published practices in Ontario, original research into traffic safety, and legislative references such as the Ontario Highway Traffic Act. However, this is a City of Greater Sudbury policy, developed in recognition of roadway environment in the City of Greater Sudbury, existing pedestrian crossing features, and existing driver expectancy within the City.

The Highway Traffic Act indicates that when a pedestrian is about to step from the boulevard onto the roadway there are fundamentally two different forms of pedestrian crossing. The crossing may be either:

- A protected crossing where vehicles must yield to pedestrians, or
- An unprotected crossing where pedestrians must yield to vehicles.

Either form of crossing may be appropriate given a range of pedestrian demand. There is generally a higher degree of concern for pedestrian safety at unprotected crossing points. However, both forms of crossing must be designed to maximize safety.

The policy has been developed in recognition that each site is unique, and that the application of the policies may not be equally applicable in all instances. In many situations opportunities to change the fundamental nature of the pedestrian environment may not be feasible. However it is intended to maximize driver and pedestrian awareness and understanding for the potential of conflicts.

B. Crossing Alternatives

The standard practice for traffic control in Ontario is defined by the *Ontario Traffic Manuals (OTM)*, **Book 15** for Pedestrian Crossing Facilities (the inaugural publication of which is imminent), **Book 12** for traffic signals and **Book 5** for regulatory signs (including stop signs). The manuals are designed to be used as a guideline by traffic practitioners. The OTM's incorporate current best practices in the Province of Ontario and have recommended thresholds for the implementation of the following protected crossings:

- Traffic control signals at intersections and mid-block
- Pedestrian crossovers (PXO's)



- Intersection pedestrian signals (IPS), and
- All-way stop signs.

An unprotected crossing is a location where there is measurable pedestrian crossing activity, such as 1 pedestrian crossing every 2 minutes for example, but has no designation or traffic control measures to protect the movement. An unprotected crossing may or may not have warning signage. Some jurisdictions supplement unprotected crossings to improve safety. These additional roadway features either increase driver or pedestrian awareness, or simplify the crossing process. These features may include:

- Refuge islands and centre medians
- Bulb outs (curb extensions)
- Textured pavement or high-visibility markings
- Standard warning signage or specialize pedestrian signage (eg: Yield to Traffic)
- Above ground flashing beacons or in-pavement flashers
- Barriers
- Delineators
- Special message signs.

C. Best Practices

Across Canada and in Ontario standard traffic control signals represent the most common feature for accommodating pedestrian crossings of major roadways. Many jurisdictions in Ontario also use a second form of protected crossing in instances where full traffic control signals are not warranted, either IPS' or PXOs. Most jurisdictions use OTM Book 12 warrants and threshold values for implementing traffic signals and pedestrian crossovers, and some utilize the OTM methodology to implement IPS'.

A number of jurisdictions indicate there is a lack of understanding of rules of the road and right of way at pedestrian crossings.

In the management of a roadway, risk and liability exist in perceived negligence, including nonfeasance and malfeasance. To minimize these risks, the City of Greater Sudbury can proactively monitor the safety of operations at pedestrian crossings to identify hazards and plan mitigation, establish policies that are consistent with accepted engineering practice and sensitive to the local environment, and implement improvements that are consistent with the policies / practices or their underlying principles. Practices should avoid ambiguity that may lead to confusion and misinterpretation of traffic control devices.

From the review of survey of current practices, risk, and research into operational characteristics of crossings, the following points were considered in the development of the crossing policy:

- It is desirable to distinguish between protected and unprotected crossings, such that drivers and pedestrians understand who has the right of way.
- Mid-block unprotected crossings with pavement markings may lead unaware pedestrians and drivers to believe that the crossing is protected for pedestrians.
- Pavement marking unprotected crossings may result in inconsistent driver yielding ('courtesy gaps') provided by drivers. This is of particular concern leading to vehicle-vehicle or vehicle-



pedestrian conflicts on 4-lane facilities where driver yielding behaviour in one lane may not be consistent with another.

- At mid-block locations, where the adjacent land uses such as high pedestrian generators and trails create high mid-block crossing demand, signage can contribute to driver awareness and pedestrian caution without making the rules of right of way ambiguous for drivers and pedestrians.
- If implementing protected crossing features (PXO's or IPS') to supplement traffic control signals, they should be done so in sufficient quantity such that pedestrians and drivers are familiar with their operation.
- There are operational concerns with PXO's related to the dilemma zone and clearance requirements.
- There is a trend toward the use of IPS' and a trend away from PXOs amongst Ontario municipalities surveyed.
- IPS' allow for a clearance interval, are an accepted device to complement traffic control signals, and are seen as an appropriate feature for the City of Greater Sudbury.
- Given that there is limited statistical research into the operations of IPS', the City of Greater Sudbury should consider driver workload turning from the side street and potential for vehicle-pedestrian conflicts at any new IPS locations.

D. Recommended Pedestrian Crossing Policy

It is recommended that the City of Greater Sudbury implement the following pedestrian features as warranted based on OTM Book methodologies and thresholds, to accommodate protected pedestrian crossings:

- Traffic control signals at intersections
- Traffic control signals mid-block
- Intersection pedestrian signals, and
- Adult crossing guards.

Where there is a documented safety problem identified (i.e. visibility or measured sight distance constraints, collision trends, or frequent vehicle-pedestrian conflicts) and traffic signals are not warranted, consideration will be given to implementation of traffic control signals and IPS'. In considering IPS applications, the City will have regard for driver workload for sidestreet approaches in the decision to implement and in the design.

Pedestrian grade separation should be considered within the context of potential benefits and costs, at locations where the other forms of protected crossings are warranted but cannot be implemented due to environmental constraints (such as distance of adjacent traffic controls). Grade separations are viable only if pedestrians can be directed to use the facility and sufficient property and capital funds are available.

With the exception of crosswalks for school crossing guards, marked unprotected crosswalks should generally be discouraged. However, the specific characteristics and needs of each location should be carefully considered and appropriate treatments applied to maximize safety. For example, consideration has been given to the delineation of high contrast markings to distinguish pedestrian desire lines in highly urban areas where drivers are aware of very high pedestrian



activity. In these locations, pedestrian signage should acknowledge that pedestrians do not have the right of way over vehicles (e.g. OTM Book 6 Wc-28 sign). In other areas where there is high pedestrian/vehicular activity and/or high vehicle speeds, pedestrian markings at unprotected locations should not be implemented.

At locations where unprotected crosswalks are maintained on two lane, low speed roads (i.e. 50 km/h or less), it is recommended a pedestrian warning sign (Wc-7) be posted in advance of the crossing per OTM Book 6, and that two back to back Wc-7 signs be mounted on each side of the road in the immediate vicinity of the crossing. Additionally, no pavement markings shall be used to denote the crossing on the roadway and existing pavement markings shall be removed.

Pedestrian refuge islands or centre medians will also be considered as a passive feature at unprotected crossing points where lane alignment is not compromised (eg. integrated with centre turn lanes). Other measures such as reflective delineator poles may be considered at the boulevard of unprotected crossing locations in order to draw the driver's attention to potential crossing activity.

The City of Greater Sudbury should consider removing line markings at unprotected crosswalks on high speed or high volume multilane roads, where the crosswalk is not specifically intended to direct pedestrians away from crossing at locations with poor sight lines or unanticipated conflicts. The City should consider the removal of unprotected crosswalks under the following circumstances:

- Where the speed limit is greater than 60 km/h, or
- On a roadway with four or more lanes without a raised median or crossing island that has (or will soon have) an Average Daily Traffic (ADT) total of 12,000 or greater, or
- On a roadway with four or more lanes with a raised median or crossing island that has (or will soon have) an ADT of 15,000 or greater.

The removal of crosswalks should include public notification.

It is recommended that the City of Greater Sudbury proactively address pedestrian safety needs and establish a program of reviews of pedestrian crossings either through on-going traffic operations studies or annual corridor reviews. Compliance with the pedestrian crossing practices should be reviewed, and necessary roadway and traffic control modifications programmed and implemented. Streetlight warrants and maintenance should also be monitored.

Other features may be considered for implementation by the City of Greater Sudbury on a site-by-site basis to enhance pedestrian safety based on the needs of the particular site.



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1. INTRODUCTION

1.1 Project Objectives

The City of Greater Sudbury has been responsive to the need to better accommodate the safety and security of pedestrians in the roadway environment. To this end, the City initiated a pedestrian crossing policy study and reviews of pedestrian safety on “in-service roads”. The study was carried out by HDR | iTRANS in association with Tranplan. This report provides a summary of best practices in pedestrian crossings and development of a policy for pedestrian crossing facilities.

The objective of this policy is to assist the City of Greater Sudbury to make rational decisions on how and when to implement pedestrian crossings. It will address issues relating to the type of measures that could be used to assist pedestrians at intersections and mid-block locations and under what conditions it would be appropriate to implement these measures. The guideline is intended as policy on practice for implementing traffic control features rather than a description of design details.

1.2 Study Context

Pedestrian safety is related to the level of awareness of drivers and pedestrians of potential conflicts, the level of pedestrian and driver understanding of who has the right of way where there is vehicle-pedestrian interaction, and the degree of care and disregard for safety. Efforts can be made to address each of these effects on pedestrian safety through public awareness and education. In addition, awareness and understanding of right of way can be enhanced through the design of road and pedestrian infrastructure.

Road designs and use of traffic control measures can help maximize driver and pedestrian awareness of vehicle-pedestrian interaction, minimize distractions and obstructions, and improve understanding of which road user has the right of way. It is engineering practice to select designs that:

- Offer consistency in design approach in order to contribute to driver expectation that is appropriate for the road environment and potential hazards, and
- Is appropriate for the unique characteristics for each individual site.

The pedestrian crossing policies have been developed in light of the benefits of improving driver and pedestrian awareness and understanding the rules of right of way. Research into the development of the policies have included a review of the practices of other jurisdictions, generally accepted and published practices in Ontario, original research into traffic safety, and legislative references such as the Ontario Highway Traffic Act. However, this is a City of Greater Sudbury policy, developed in recognition of roadway environment in the City of Greater Sudbury, existing pedestrian crossing features, and existing driver expectancy within the City.

The policy has been developed in recognition that each site is unique, and that the application of the policies may not be equally applicable in all instances. In many situations opportunities to



change the fundamental nature of the pedestrian environment may not be feasible. However is intended to maximize driver and pedestrian awareness and understanding for the potential of conflicts.

1.3 Forms of Pedestrian Crossing

The Ontario Highway Traffic Act (HTA) defines the rules of the road, including conditions under which pedestrians can cross a road. The HTA identifies the responsibilities and rights of pedestrians and drivers at different forms of pedestrian crossing. Interpretation of rights and responsibility are further defined through case law.

The Highway Traffic Act indicates when a pedestrian is about to step from the boulevard onto the roadway there are fundamentally two different forms of pedestrian crossing. The crossing may be either:

- A protected crossing where vehicles must yield to pedestrians, or
- An unprotected crossing where pedestrians must yield to vehicles.

Protected crossings include those locations where there is traffic control that requires a vehicle to yield or stop, such as a traffic control signal, an intersection pedestrian signal, a pedestrian crossover with flashing lights, a stop sign, or a crossing guard.

An unprotected crossing may or may not have warning signage and in some jurisdictions crosswalk pavements markings. An unprotected crossing may also have no designation or traffic control measures, but are locations where there is measurable pedestrian crossing activity.

Either form of crossing may be appropriate given a range of pedestrian demand. There is generally a higher degree of concern for pedestrian safety at unprotected crossing points. However, both forms of crossing must be designed to maximize safety.



2. TYPES OF PEDESTRIAN CROSSINGS

2.1 Types of Protected Crossings

Protected crossings include those locations where there is traffic control device that requires a vehicle to yield or stop, such as a traffic control signal, an intersection pedestrian signal, a pedestrian crossover with flashing lights, a stop sign, or a crossing guard. The protected crossing options are defined in this section.

2.1.1 Traffic Control Signals

At signalized locations a pedestrian crossing is protected during the WALK and flashing DON'T WALK phase of the cycle. Traffic control signals can accommodate pedestrian crossing through traditional signals at intersections or at mid-block. Warrants and design requirements of traffic control signals are documented in the Ontario Traffic Manual Book 12. Signals are either implemented at intersections, accesses, or mid-block where there are pedestrian desire lines and pedestrian demand is high.

2.1.2 Intersection Pedestrian Signals

An alternative form of traffic control signals that accommodate pedestrian crossing is the Intersection Pedestrian Signal (IPS) or half-signal. It is used in an increasing number of jurisdictions, including: City of Hamilton, City of Burlington, Region of Waterloo, York Region, City of Oshawa and City of Greater Sudbury. Pedestrian crossing is controlled on the main street by standard traffic signal heads. A pedestrian indicates the desire to cross by pushing a button that would activate the signal to stop the traffic on the main street. At all times, the side street traffic is controlled by a “stop” sign and vehicles entering the main street from the side street must yield right of way to all main street traffic and pedestrians.

2.1.3 Pedestrian Crossovers

Protected pedestrian crosswalks in Ontario are defined as pedestrian crossovers (PXOs) and represent protected crossings for pedestrians. Section 140 of the Highway Traffic Act of Ontario requires motorists to yield to a pedestrian in a crossover when the pedestrian is upon the half of the road upon which the vehicle is travelling or when a vehicle is close enough to endanger a pedestrian. The presence of a pedestrian is what triggers the motorist's requirements to yield. Municipalities that operate PXOs include: Town of Milton, Oakville, and Town of Caledon. The City of Toronto operates over 600 PXOs. However many jurisdictions no longer implement PXOs due to safety and cost concerns.

The design of a pedestrian crossover is prescribed in the Highway Traffic Act Regulation 615, Section 20 and in Book 12 of the Ontario Traffic Manuals. The design consists of overhead illuminated signs with flashing amber beacons, regulatory signs at and approaching the crossover and pavement markings on the roadway.



2.1.4 Stop Control

Pedestrian crossings are protected at stop controlled intersections where pedestrians are crossing the minor street at two-way stop controlled intersections and for all legs of an All-Way stop intersection. Vehicles must yield to pedestrians lawfully in these crosswalks.

2.1.5 Crossing Guard

Adult crossing guards provide protection for pedestrians crossing the street. Vehicles must yield to a crossing guard within the crosswalk at both protected and unprotected crossings. Crossing guards are stationed at school crossing locations and school crossing signs are situated in advance of and at the crossing guard location. The crossing is also typically marked with pavement markings.

2.1.6 Pedestrian Grade Separation

Grade separated crossings are protected by the physical separation from vehicles through either an overpass or an underpass. Grade separation provides the highest form of protection for pedestrians, but is also the most expensive option for a protected crossing as it requires more property and a more complex implementation process. In many instances, grade separated crossings require pedestrians to divert their route from more direct connections and may have limited accessibility if the design includes stairs or steep ramps. Grade separation may be recommended if other forms of protected crossing are not appropriate and/or when there are insufficient gaps and obvious safety concerns for pedestrian crossings, due to high traffic volume, high vehicle speeds, or long crossing distance such as high speed freeways and expressways. Grade separation may also be appropriate in developed areas with established vehicular and pedestrian traffic volume, but with limited opportunity for other types of crossing.

2.2 Unprotected Crossings

An unprotected crossing may or may not have warning signage and in some jurisdictions crosswalk pavement markings. A unprotected crossing may also lack designation or traffic control measures, but tend to be at locations where there is measurable pedestrian crossing activity, such as (1 pedestrian crossing every 2 minutes for example).

At 2-way stop intersections, an unprotected pedestrian crossing can be accommodated by the provision of warning signage or a crosswalk across the major road. However crosswalk markings across a major street may give pedestrians the false impression that they have the right of way. Pavement markings at unprotected crossings may encourage pedestrian crossing activity at unprotected locations. For this reason, many jurisdictions do not mark crosswalks where pedestrians do not have the right of way prior to entering the crosswalk. In some instances crossings of the major road are signed to prevent potential confusion about who has the right of way, indicating that pedestrian should yield to traffic on the major road and / or wait for a suitable gap.



Some jurisdictions, such as City of Toronto, City of Hamilton, City of Kingston, supplement unprotected crossings to improve safety. These additional roadway features either increase driver or pedestrian awareness, or simplify the crossing process. These features may include:

- Refuge islands and centre medians
- Bulb outs (curb extensions)
- Textured pavement or high-visibility markings
- Standard warning signage
- Specialized pedestrian signage (eg.: Courtesy Crossing, or Yield to Traffic)
- Above ground flashing beacons
- Barriers to control pedestrian flow, and
- Delineators.

The use of some of these features at unprotected crossing points may also increase pedestrian's sense of security. The safety benefits must be weighed against a potentially more aggressive pedestrian behavior, likelihood of increases in pedestrian crossing activity, and the resultant exposure to conflict with vehicles. Each feature is briefly described below.

2.2.1 Refuge Islands / Centre Medians

The presence of pedestrian islands simplifies the pedestrian crossing movement by providing a safe refuge in the center of the road. Refuge islands reduce the distance required to cross and increase the available gaps for pedestrians. They allow pedestrians to concentrate on crossing one direction of traffic at a time. Pedestrian refuge islands are suitable for wide two-way streets with four or more lanes of moving traffic travelling at higher speeds and are commonly located mid-block. They are useful to persons with mobility disabilities, very old or very young pedestrians who walk at slower speeds.

2.2.2 Bulb Outs (Curb Extensions)

Curb extensions reduce the distance that pedestrians have to walk. With the reduced crossing distance, pedestrians require smaller gaps to cross and pedestrian delays will generally become shorter. The extensions create a traffic calming effect – vehicles slow down, making it safer for pedestrian to cross. They also improve the visibility of pedestrians.

2.2.3 Textured Surfaces / High-Visibility Markings

Textured surfaces and high-visibility (e.g. zebra) markings are ideally suited for crossing in low speed, high traffic volume and pedestrian environments. They increase drivers' awareness of possible crossing at an unprotected crossing. The use of these features such as textured pavement is not preferred at unprotected crossings on high volume roads. Many municipalities use textured crosswalks in downtown areas including the City of Greater Sudbury.

2.2.4 Standard Warning Signage

A number of pedestrian crossing signs are documented in the Ontario Traffic Manuals: Book 5 Regulatory Signs, Book 6 Warning Signs and Book 11 Markings and Delineation. They include



a Pedestrian Ahead sign (Refer to Wc-7, page 109 of OTM Book 6, July 2001). The manuals also list a number of signs that can be used at school crossings.

More recently the use of the florescent yellow-green sign has been used by some jurisdictions, including the City of Kingston, for school crossings and City of Belleville for courtesy crossings.

2.2.5 Special Message Signs

Given the inconsistent understanding of the right-of-way at unprotected crossings, some jurisdictions have implemented special message signs that explicitly identify the right-of-way such as “Yield to Traffic” or “Courtesy Crossing”.

2.2.6 Flashing Beacons

Flashing beacons could be used with the Pedestrian Crosswalk Ahead warning signs to make drivers more aware of the crosswalk ahead and of the need to slow down and drive with caution. Flashing beacons could also be implemented on the Refuge Island when there is a safety concern of vehicles colliding with the refuge island.

2.2.7 Barriers

Barriers or railings placed along the top curb can be used to channelize pedestrians to preferred crossing points and discourage pedestrians crossing at undesirable locations (where sight distance constraint or conflicting flows exist). However, pedestrians who have entered the roadway upstream or downstream of the barrier may also have difficulties exiting the roadway around barriers. In some environments, barriers may be viewed as aesthetically unattractive.

2.2.8 Delineators

Delineator posts can be used to alert drivers to the boulevard increasing their detection of the presence of a crossing. Reflective tape on delineators can significantly improve night visibility of protected and unprotected crossings.



2.3 Design Elements

Table 1 shows the design elements and approximate cost associated with alternative forms of pedestrian crossings.

Table 1: Alternative Pedestrian Facilities

Facility Type	Description of Traffic Control	Cost
Traffic Control Signals	<ul style="list-style-type: none"> ▪ Pedestrian walk / don't walk indicator ▪ Pedestrian crosswalk markings 	\$100,000 - \$200,000
Mid-block Pedestrian Signals	<ul style="list-style-type: none"> ▪ Pedestrian walk/don't walk indicator ▪ Pedestrian crosswalk markings 	\$80,000 - \$120,000
Intersection Pedestrian Signals (IPS)	<ul style="list-style-type: none"> ▪ Pedestrian walk / don't walk indicator ▪ Push button to activate signal to stop traffic ▪ Pedestrian crosswalk markings ▪ Side street traffic is stop-controlled ▪ No parking is permitted on both sides of signals 	\$80,000 - \$120,000
Pedestrian Crossovers	<ul style="list-style-type: none"> ▪ Overhead flashing lights ▪ "Push Button to activate early warning system" ▪ "Pedestrian Advance (Wc-7)" ▪ No passing sign ▪ Pedestrian crosswalk markings ▪ No passing solid demarcation between lanes ▪ "X" pavement marking 	\$60,000
Stop Control Pedestrian Crossing	<ul style="list-style-type: none"> ▪ Pedestrian Crosswalk markings 	\$1,000 - \$3,000
Crossing Guard	<ul style="list-style-type: none"> ▪ School crossing signs and advance warning signs ▪ Crosswalk markings 	
Pedestrian Grade Separation	<ul style="list-style-type: none"> ▪ Overpass or underpass ▪ Ramps or elevators; and stairs or escalators ▪ Fencing to direct pedestrians 	\$500,000
Unprotected Pedestrian Crosswalks	<ul style="list-style-type: none"> ▪ Pedestrian crosswalk markings and signs 	\$ 2,000

* Note: costs shown are typical 2011 prices; actual costs vary based on site conditions

Unprotected crossing facilities typically do not exhibit the same design elements that protected crosswalks provide. This is appropriate. The configuration of protected and unprotected crossings should be significantly different, to allow the public a clear understanding of whether driver or pedestrian has the right of way.



3. IMPLEMENTATION GUIDELINES

3.1 Ontario Traffic Manual

The standard practice for traffic control in Ontario is defined by the *Ontario Traffic Manuals (OTM)*, **Book 15** for Pedestrian Crossing facilities, as well as **Book 12** for traffic signals, **Book 6** for warning signs and **Book 5** for regulatory signs (including stop signs). The manuals are designed to be used as a guideline by traffic practitioners. The OTM books incorporate current best practices in the Province of Ontario and have recommended thresholds for the implementation of:

- Traffic control signals
- Mid-block pedestrian signals
- Pedestrian crossovers (PXO's)
- Intersection pedestrian signals (IPS), and
- All-way stop signs.

Municipalities have generally followed the standards defined by the manuals, while some have adopted modified warrant thresholds to better reflect local characteristics. The City of Greater Sudbury bases its approach on these manuals, however, not all warrants and guidelines presented in this section are necessarily recommended for the City's policy. Specifics of the recommended policy are presented in **Section 6**. They are listed in this report for reference and to guide the process of developing a set of policies specific to the City of Greater Sudbury.

3.2 Signal Warrants

The OTM provided recommended thresholds based on vehicle volume, pedestrian volume, pedestrian delay, and accident frequency. The signal justification for mid-block and intersection locations is based on the following criteria summarized in **Table 2**.

Table 2: OTM Signal Justification Method

Justification	Threshold
Justification 1 – Minimum Vehicle Volumes	<p>The 8 hour average vehicle volume must exceed the following thresholds:</p> <p>Restricted Flow (Urban) Conditions</p> <ul style="list-style-type: none">▪ Total Traffic Volume Entering Intersection: 720 vph (1 lane approach) or 900 vph (2 lane approach); and▪ Crossing Traffic Volume: 170 vph (full intersection) or 255 (T-intersection). <p>Free Flow (Rural) Conditions</p> <ul style="list-style-type: none">▪ Total Traffic Volume Entering Intersection: 480 vph (1 lane approach) or 600 vph (2 lane approach); and▪ Crossing Traffic Volume: 120 vph (full intersection) or 180 (T-intersection).



Justification	Threshold
Justification 2 – Delay to Cross Traffic ¹	<p>The 8 hour average vehicle volume must exceed the following thresholds:</p> <p>Restricted Flow (Urban) Conditions</p> <ul style="list-style-type: none"> ▪ Main Road Traffic Volume: 720 vph (1 lane approach) or 900 vph (2 lane approach); and ▪ Crossing Traffic Volume: 75 vph <p>Free Flow (Rural) Conditions</p> <ul style="list-style-type: none"> ▪ Main Road Traffic Volume: 480 vph (1 lane approach) or 600 vph (2 lane approach); and ▪ Crossing Traffic Volume¹: 50 vph
Justification 3 – Volume/Delay Combination	<ul style="list-style-type: none"> ▪ If Justifications 1 or 2 are both satisfied to the extent of 80% or more of the threshold
Justification 4 – Minimum Four-Hour Vehicle Volume	<ul style="list-style-type: none"> ▪ Intended for applications where the intersection experiences excessive delays for four or more peak hours of the day, but do not meet an eight-hour warrant ▪ Signal justification is considered if the plotted point representing the vehicles per hour on both approaches of the major street and the corresponding vehicles per hour on the highest minor street approach falls above the applicable curve illustrated in Figure 1 and Figure 2 ▪ Focused on locations such as: <ul style="list-style-type: none"> • Commuter-dominated roadways – with heavy demands for two or more hours in each of the AM and PM peak, but considerably reduced for the remainder of the day • Commercial areas – with limited demand in the morning, but substantial four to six hour peak in the afternoon and early evening • Manufacturing, office or industrial areas / accesses – where minor street existing traffic experiences considerable delays when entering the major street during the mid-day and PM peak periods but the AM arrive peak realizes little side street demands
Justification 5– Collision Experience ²	<ul style="list-style-type: none"> ▪ 5 or more reportable collisions of types preventable by traffic control signals occurred during each of the three preceding twelve month periods ▪ $\geq 80\%$ of the requirements specified in Justification 1 and Justification 2
Justification 6 – Pedestrian Volume ³	<p>Pedestrian volume justification is based on an exposure approach (Figure 3):</p> <ul style="list-style-type: none"> ▪ Pedestrian volume justification (Figure 3): <ul style="list-style-type: none"> ▪ 8-hour vehicle volume > 7000 and net 8-hour pedestrian volume > 276; or ▪ 8-hour vehicle volume = 2601 to 7000 and net 8-hour pedestrian volume > 476; or ▪ 8-hour vehicle volume = 1440 to 2600 and net 8-hour pedestrian volume > 1000 ▪ Pedestrian delay justification: <ul style="list-style-type: none"> ▪ Net total 8 hour volume of delayed pedestrians = 75 pedestrians or more



1. The crossing volume consist of the sum of: the number of pedestrians crossing the main road; plus total left turns from both the sideroad approaches; plus highest through volume from one of the side street approach; plus 50% of the heavier left turn traffic
2. On the condition that adequate trial of less restrictive remedies with satisfactory observance and enforcement have failed to reduce collision frequency
3. Pedestrian volume is adjusted by a factor of 2 for senior citizens, disabled pedestrians and children under 12

Most jurisdictions surveyed have been following the guideline prescribed by the manual. Consideration beyond OTM 12 has been given for crossings requiring specialized treatments such as audible signals, countdown signals, timing operations based on lower pedestrian walking speed for seniors and assisted pedestrian crossing or pedestrian grade separation. While there is no warrant for accommodating seniors, a reduction of 0.1 to 0.2 m/sec from typical walking speed assumptions are considered adjacent to seniors' residences or facilities.

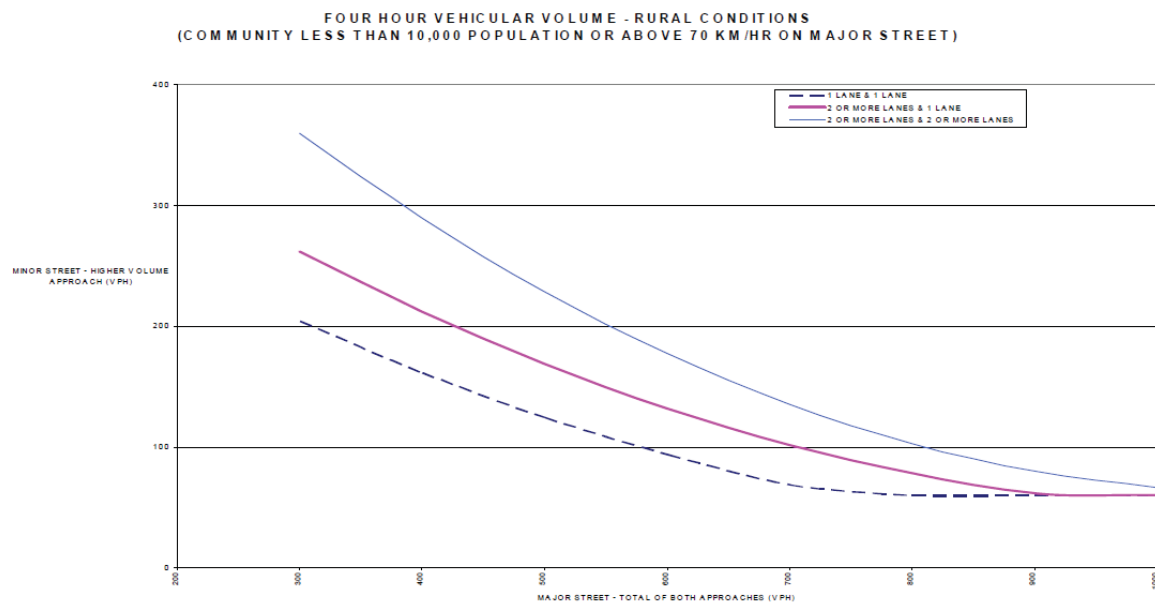


Figure 1: Justification 4 – Minimum Four Hour Justification, Unrestricted Flow

(Source: Figure 19, OTM Book 12, February 2007)

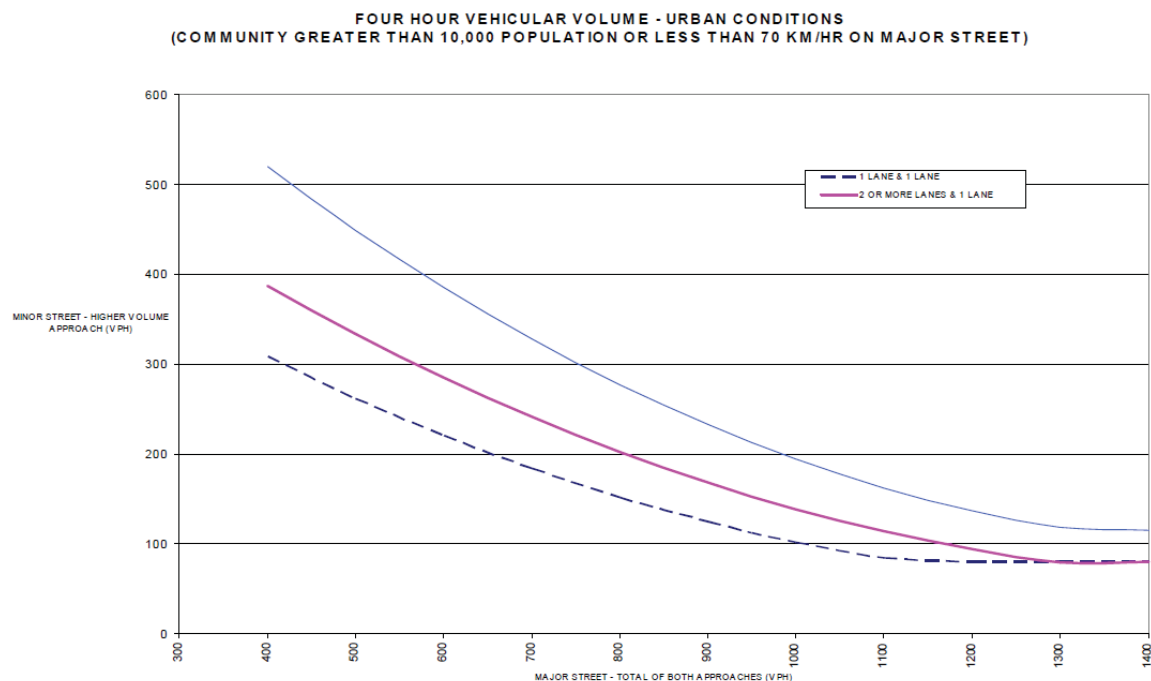


Figure 2: Justification 4 – Minimum Four Hour Justification, Restricted Flow
(Source: Figure 20, OTM Book 12, February 2007)

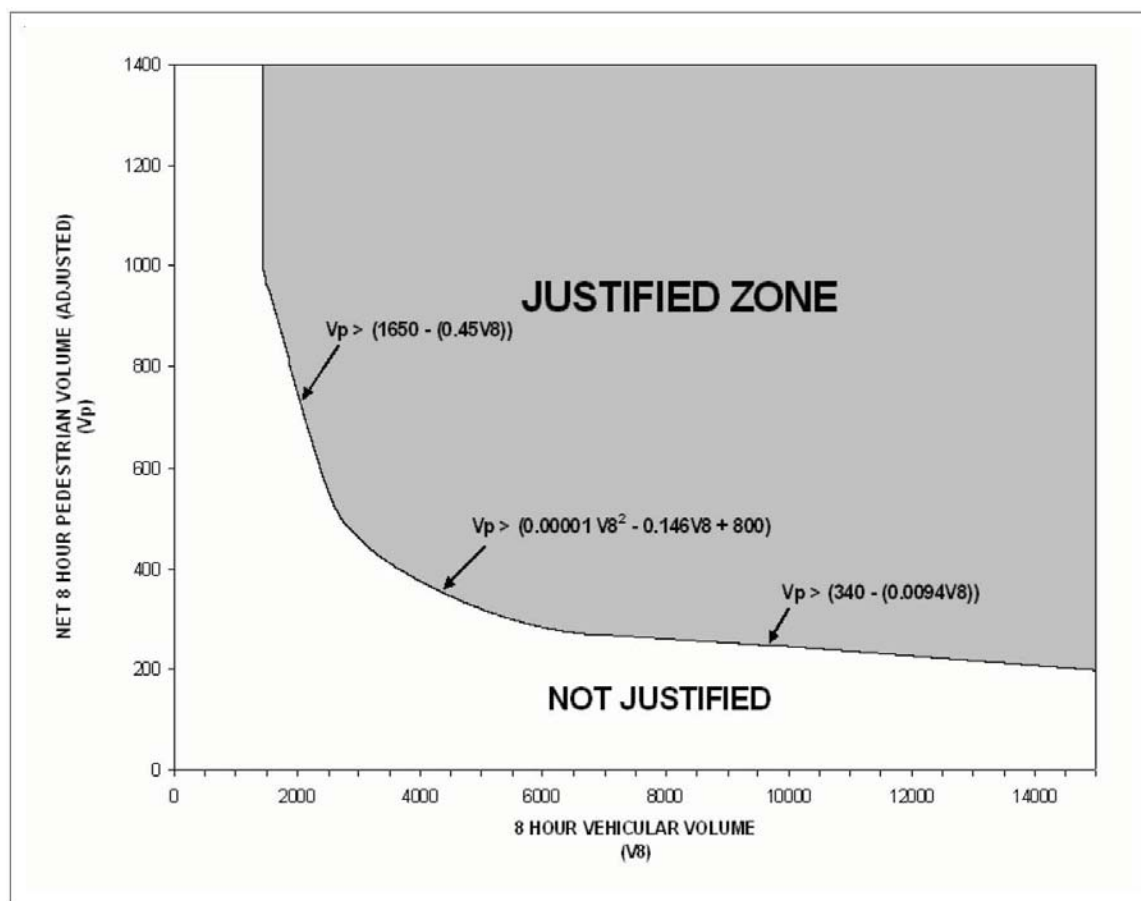


Figure 3: 8 Hour Pedestrian Crossing Warrants

(Source: OTM Book 12, Figure 21 – Justification 6 – Pedestrian Volume)

3.3 IPS Warrants

OTM Method

According to the OTM method, “if the pedestrian crossing under consideration is to be at an intersection, justification should be made on the basis of Signal Justification 5 being fulfilled but the crossing vehicular traffic should be so light as to not meet one of the other justifications (1-4).” The City of Greater Sudbury bases its warrant on the OTM method.

Priority Points Method

The City of Hamilton in cooperation with Ministry of Transportation Ontario developed the “priority points” method, which is based on a cumulative scoring of different criteria under consideration. The criteria include combined “pedestrian volume and delay”, collision frequency, distance of upstream / downstream of the protected crossing location and vehicle operating speed.

As a minimum, there should be at least **100 pedestrians** entering the main street during the 7 highest hours of the day and there should also be fewer than **5000 vehicles** total per day on the intersecting side street approach. **Table 3** summarizes the priority point system where a cumulative score of 80 is required for warrant.



Table 3: IPS Cumulative Point System

Test A – Pedestrian Volume and Delay¹	Priority points = $\sqrt{\text{Avg.delay} \times \text{hrVol}_{\text{adjusted}}}$																		
Test B – Average Number of Preventable Collisions in a ten year period	<p style="text-align: center;">Intersection Pedestrian Signal (IPS) Test B, Average Number of Preventable Collisions in a Ten Year Period</p> <table border="1"> <caption>Data for Test B Graph</caption> <thead> <tr> <th>Average number of preventable collisions in a ten year period</th> <th>Priority Points</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>15</td> </tr> <tr> <td>2</td> <td>30</td> </tr> <tr> <td>3</td> <td>45</td> </tr> </tbody> </table> <p style="text-align: center;">15 priority points per collision</p>	Average number of preventable collisions in a ten year period	Priority Points	1	15	2	30	3	45										
Average number of preventable collisions in a ten year period	Priority Points																		
1	15																		
2	30																		
3	45																		
Test C – Distance to Nearest Protected Crossing	<p style="text-align: center;">Intersection Pedestrian Signal (IPS) Test C, Distance to nearest protected pedestrian crossing</p> <table border="1"> <caption>Data for Test C Graph</caption> <thead> <tr> <th>Distance to nearest protected pedestrian crossing (m)</th> <th>Priority Points</th> </tr> </thead> <tbody> <tr> <td>200</td> <td>0</td> </tr> <tr> <td>250</td> <td>7.5</td> </tr> <tr> <td>300</td> <td>15</td> </tr> <tr> <td>350</td> <td>20</td> </tr> <tr> <td>400</td> <td>20</td> </tr> <tr> <td>450</td> <td>20</td> </tr> <tr> <td>500</td> <td>20</td> </tr> <tr> <td>550</td> <td>20</td> </tr> </tbody> </table>	Distance to nearest protected pedestrian crossing (m)	Priority Points	200	0	250	7.5	300	15	350	20	400	20	450	20	500	20	550	20
Distance to nearest protected pedestrian crossing (m)	Priority Points																		
200	0																		
250	7.5																		
300	15																		
350	20																		
400	20																		
450	20																		
500	20																		
550	20																		
Test D – Vehicle Operating Speed	<p style="text-align: center;">Intersection Pedestrian Signal (IPS) Test D, Vehicle Operating Speed (km/hr)</p> <table border="1"> <caption>Data for Test D Graph</caption> <thead> <tr> <th>Operating Speed (km/hr)</th> <th>Priority Points</th> </tr> </thead> <tbody> <tr> <td>50</td> <td>-10</td> </tr> <tr> <td>60</td> <td>0</td> </tr> <tr> <td>70</td> <td>10</td> </tr> <tr> <td>80</td> <td>0</td> </tr> <tr> <td>90</td> <td>-10</td> </tr> </tbody> </table>	Operating Speed (km/hr)	Priority Points	50	-10	60	0	70	10	80	0	90	-10						
Operating Speed (km/hr)	Priority Points																		
50	-10																		
60	0																		
70	10																		
80	0																		
90	-10																		

1. Pedestrian volume is adjusted by a factor of 2 for assisted pedestrians (senior citizens, disabled pedestrians and children under 12)

The City of Burlington and the City of Hamilton were the pioneers for such devices in Ontario. These municipalities have implemented and monitored the effectiveness of the IPS since 1998.



Other jurisdictions such as the City of Mississauga, City of Pickering, City of Barrie and the Region of York have adopted this control type in some capacity.

Standard practice also includes implementation of pedestrian features within acceptable environmental conditions:

- Minimum distance of 215 metres from nearest traffic control signal or stop sign on a two-way street or 125 metres on a one-way street
- Adequate sight distance must be available for both pedestrians and vehicles for the operating speed of the roadway
- Parking prohibition within 30 metres of the crossing
- Posted speed of less than 60 km/h, and
- Fewer than 5,000 vehicles per day on the intersecting side street approaches.

3.3.1 Comparison of IPS Warrants

The priority points method allows for greater detail by directly assessing pedestrian delay, spacing of protected crossings, and operating speeds. However the priority points method is supportive of IPS implementation on higher speed roads (70 km/hr vs. 60 km/hr roads) and roads with very high volumes that generate long pedestrian delays despite modest pedestrian volumes. The sensitivity of the warrant to the spacing of protected pedestrian crossings is limited to the range of 215 metres to 350 metres. The priority points method also has greater data requirements (pedestrian delay and vehicle speed).

The OTM method provides an IPS warrant methodology that is consistent with traffic signal warrants. The OTM methodology is a generally accepted source in Ontario. The additional data collection associated with the priority points method has not been proven to merit change from the use of the OTM method by the City of Greater Sudbury.

3.4 Advanced Pedestrian Phases

Advanced pedestrian phases give pedestrians an advanced walk signal before motorists receive their “green” indication giving pedestrians a “head start” when entering a crosswalk. The intention is to position pedestrians within the crosswalk and make them more visible to motorists increasing the potential for motorists to yield the right of way. Advanced phases are typically four to six seconds in duration.

There are no standard warrant practices for advanced pedestrian phases, however, they have been used in various municipalities around the world, and are known to be particularly beneficial to pedestrians when crossing roadways with two or more lanes per direction, where there are high levels of pedestrians and high volumes of turning vehicle traffic, and there is a known problem of driver’s not yielding to pedestrians. In some instances, right-turn-on-red prohibitions may be necessary to prevent vehicles from turning into the crossing and blocking pedestrian access to the crosswalk during the advanced phase.



3.5 Pedestrian Scramble Phases

A pedestrian scramble phase gives a walk signal to pedestrians on all approaches simultaneously (including diagonally with some installations), while displaying a red signal indication to all vehicular traffic. While there are no formal warrants for this form of pedestrian crossing control, it requires a dedicated phase within the signal cycle and therefore usually increases the signal cycle time and/or creates longer delays for vehicular traffic. As a result, it is typically only justified at intersections with very large pedestrian movements that wish to cross in all directions (i.e. Calgary sited installations at locations with over 6,000 pedestrians per hour for each of the highest 6 hours of the day). Pedestrian scramble phases do not work well with accessible pedestrian signal devices since they are all activated together.

3.6 Pedestrian Crossover Warrants

The OTM identifies two forms of Pedestrian crossovers, Type 1 and Type 2.

Type 1 pedestrian crossovers are distinctly defined by the prescribed use of regulatory and warning signs, flashing amber beacons and pavement markings. They provide pedestrians with protected crossing opportunities by requiring motorists to yield to pedestrians within the crosswalk. OTM Book 15 states that “a Type 1 PXO may be installed on the basis that pedestrian volumes meet the thresholds of the pedestrian warrant specified in Justification 6 (from OTM Book 12), described in *Section 3.2* of this report, and provided that:

- Type 1 PXO is intended to serve pedestrian traffic crossing roadways with 60 km/h or less posted speed limits and AADT's less than 35,000
- The PXO is not within 200 metres of other signal-protected pedestrian crossings
- There are not more than four lanes of two-way traffic or three lanes of one-way traffic
- Parking and other sight obstructions are prohibited within at least 30 metres of the crossing, and
- If at an intersection, side street vehicular traffic does not meet one of the other justifications (1 through 5) under which full traffic control signals may be installed.

A Type 1 Pedestrian Crossover is illustrated in **Figure 4**.





or elsewhere, distinctly indicated for pedestrian crossing by signs on the highway and lines or other markings on the surface of the roadway as prescribed by the Highway Traffic Act regulations". Type 2 PXO's are applied in lower vehicle-volume environments and may be considered as a treatment for accommodating pedestrians at crossing locations where there is a consistent level of pedestrian activity, but the location does not warrant for traffic control signals, IPS or Type 1 PXO's.

The following conditions are required to warrant Type 2 PXO's:

- Maximum of two lanes of traffic
- Sufficient stopping sight distance, 100 metres and 120 metres sight distance required for operating speeds of 50 km/h and 60 km/h respectively
- Sufficient distance to alternate crossings, offering equal or higher level of control (a minimum spacing of 200 metres from an adjacent traffic signal is recommended),
- Grades of less than eight percent, and
- Consistent level of pedestrian activity, typically greater than 10 to 20 pedestrians per hour.

An example of a Type 2 Pedestrian Crossover and its supporting elements are illustrated in **Figure 5**.

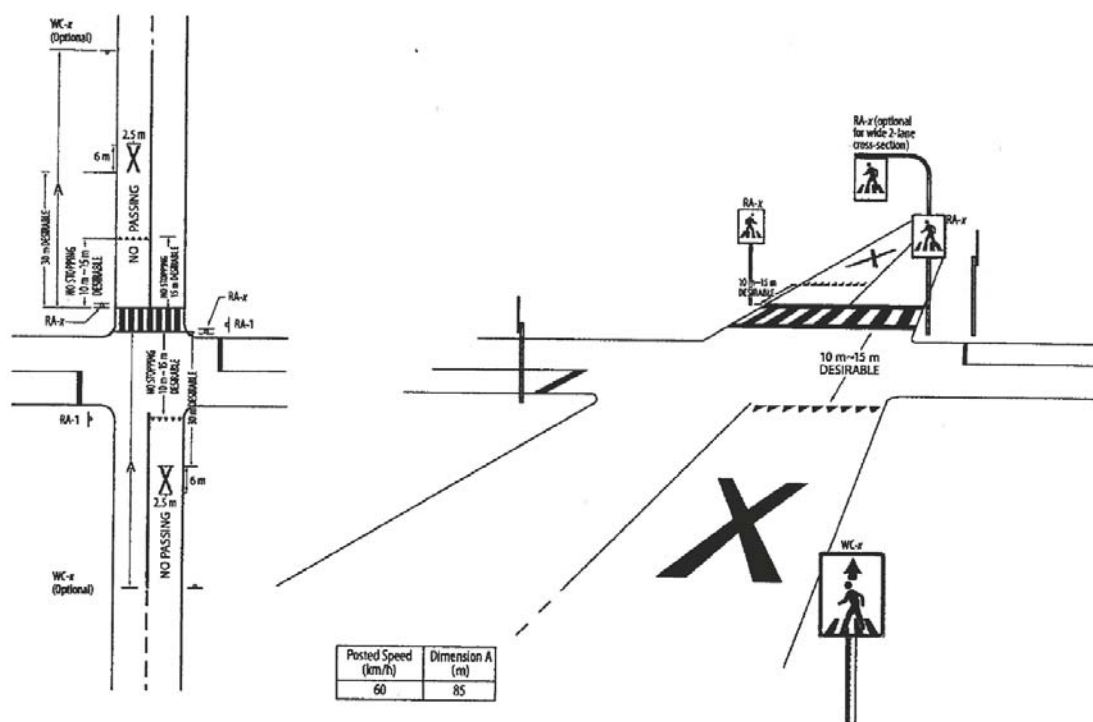


Figure 5: Type 2 Pedestrian Crossover

(Source: Figure 13 – OTM Book 15, December 2010)

The warrants for Type 1 and Type 2 pedestrian crossovers are also suitable for IPS and mid-block signals.



3.7 All-Way Stop Warrants

The City of Greater Sudbury has adopted a modified All-Way Stop policy that is modified from the provincial warrants published in the OTM, since it was determined that the provincial all-way stop warrants were too restrictive. The warrant used is based on the same principles contained in the Ontario Traffic Manual. The main difference is that the traffic volume and collision warrants have been reduced for lower volume collector roads and residential roadways. A summary of the warrant is as follows:

Minimum Volume Warrant

- 1) Arterial and major collector roadways with Annual Average Daily Traffic volume (AADT) greater than 5,000
 - a. Total vehicle volume on all approaches exceeds 500 vehicles per hour for an eight (8) hour period, and
 - b. A combined vehicle and pedestrian volume for the minor street is more than 200 per hour for the same eight (8) hours, and
 - c. The traffic volume on the intersecting streets is similar and does not exceed a 70/30 split
- 2) Minor collector roads with an AADT between 1,000 and 5,000
 - a. Total vehicle volume on all approaches exceeds 350 vehicles per hour for four (4) hours
 - b. The combined vehicle and pedestrian volume from the minor street is more than 140 per hour for the same four (4) hours,
 - c. The traffic volume on the intersecting streets is similar and does not exceed a split of 70/30

Collision Warrant

- d. For both major and minor roadways, All-way stops are warranted when there is an average of four (4) or more collisions over a three (3) year period. Only those collisions that may be corrected with an all-way stop are to be considered.
- 3) Local roads with an AADT less than 1,000
 - a. Total vehicle volume on all approaches exceeds 250 vehicles per hour for a four (4) hour period.
 - b. The traffic volume on the intersecting streets is similar and does not exceed a split of 65/35 for four-way control and 75/25 for three-way control.

Collision Warrant

- c. For intersecting roadways, All-way stops are warranted when there is an average of two (2) collisions per year over a three (3) year period. Only collisions that may be corrected with an all-way stop are to be considered.

3.8 Pedestrian Crossing Guard

The *School Crossing Guard Review 1992*, published by the Ministry of Transportation (MTO) and the Ontario Traffic Conference (OTC) is the most common guideline used in jurisdictions across Ontario. These municipalities include City of Mississauga, Town of Aurora, Town of



Markham, Town of Richmond Hill and City of Kingston. The guideline outlines the procedures for investigating requests for school crossing guards. The warrants are assessed based on the existence of adequate gaps in traffic to permit students to safely cross the roadway. The procedure involves site investigations, measurement of gaps in traffic, and sight line and stopping sight distance measurements.

The City of Greater Sudbury has adopted this School Crossing Guard criteria for use in their jurisdiction as listed in **Table 3** below.



Table 3: City of Greater Sudbury - Crossing Guard Warrant

A School Crossing Guard will be added at a location within the City of Greater Sudbury when both Criteria I (Number of School Children) and Criteria II (Gap Time or Sight Lines) are met.
Criteria I - Number of School Children
<p>A minimum of 40 elementary school children cross a two lane street with a regulatory speed limit of 40 km/hour or 50 km/hour or, 20 children crossing a major arterial road with two or four lanes with a regulatory speed limit of 60 km/hour.</p>
Criteria II – Gap Time
<p>Fewer than 5 sufficient time gaps (based on five minute time frames) during the defined periods children go to school, namely before and after school, are available for children to cross a roadway safely.</p>
<p><i>OR</i></p>
Criteria II – Site Lines
<p>Insufficient sight visibility distances are provided for either the child or the driver at a crossing location.</p>
Deleting a School Crossing Location
<p>A school crossing guard location will be deleted when either Criteria III or IV are met.</p>
Criteria III – Number of School Children
<p>The number of elementary school children crossing a two lane street with a regulatory speed limit of 50 km/hour decreases to 20 students or less; or the number of school children crossing a major arterial road with two or four lanes with a regulatory speed limit of 60 km/hour decreases to 10 students or less.</p>
Criteria IV – Gap Time
<p>Street conditions are altered either through design or other external factors which results in an increase in Gap Times such that there are five (5) or more sufficient gaps (based on five minute time frames) during the defined periods children go to school, namely before and after school, which are available for children to cross a roadway safely.</p>
<p><i>OR</i></p>
Criteria IV – Sight Lines
<p>The sight visibility distances improve through design or external factors which are sufficient to provide for the safe crossing of elementary school children at the crossing location.</p>



3.9 Pedestrian Grade Separation

Documented and accepted warrant thresholds for grade separation are not available. Consideration for grade separation is usually based on the lack of alternative crossing options. Such is the case when some form of protected crossing is warranted, but installation of warranted devices are not practical due to limiting constraints such as road geometry/environment or spacing of adjacent traffic control devices. Grade separation may be considered when there is pedestrian volume, high risk of conflict with vehicles, limited opportunities for safe at-grade crossing, and where the road environment and elevations are conducive. Grade separated crossings are only effective where pedestrians can be directed to use the facility and sufficient property and capital funds are available.

3.10 Supplementary Features

The use of supplementary features, such as islands do not have warrant thresholds identified in the OTM, but thresholds have been established by other jurisdictions as shown in **Table 4**.

Crosswalk warrants and implementation guidelines are contained in the Transportation Association of Canada (TAC) Pedestrian Crossing Control Manual. In these guidelines the pedestrian volume is converted into equivalent adult units (EAU's) where children, seniors and the disabled are given preferential treatment to account for their higher vulnerability. Children and the disabled receive a weighting factor of 2 and seniors a factor of 1.5.

Thresholds for the use of bulb outs, textured pavement at pedestrian crossings/high visibility markings, specialized pedestrian signage, flashing beacons, barriers or delineators are not available.

Table 4: Supplementary Control Features Warrants

Traffic Control Feature	Threshold	Source
Refuge Island	100 pedestrians over peak 8 hours of the day Documented pedestrian safety concerns	City of Toronto
Flashing Beacon	3 collisions per year for 3 years	MUTCD
Crosswalk Lines	For a 2-lane (7.5m) cross-section : Traffic volume > 400 veh/h AND Equivalent Adult Units (EAUs) > 15 /hour ¹ For a 4-lane (15 m) cross-section : Traffic volume > 300 veh/h AND Equivalent Adult Units (EAUs) > 15 /hour ¹	TAC

¹ Based on an "analysis period" which consists of the peak hour for traffic and pedestrian volumes combined.



3.11 Removal of Pedestrian Crosswalks

The use of crosswalk markings at unprotected locations offers the benefit of directing pedestrians to a preferred crossing location where alternative protected crossings are not conveniently available. The crosswalk can focus pedestrian activity and direct pedestrians to locations where sight distance is greatest or unanticipated conflicts are lowest.

However, unprotected crosswalks offer disbenefits of potentially encouraging pedestrians to cross at unprotected locations. There is also the potential that pedestrians who do not understand the rules of the road may mistakenly interpret the crosswalk markings as a protected crossing.

As vehicle volumes and speed on the roadway increase the exposure and risk to pedestrians, the disbenefits of unprotected crosswalks outweigh the benefits. According to the *Pedestrian Facilities Users Guide – Providing Safety and Mobility*, March 2002 by the U.S. Department of Transportation, marked crosswalks should not be used under the following conditions:

- Where the speed limit is 60 km/h or higher, and
- On a roadway with four or more lanes without a raised median or crossing island that has (or will soon have) an ADT of 12,000 or greater, or
- On a roadway with four or more lanes with a raised median or crossing island that has (or will soon have) an ADT of 15,000 or greater.

3.12 Pedestrian Crossings at Roundabouts

The OTM Book 15 provides recommendations for the application of pedestrian crossings at Roundabouts. Accommodating pedestrian crossings at roundabouts requires sidewalk connections to the pedestrian crossing, signing, curb depressions, and refuge islands on splitter islands. The following building principles for accommodating pedestrian crossings at roundabouts are outlined in OTM Book 15:

- Pedestrian crossings are provided around the perimeter of the roundabout, with pedestrian access to the centre island strongly discouraged.
- Pedestrian crossings be located one vehicle length (typically 6.0 to 7.5 metres), or a multiple thereof, back from the yield line.
- Aligning pedestrian crossings in a straight, continuous alignment across the entire roundabout, or angling the pedestrian crossing perpendicular to the direction of traffic.
- The width of the splitter refuge island areas used as part of the pedestrian crossing should be at least 1.8 metres wide; while the cut-through width along the length of the refuge island should be the same width as the pedestrian crossing.
- The application of pavement markings and signage, since there is no formal pedestrian right-of-way at roundabouts, unless accompanied by a traffic control device.
- Consideration of the application of the PEDESTRIAN AHEAD (Wc-7) sign.

An example of a roundabout with a pedestrian crossing the recommended signage, as per OTM Book 15, is illustrated in **Figure 6**.

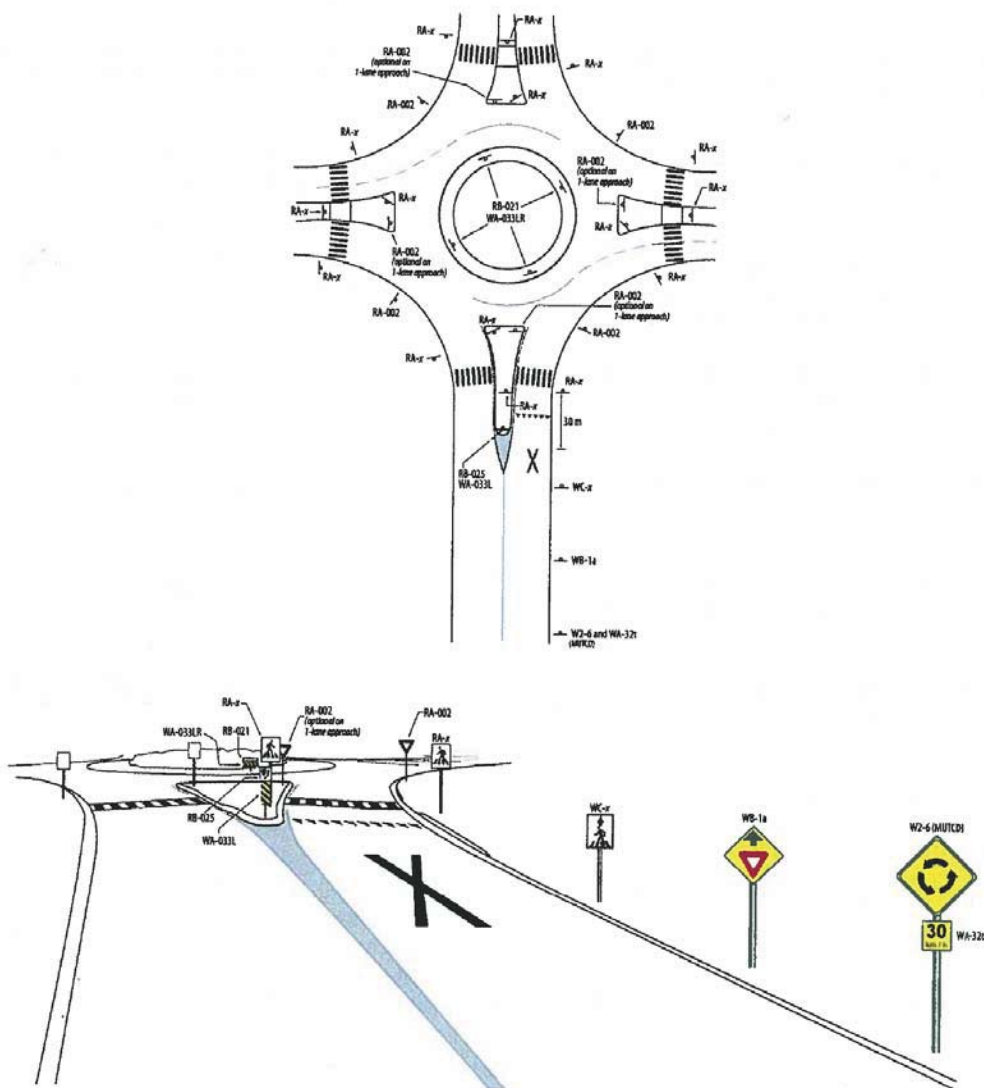


Figure 6: Example of a Roundabout with a Pedestrian Crossing and Recommended Signage

(Source: Figure 23 – OTM Book 15, December 2010)

3.13 Safety and Security

OTM Book 15 identifies various factors to be considered which influence the level of safety for pedestrians in the roadway environment. Those factors include:

- The degree of pedestrian-vehicle interaction
- Vehicle speeds
- Road users' expectancy
- Road users' perception
- Road users' awareness
- Road users' ability (mobility, vision, hearing and cognition), and
- Road users' understanding of the rules of the road.



These factors are further described in **Table 5**.

Table 5: Factors Influencing Safety

Factors Influencing Safety	Related Impacts and Considerations for Treatment of Pedestrian Crossings
Degree of pedestrian-vehicle interaction	The potential for conflicts and collisions is directly affected by the level of interaction between road users. A higher exposure of pedestrians interacting with vehicles (from higher vehicle or pedestrian volumes) will generally result in a higher potential for pedestrian collisions.
Vehicular speed	The higher the vehicular speed at the time of impact, the higher the probability of fatality of pedestrians. Relatively small changes in speed can have a large impact on the severity of a pedestrian crash (particularly between 40 km/h and 60 km/h). ²
Driver and pedestrian expectancy	Expectancy influences the speed and accuracy of information processing; and conditions that meet or reinforce expectancies help drivers and pedestrians to respond quickly, efficiently and without error. Violations of expectancy increase the chance of inappropriate decisions that lead to conflicts or inability to control vehicles safely.
Perception (visual acuity and visual contrast)	There is an inherent limitation in drivers' or pedestrians' ability to detect objects especially under low visibility conditions. The amount of sight distance available is not the same as the distance at which the driver or pedestrian can detect and identify a conflicting object. Furthermore, the difference between visual acuity and visual contrast should also be considered. Visual acuity is a measure of the ability to identify black symbols on a white background at a standardized distance. The common threshold of "20/20 vision" translates to the ability to read text at 17 metres away for every 2.5 centimetres of text height. Visual contrast on the other hand is the ability to distinguish between various shades of gray. At night, a driver's visual contrast is much more important for detecting pedestrians than visual acuity. Both visual acuity and visual contrast decline continuously with age. In particular vision performance begins to worsen at age 20. The decline in visual acuity increases most rapidly after age 40 for objects perceived while in relative motion to the target (driving), and after age 60 for static objects. ³
Level of awareness (positive guidance and driver workload)	Humans behave as a single channel processor, which means they are able to conduct one task consciously at a time. A more complex driving environment will therefore require a higher level of mental effort and reduce one's ability to focus upon the driving tasks. Positive guidance serves to consider a driver's workload and reduce the occurrence of

² Shinar, David, Traffic Safety and Human Behavior, Elsevier Ltd, 2007, p. 640

³ Dewar, Robert and Olson, Paul. Human Factors in Traffic Safety, Lawyers & Judges Publishing Company, Inc. p. 146



Factors Influencing Safety	Related Impacts and Considerations for Treatment of Pedestrian Crossings
	multiple potential conflicts. As defined in OTM Book 1C, “Positive Guidance is provided when that information is presented unequivocally, unambiguously and conspicuously enough to meet decision sight distance criteria and enhances the probability of drivers making appropriate speed and path decisions.”
Comprehension of crossing requirements	Ambiguity in the form of crossing features can affect the consistency of driver and pedestrian behaviour in yielding right of way. An inconsistency in road user behaviour can lead to reduced safety.
Pedestrians ability	<p>Pedestrians differ in terms of their mobility, and speed, and their ability to perceive and react to potential conflicts, and recognize and understand traffic control devices. Designs for crossing devices should have regard for the needs of all pedestrians (i.e. the elderly, young and persons with a disability).</p> <p>It is also important to note that under the Accessibility for Ontarians with Disabilities Act, 2005, design elements as part of pedestrian crossings must meet the mandatory accessibility standards (see Section 5.3 of OTM Book 15).</p>
Rules of the Road	The rules of the road under the Highway Traffic Act provides the basis that governs and manages competing traffic movements, however, inconsistent interpretation, ignorance, or disregard of the law leads to potential for conflicting actions. A balance of continuous education and enforcement contributes to general population’s awareness and understanding, which contributes to the overall safety.

Source: OTM Book 15 – Table 1 – Factors Influencing Safety, December 2010



4. CURRENT PRACTICES IN SUDBURY

Current pedestrian crossing facilities and practices within the City of Greater Sudbury can be summarized as follows:

- Pedestrian crossings were within the jurisdictions of lower tier municipalities prior to the amalgamation of the City of Greater Sudbury.
- The City of Greater Sudbury currently applies guidelines prescribed in the Ontario Traffic Manual for traffic signal control. There are approximately 117 traffic signals in the City of Greater Sudbury.
- The use of intersection pedestrian signals and pedestrian signals is based on the OTM method, using Justification 5 Pedestrian Signals Warrant. There are currently two intersection pedestrian signals and three pedestrian signals in the City.
- There are no pedestrian crossovers installed in the City.
- The use of refuge islands has been implemented at several unprotected crossing locations. Common pedestrian treatments include curb depressions, warning signage, and use of partial zebra markings in lieu of typical crosswalk lines. Crossings of this nature include special message signage instructing pedestrians to yield to vehicular traffic, using “yield to traffic” signs. The City has also undertaken educational campaigns through the dissemination of pamphlets on the rules of road at these crossing.
- The uses of textured crosswalks are found at several all-way stop intersections in the downtown area. There are also painted crosswalk lines in parallel.
- The City has various unprotected crossings that are located at midblock locations, which are used to connect off-road pathways that typically run between properties. Wc-7 signs (refer to OTM Book 6) are placed along the roadway on each approach to the crossing. No warning signage is currently used along the pathway at the midblock crossing.
- There are crossing locations that are marked but unsigned. There is no formalized process for the removal of unsigned painted crosswalks.



5. BEST PRACTICES RESEARCH

5.1 Survey of Current Practices

Across Canada and in Ontario standard traffic control signals represent the most common feature for accommodating pedestrian crossings of major roadways. Many jurisdictions in Ontario also use a second form of protected crossing in instances where traffic control signals are not warranted, either IPS' OR PXOs.

For protected crossings most jurisdictions use OTM Book 12 warrants and threshold values for implementing traffic signals and pedestrian crossovers. There are an increasing number of jurisdictions implementing IPS'. Some utilize OTM methodology to implement IPS' including the City of Greater Sudbury, while other jurisdictions use the Priority Points methodology. Overall there is a trend away from the use of PXOs due to concerns over costs and dilemma zone and lack of a clearance interval.

The City of Toronto, which operates over 600 PXOs, has initiated a policy to review pedestrian crossover locations and to convert PXOs that do not meet environmental criteria to traffic control signals. The City of Ottawa and the Region of Durham have also implemented phase-out strategies.

Other features used by Ontario jurisdictions to accommodate pedestrians include: pedestrian refuge islands, specialized signs for unprotected crossings (Belleville and Kingston "Courtesy Crossings"), and grade separations (Belleville and Oakville). Four of nine jurisdictions indicated that they mark unprotected crossings.

A number of jurisdictions also indicated there is a lack of understanding of rules of the road and right of way at pedestrian crossings.

5.2 Risk and Liability

In the management of a roadway, risk and liability exist in perceived negligence, including nonfeasance and malfeasance. Nonfeasance is a condition that exists when a hazard knowingly or unknowingly exists and no effort is made or planned to be made to correct the problem. Malfeasance is a condition when an effort is made to address a hazard, but poor judgment or implementation is cited for an unsuccessful operation.

To minimize these risks, the City of Greater Sudbury can proactively monitor the safety of operations at pedestrian crossings to identify hazards and plan mitigation, establish policies that are consistent with accepted engineering practice and sensitive to the local environment, and implement improvements that are consistent with the policies / practices of their underlying principles. Practices should avoid ambiguity that may lead to confusion and misinterpretation of traffic control devices.



5.3 Safety Research

As noted, pedestrian safety is related to the level of awareness of drivers and pedestrians of potential conflicts and the level of pedestrian and driver understanding of who has the right of way where there is vehicle-pedestrian interaction. The use of traffic control features for pedestrian crossings must balance the risk (i.e. safety and liability) of encouraging pedestrian crossing activity at unprotected locations where there is potential for conflict, with the benefits of defining a preferred crossing location or alerting drivers to crossing activity.

5.3.1 Protected Crossings

Mid-block Signals

A study in the City of Tucson (*Implementation of a Program to Reduce Pedestrian-Related Accidents and Facilitate Pedestrian Crossing*, Glock et al.) reported driver's compliance at mid-block signal locations is as good as driver compliance at traditional signals. In a separate publication, some driver violations were reported (*Alternative Treatments for At-Grade Pedestrian Crossings*, ITE), however this report did not offer a quantitative assessment of the relative frequency of violations. Overall, the right-of-way at mid-block crossings with traffic signals are generally well understood by pedestrians and drivers, and as such, pedestrians and drivers are generally receptive to this type of control measures. Mid-block signals remain an accepted and appropriate crossing feature.

Intersection Pedestrian Signals (IPS or half-signals)

The concern with Intersection Pedestrian Signals has been the familiarity of road users with the signal operation and the "stop" sign compliance of motorists since side street traffic may focus on vehicle gaps rather than pedestrian phase. Failure to complete a full stop during pedestrian phase may result in a conflict. According to the recent research *A Technical Review of Pedestrian Signals in Canada* by the Canadian Institute of Transportation Engineers on "stop" sign compliance:

- There is no consistent trend on the observed stop sign violation rates between the 2000 and 2002 surveys. Some locations were subject to increased rates while rates decreased at other locations.
- Those locations with high main street volumes and high side street volumes show high stop sign violation rates.
- The warrant analysis has shown that high motorist non-compliance with side street stop signs has often occurred at locations where a pedestrian signal is operating where a full traffic signal is warranted.

A safety review of collision data for 25 pedestrian signals in Hamilton, Ontario determined that pedestrian collision rates decreased after installation of the intersection pedestrian signals. While vehicle collision rates increased at some locations and decreased at other locations, the average vehicle collision rate over all of the locations studied was lower after the IPS' were installed (*Safety Review of 25 Pedestrian Signals*, City of Hamilton)



A study in Portland, Oregon indicated that the frequency of angle collisions involving side street traffic was not increased, however, red light violations increased due to the long dwelling period on the green signal. (*Alternative Treatments for At-Grade Pedestrian Crossings, ITE*)

Overall, IPS' allow for a clearance interval, is an accepted device to complement traffic control signals, and are seen as an appropriate feature for the City of Greater Sudbury. However, given that there is limited statistical research into the operations of IPS', the City of Greater Sudbury should consider driver workload turning from the side-street and potential for vehicle-pedestrian conflicts at any new IPS locations.

Pedestrian Crossover

No published references quantifying the safety implications of pedestrian crossovers were identified, however previous studies have been raised concerns about PXO operations. Unlike traffic control signals, PXOs do not have a clearance interval (amber phase) during which time drivers can clear the crossing. Without the clearance phase, drivers face a 'dilemma zone' where drivers may have insufficient time to see pedestrians and stop comfortably. In many locations driver stopping behaviour is inconsistent, leading to rear-end vehicle-vehicle collisions. Human factors experts have raised concerns over the conspicuity of flashers, particularly during daytime hours (*Review of Pedestrian Refuge Islands and Split Pedestrian Crossovers*, City of Toronto).

The City currently does not have any PXOs. Past staff reports have noted unfamiliarity among Sudbury drivers and pedestrians as one of the reasons for not installing PXOs. There is no research available that addresses the acceptability of the 'dilemma zone' inherent in PXOs or any benefits of PXOs over alternative crossing features such as IPS' or traffic control signals.

Pedestrian Grade Separation

Studies have shown that pedestrians will not use the overpass or underpass if they can cross at street level in less time (*Canadian Research on Pedestrian Safety, Report No. FHWA-RD-99-090*, Van Houten). Other important design considerations include accessibility, lighting, drainage, and aesthetics.

Grade separation can be a feasible alternative to at-grade crossings. However the benefits should be assessed relative to costs and in recognition of the likelihood of pedestrians using the grade separation.

A summary of the implications of crossing alternative is summarized in



Table 6.



Table 6: Assessment of Alternative Pedestrian Facilities

Facility Type	Pros	Cons
Traffic Control Signals	<ul style="list-style-type: none"> Allows for pedestrians to cross during their own “protected phase” Drivers must yield during pedestrian green phase Amber phase allows drivers to clear the intersection 	<ul style="list-style-type: none"> Pedestrians susceptible to conflicts with turning traffic Unwarranted signals can increase delay to traffic May increase delay to pedestrians Potential for higher number of rear end collisions
Intersection Pedestrian Signals	<ul style="list-style-type: none"> Minimize side street delay Pedestrians cross during own “protected phase” Amber phase allows drivers to clear the crossing Lower delay to side street than all-way signals Does not attract more traffic to the side street as would a conventional signal 	<ul style="list-style-type: none"> Low public familiarity Side street vehicle focus is on vehicle gaps rather than pedestrian activities Main street driver confusion may contribute to rear end collision potential Limited data on the safety implications of IPS Cost of installation is high
Mid-block Pedestrian Signals	<ul style="list-style-type: none"> Allows for pedestrians to cross during their own “protected phase” Drivers must yield during pedestrian green phase Amber phase allows drivers to clear the intersection 	<ul style="list-style-type: none"> Unwarranted signals can increase delay to traffic Cost of installation is significant Potential for higher number of rear end collisions
Pedestrian Crossovers	<ul style="list-style-type: none"> Drivers must yield after pedestrian activate flashers Flashing beacon may draw driver attention to a crossing 	<ul style="list-style-type: none"> Beacons not conspicuous during daylight conditions Lack of amber phase results in a “dilemma zone”, drivers may not have time to see pedestrian and stop comfortably Inconsistent driver behaviour with stopping Significant costs for installation and on-going maintenance
Pedestrian Grade Separation	<ul style="list-style-type: none"> Highest form of protected measure 	<ul style="list-style-type: none"> Cost of installation and maintenance Pedestrians will not use if a more direct route is available Possible security concerns



5.3.2 Unprotected Crossings

The decision to implement unprotected crossings is a balance between increased driver awareness of crossing activity (on the positive side) and more aggressive pedestrian activity (on the negative side). Painted crosswalks for example, in absence of a crossing guard, stop control, PXO or traffic signals can instill a false sense of security for pedestrians. Extensive research projects have demonstrated how the introduction of unmarked crosswalks has increased vehicle-pedestrian collision frequency (*Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Analysis of Pedestrian Crashes in 30 Cities, Zegeer et. al.*).

Warning signage on the other hand may help alert drivers, without increasing pedestrian aggressiveness. In addition, a variety of treatments as discussed in **Section 2.2** may be considered. The advantages and disadvantages of each type of treatment are summarized in **Table 7**.

Table 7: Summary of Common Supplementary Treatment Options

Facility Type	Pros	Cons
Refuge Island and Centre Medians	<ul style="list-style-type: none"> ▪ Simplifies pedestrians crossing decisions ▪ Reduces walking distance ▪ Reduces pedestrian delays through increases in gap availability 	<ul style="list-style-type: none"> ▪ Ineffective under certain conditions ▪ Inconvenience to road maintenance vehicles ▪ Vehicle-curb collisions
Bulb Outs or Curb Extensions	<ul style="list-style-type: none"> ▪ Reduces walking distance ▪ Improves visibility of pedestrians ▪ Traffic calming 	<ul style="list-style-type: none"> ▪ Inconvenience to road maintenance vehicles ▪ Vehicle-curb collisions ▪ Reduces on-street parking
Textured Surfaces	<ul style="list-style-type: none"> ▪ Attracts drivers' attention ▪ Identifiable by pedestrians with visual impairment ▪ Traffic calming 	<ul style="list-style-type: none"> ▪ Noise impacts ▪ Maintenance cost ▪ May not be as visible as the high-visibility markings ▪ May lead pedestrians to believe they have the right of way if crosswalk is unsigned
High-visibility markings	<ul style="list-style-type: none"> ▪ Attracts drivers attention ▪ Identifiable by pedestrians with low vision 	<ul style="list-style-type: none"> ▪ Maintenance cost ▪ May lead pedestrians to believe they have the right of way if crosswalk is unsigned
Standard Warning Signage (e.g. Pedestrian ahead sign)	<ul style="list-style-type: none"> ▪ Heighten driver and pedestrian awareness 	<ul style="list-style-type: none"> ▪ Overuse of treatment may result in "novelty effect"



Facility Type	Pros	Cons
Specialize Sign Formats (e.g. Fluorescent yellow-green warning signs)	<ul style="list-style-type: none"> Attracts drivers attention to crossing activity More conspicuous at night and at dusk 	<ul style="list-style-type: none"> Overuse of treatment may result in “novelty effect”
Flashing Beacons	<ul style="list-style-type: none"> Attract driver attention 	<ul style="list-style-type: none"> Inconsistent driver behaviours at crossing
Barriers	<ul style="list-style-type: none"> Control pedestrian activity and direct pedestrians to preferred crossing point 	<ul style="list-style-type: none"> Pedestrians who enter the road around or over the barriers may become trapped within the roadway and become in conflict with on-coming vehicles
Delineators	<ul style="list-style-type: none"> Delineator posts can be used to alert drivers to the boulevard Reflective tape can significantly improve night visibility of formal and informal crossings 	
Special Message Signs (e.g. Courtesy Crossing or Yield to traffic)	<ul style="list-style-type: none"> Clearly identifies right-of-way 	<ul style="list-style-type: none"> Inconsistent driver behaviour and stopping expectation and pedestrian compliance for “Courtesy Crossing”

Research related to some of the more common treatments are summarized. It is not all inclusive as there are many combinations and variations for each treatment.

Refuge Island

As noted, “Pedestrian refuge islands are suitable for wide two-way streets with four or more lanes of moving traffic travelling at higher speeds [50 km/hr or higher]. They are useful to persons with mobility disabilities, very old or very young pedestrians who walk at slower speeds.” Research by the Federal Highway Administration entitled ***Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations*** (2002) concluded that the presence of a raised pedestrian island (or median) was associated with a significantly lower pedestrian crash rate at multi-lane sites. These results were in basic agreement with previous studies that found safety benefits for medians and refuge islands. However, the use of refuge or median islands is dependent on the surrounding condition. Research has shown that reductions in pedestrian-related collisions occurred only at sites where refuge islands were constructed on roads adjacent to high pedestrian generators (***Road Safety at Pedestrian Refuges, Lalani***).

Some municipalities do not install refuge islands, citing maintenance issues.

There is an overall benefit in refuge islands if they are implemented within suitable environmental conditions; and the City has successfully implemented number of them. It is recommended that the City continues the use of pedestrian refuge islands as appropriate. Traffic



conditions at the existing locations should be monitored on a regular basis for any increase in traffic, which may warrant more protective measures.

Curb Extensions

Curb extensions reduce the crossing distance for the pedestrians and also increases visibility of pedestrians. It may be considered where there are mid-block crossing from both sides. Numerous publications document the benefits of curb extensions and their application in urbanized low speed environments.

Curb extensions represent a new alternative feature that the City of Greater Sudbury can consider in urbanized low speed environments.

Textured Surface

Although there has been limited research with respect to the use of textured crosswalk and its safety impact, the use of textured surface is prescribed under the *Alternative Treatment for At-Grade Pedestrian Crossings, ITE* and the *Canadian Guide to Neighbourhood Traffic Calming, TAC*. However based on observations at unsignalized crosswalks in the City of Belleville and City of Kingston and other jurisdictions, driver behaviour (courtesy gaps) may not be consistent and may contradict the rules of the road.

Textured surface and high-visibility markings are similar in that both styles attract drivers' attention. Zebra style markings have been implemented with the City, and to maintain uniformity, textured surface is not recommended at mid-block locations.

High-visibility Markings

High visibility markings include Zebra style markings. One recent study investigated the safety effects of Zebra markings at two signalized intersections. The study results showed a statistically significant 80% reduction in vehicle-pedestrian conflicts after the implementation of the markings at one of the two sites (*Evaluation of Zebra Crossings*, City of Toronto).

No definitive North American research findings have been presented on Zebra style markings at unprotected crossings. The lack of research neither draws into question nor supports the use of Zebra style markings.

The City of Greater Sudbury has implemented Zebra style markings at fourteen intersections as a trial to enhance the visibility of the crosswalk and improve safety for pedestrians. Many of the trial locations included crossings locations where previous concerns about pedestrian safety were raised, as well as locations with high volumes of pedestrian and vehicle traffic, and a high percentage of seniors and school aged children. The City has received positive responses to the zebra markings, and as budget becomes available, the City has recommended continuing to install the zebra crossing markings at signalized intersections. The City however, has stopped using Zebra style markings at unprotected crossing locations, with the exception of the crossing at the Rainbow Mall, across Elm Street and at some rural school crossings.



Fluorescent Yellow-Green Warning Signs

The use of fluorescent yellow-green signs attracts attention and enables higher frequency of detection and recognition by drivers in comparison to regular yellow warning signs.⁴ Its application includes courtesy crossing (City of Belleville) and school crossing (City of Burlington, City of Kingston). Studies have shown that drivers were able to detect and recognize the signs from greater distances than standard yellow warning signs (*Fluorescent Yellow Green Warning Signs for Pedestrians, School and Bicycle Crossings, Kittle*). A human factors study has also identified that the “novelty effect” does not negate the effectiveness over the long term (*Driver Looking Behavior in School Zones with Florescent Yellow Green and Normal Yellow Signs*). The City of Kingston has cited a 50% increase in yielding to pedestrians at unprotected crossings.

The results of the City of Kingston study highlights the effectiveness of the sign, but raises questions about increasing ambiguity of right of way rules at unprotected crossings. Therefore, the use of fluorescent yellow-green signs should not be adopted as a means of justifying unprotected crossings.

“Yield to Traffic” Sign

The Province of Ontario is unique in that pedestrians must yield to traffic approaching an unprotected crossing. In some instances signage (Wc-28 in the OTM Book 6) are used to clarify to pedestrians in instances when they do not have the right of way. No research has been completed assessing the effectiveness of these signs; however similar signs have been implemented to address operational issues with pedestrian refuge islands.

5.3.3 Removal of Pedestrian Crosswalks

Studies have shown that marked crosswalks alone have resulted in higher numbers of pedestrian-related collisions at uncontrolled or unsignalized (mid-block and intersection) locations when compared with having no marked crosswalks on multilane (four or more travel lanes) roadways with ADTs of 10,000 or more (*Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations, Zegeer et. al.*). In contrast, there was no difference on two-lane roads and multilane roads with less than 10,000 ADT. As a result of this study, countries such as Great Britain, Germany, Sweden and some California Cities (Los Angeles) have removed marked crosswalks as a treatment at uncontrolled locations on multilane streets during resurfacing projects with some positive results (*Alternative Treatments for At-Grade Pedestrian Crossing, Lalani et. al*).

The City of Greater Sudbury may consider the quantitative and qualitative measures identified in **Section 3.11** in justifying crosswalk removal on multilane roads. It is important to consult all the stakeholders in the process and consider all legal ramifications regardless of removal or not. Pedestrians and especially those with mobility needs will have to be accommodated elsewhere if pedestrian crosswalks are removed. Crosswalk markings must be maintained in good condition,

⁴ Alternative Treatments for At-Grade Pedestrian Crossings, ITE



and be supplemented with warning signs or other features that will increase drivers' and pedestrians' awareness if pedestrian crosswalks are not removed.

5.4 Conclusions

From the review of survey of current practices, risk, and research into operational characteristics of crossings, the following points were considered in the development of the crossing policy:

- It is desirable to distinguish between protected and unprotected crossings, such that drivers and pedestrians understand who has the right of way.
- Mid-block unprotected crossings with pavement markings may lead unaware pedestrians and drivers to believe that the crossing is protected for pedestrians.
- Pavement Markings at unprotected crossings may result in inconsistent driver yielding ('courtesy gaps') provided by drivers. This is of particular concern leading to vehicle-vehicle or vehicle-pedestrian conflicts on 4-lane facilities where driver yielding behaviour in one lane may not be consistent with another.
- At mid-block locations, where the adjacent land uses such as high pedestrian generators and trails create high mid-block crossing demand, signage can contribute to driver awareness and pedestrian caution without making the rules of right of way ambiguous for drivers and pedestrians.
- If implementing protected crossing features (PXO's or IPS') to supplement traffic control signals, they should be done so in sufficient quantity such that pedestrians and drivers are familiar with their operation.
- There are operational concerns with PXO's related to the dilemma zone and clearance requirements.
- There is a trend toward the use of IPS' and a trend away from PXO's amongst Ontario municipalities surveyed.
- IPS' allow for a clearance interval, is an accepted device to complement traffic control signals, and are seen as an appropriate feature for the City of Greater Sudbury.
- Given that there is limited statistical research into the operations of IPS', the City of Greater Sudbury should consider driver workload turning from the side street and potential for vehicle-pedestrian conflicts at any new IPS location.



6. RECOMMENDED PEDESTRIAN CROSSING POLICY

6.1 Decision Process for the Consideration of Traffic Control Devices

It is recommended that the City of Greater Sudbury implement the following pedestrian features as warranted based on OTM Book methodologies and thresholds, to accommodate protected pedestrian crossings:

- Traffic control signals at intersections
- Traffic control signals mid-block
- Intersection pedestrian signals, and
- Adult crossing guards.

The decision process for determining an appropriate traffic control device to accommodate pedestrians crossing a roadway is dependent on an assessment of pedestrian crossing needs at a particular intersection and the available warrants for traffic control devices. The implementation of traffic control devices must take into consideration the accommodation of pedestrians, while also maintaining the overall continuity and connectivity of the road network.

The process should commence with an assessment of traffic conditions based on field-generated data such as vehicle and pedestrian volumes, delays to crossing pedestrians, roadway geometry, pedestrian desire lines and collision data for example.

Based on this assessment, Justifications 1 through 6 identified in OTM Book 12 should be referred to, to determine if full traffic signals are warranted. If warranted, then an engineering assessment should be undertaken to determine whether the installation of traffic signals is geometrically feasible based on the conditions of that particular site (e.g. signal spacing, adequacy of sight lines, traffic progression, benefit/cost, etc.)

If traffic signals are not warranted, then other pedestrian control measures should be considered such as the use of stop or yield signs, pedestrian crossing enhancements such as pavement marking improvements, or the addition of applicable pedestrian-crossing warning signage.

Other considerations such as grade separation may also be considered if such as crossing is warranted, funding is available for a grade separated crossing, and other recommended pedestrian crossing measures are not feasible.

Additional details on the decision-making and selection process for traffic control devices are provided in Section 3.1.2 of the OTM Book 15. It is recommended that the City of Greater Sudbury follow this decision-making process when considering and selecting appropriate pedestrian crossing facilities.

Additional recommendations for various types of traffic control devices for the City of Greater Sudbury are provided in the following subsections.



6.2 Traffic Control Devices

6.2.1 Traffic Control Signals

For the installation of traffic control signals at intersections, mid-block locations, it is recommended that the City of Greater Sudbury implement these features as warranted, based on the OTM Book methodologies and thresholds.

6.2.2 Intersection Pedestrian Signals

For the installation of Intersection Pedestrian Signals (IPS), it is recommended that the City of Greater Sudbury implement these features as warranted, based on the OTM Book methodologies and thresholds. IPS's should particularly be considered at locations where there is a documented safety problem (i.e. visibility or measured sight distance constraints, collision trends, or frequent vehicle-pedestrian conflicts) and traffic signals are not warranted. In considering IPS applications, the City will have regard for driver workload for sidestreet approaches in the decision to implement and in the design. The decision to install unwarranted signals should weigh the benefits against the negative impacts.

6.2.3 Pedestrian Grade Separation

Pedestrian grade separation should be considered within the context of potential benefits and costs, at locations where the other forms of protected crossings are warranted, but cannot be implemented due to environmental constraints (such as distance of adjacent traffic controls). Grade separations are viable only if pedestrians can be directed to use the facility and sufficient property and capital funds are available.

6.2.4 Unprotected Crosswalks

With the exception of crosswalks for school crossing guards, marked unprotected crosswalks should generally be discouraged. However, the specific characteristics and needs of each location should be carefully considered and appropriate treatments applied to maximize safety. For example, consideration has been given to the delineation of high contrast markings to distinguish pedestrian desire lines in highly urban areas where drivers are aware of very high pedestrian activity. In these locations, pedestrian signage should acknowledge that pedestrians do not have the right of way over vehicles (e.g. OTM Book 6 Wc-28 sign). In other areas where there is high pedestrian/vehicular activity and/or high vehicle speeds, pedestrian markings at unprotected locations should not be implemented.

At locations where unprotected crosswalks are maintained, warning signage can be implemented as appropriate (OTM Book 6 Wc-3, Wc-7 signs or specialized signs) that will increase drivers' awareness of pedestrian activity. Pedestrian refuge islands or centre medians will also be considered as a passive feature at unprotected crossing points where lane alignment is not compromised (e.g. integrated with centre turn lanes). Other measures such as reflective delineator poles may be considered at the boulevard of unprotected crossing locations in order to draw the driver's attention to potential crossing activity.



The City of Greater Sudbury shall consider removing unprotected crosswalks on high speed or high volume multilane roads, where the crosswalk is not specifically intended to direct pedestrians away from crossing at locations with poor sight lines or unanticipated conflicts. The City will consider the removal of unprotected crosswalks under the following circumstances:

- Where the speed limit is greater than 60 km/h, and
- On a roadway with four or more lanes without a raised median or crossing island that has (or will soon have) an ADT of 12,000 or greater, or
- On a roadway with four or more lanes with a raised median or crossing island that has (or will soon have) an ADT of 15,000 or greater.

The removal of crosswalks should include public notification.

On two lane, low speed roads (e.g. 50 km/h or less) in sub-urban areas, where unprotected crosswalks are maintained, it is recommended a pedestrian warning sign (Wc-7) be posted in advance of the crossing per OTM Book 6, and that two back to back Wc-7 signs be mounted on each side of the road in the immediate vicinity of the crossing. Additionally, no pavement markings shall be used to denote the crossing on the roadway and existing pavement markings shall be removed.

6.2.5 Off-Road Pathway Crossings

For off-road pathway crossings, the City should remove the pavement markings used to denote the crossing. Since pedestrian crossing activity would likely continue at these locations, following the removal of the crossing pavement markings, the City should follow the recommendations identified in Section 6.2.4 for two lane, low speed roads, where existing off-road pathway crossings are located.

In addition, “Yield to Traffic” signs, similar to those used at the Elm Street crossing, bollards or gates should be considered on the pathway approaches to the road crossing. Wc-7 signs should continue to be used on each of the roadway approaches. It should also be noted that these locations may also be suitable for the application of RA-x signage, as indicated in OTM Book 15, as a pilot project. OTM Book 15 identifies the application of RA-x signage placed along the roadway between 10 and 15 metres from the pathway crossing (Refer to OTM Book 15; for Proposed HTA, December 2010 - Figure 23).

6.3 Next Steps

It is recommended that the City of Greater Sudbury proactively address pedestrian safety needs and establish a program of reviews of pedestrian crossings either through on-going traffic operations studies or annual corridor reviews. Compliance with the pedestrian crossing practices will be reviewed, and necessary roadway and traffic control modifications programmed and implemented. Streetlight warrants and maintenance should also be monitored.

Other features may be considered for implementation by the City of Greater Sudbury on a site-by-site basis to enhance pedestrian safety based on the needs of the particular site.



February 2012

Pedestrian Traffic Study Crossing Review

City of Greater Sudbury



Final Report





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1. INTRODUCTION

1.1 Project Objectives

The City of Greater Sudbury has been responsive to the need to better accommodate the safety and security of pedestrians in the roadway environment. To this end, the City initiated a pedestrian crossing policy study and reviews of pedestrian safety and accommodation of “in-service roads”. This study is an assessment of specific pedestrian crossings in downtown Sudbury.

It is the objective of the study to assess the appropriateness of the existing forms of pedestrian crossings. It provides an inventory of existing conditions and identifies opportunities to improve pedestrian crossing safety. For the recommended measures, an implementation strategy is also identified.

It should be noted that this study commenced in 2006 with a draft report submitted to the City at that time. Since then, some of the recommendations identified in the draft report have been implemented. Other changes that have occurred at the study sites since 2006 have also been noted in this version of the report.

1.2 Study Context

Pedestrian safety is related to the level of drivers and pedestrian awareness of potential conflicts, the level of pedestrian and driver understanding of who has the right of way where there is vehicle-pedestrian interaction, and the degree of care and disregard for safety. Efforts can be made to address each of these effects on pedestrian safety through public awareness and education. In addition, awareness and understanding of right of way can be enhanced through the design of road signs and pavement markings, and pedestrian infrastructure.

Road designs and use of traffic control measures can help maximize driver and pedestrian awareness of vehicle-pedestrian interaction, minimize distractions and obstructions, and improve understanding of which road user has the right of way. It is engineering practice to select designs that:

- Offer consistency in design approach in order to contribute to driver expectation that is appropriate for the road environment and potential hazards, and
- Are appropriate for the unique characteristics for each individual site.

The City developed draft pedestrian crossing policies in light of the benefits of improving driver and pedestrian awareness and understanding of right of way. The application of the policies cannot be applied in all instances. It is recognized that each site is unique. The sites under review have been identified as a result of configurations that are historical and may have resulted from a combination of land uses and roadway characteristics that are no longer desirable from a pedestrian safety and security perspective. In many situations, opportunities to change the fundamental nature of the pedestrian environment may not be feasible. However through this



study, efforts have been made to maximize driver and pedestrian awareness and understanding for each site.

1.3 Study Scope

This report presents the findings of the pedestrian review for three specific crossing locations in the downtown area, identified below and indicated in **Exhibit 1**:

- Elm Street (west of Notre Dame Avenue between City Centre and Sudbury Transit Terminal)
- Ste. Anne Road (between Ignatius Street and Notre Dame Avenue), and
- Brady Street at Shaughnessy Street

A detailed review of collision history was beyond the scope of this study. However, the City did provide traffic and pedestrian volume and collision data. The study included field visits that included observations of driver and pedestrian behavior and documentation of traffic controls and traffic conditions.

The report provides a site description, a summary of road and traffic conditions, existing traffic control, an assessment of factors that affect pedestrian safety, and opportunities for pedestrian safety improvements. The report assesses the relative merits of safety improvement alternatives and identifies any improvements recommended for implementation.



Exhibit 1: Site Locations



2. ELM STREET CROSSING



Exhibit 2: Elm Street Crossing

2.1 Site Description

The Elm Street crossing is an unprotected marked mid-block crossing located between two signalized intersections, Notre Dame Avenue – Paris Street approximately 50 metres to the east and Lisgar Street approximately 100 metres to the west. Elm Street is a 5-lane road with centre left turn lanes at the intersections. The posted speed on Elm Street is 50 km/h and carries a daily traffic volume of 16,000 vehicles. There are sidewalks along both sides on Elm Street with roadway illumination. Parking is prohibited within the vicinity of the crossing.

The surrounding land uses and buildings are illustrated in **Exhibit 2**. They include:

- Rainbow Value Centre (northwest corner of the Elm Street and Notre Dame Avenue – Paris Street intersection)
- Sudbury Transit Terminal (southwest quadrant of the Notre Dame Avenue and Elm Street intersection)
- Public parking lot located west of Sudbury Bus Terminal
- Commercial retail, offices and government buildings
- Residential and senior's home.



There are driveways within the proximity of the crossing:

- The Rainbow Value Centre driveway (35 metres west of the crossing)
- Public Parking lot driveway (35 metres west of the crossing), and
- Bus Terminal driveway (slight offset to the west of the crossing).

A raised median extends approximately 90 metres westerly from Notre Dame Avenue-Paris Street to the Mall entrance driveway with a 3-metre cut-out for the mid-block crossing. Fencing barrier is installed on portion of the median close to the Elm Street / Notre Dame Avenue – Paris Street intersection and the remaining portion has planters constructed. See **Exhibit 3**.



Exhibit 3: Raised Median Extending from Elm Street / Notre Dame Avenue – Paris Street Intersection

There are curb depressions at both ends of the crosswalk. The crosswalk lines are identified through zebra markings. The crossing is signed with “Seniors Crossing” warning signs. There are two signs facing each direction of traffic. There are also “Yield to Traffic” warning signs facing each curb side directed at pedestrians. See **Exhibit 3** and **Exhibit 4**.

The Elm Street / Notre Dame Avenue – Paris Street intersection is west of a vertical crest on Elm Street. The Elm Street / Notre Dame Avenue – Paris Street intersection has a channelized southbound right turn lane that is ‘Yield’ controlled.



Exhibit 4: Elm Street Crossing

2.2 Traffic Conditions

There is considerable pedestrian activity at the Elm Street crossing. The Rainbow Value Centre and the Sudbury Transit Terminal are both major pedestrian generators and contributors. Significant pedestrian activity is also generated from the surrounding land uses, which includes commercial retail, government buildings, a residential area, and schools. In a peak period count conducted on October 18, 2005, 757 pedestrian crossings were observed from 11:45 am to 1:15 pm.

Crossing opportunities are created naturally by breaks in traffic flows created by signals upstream of the crossing. Courtesy gaps are also provided by drivers stopping at the crossing. As observed on site, drivers do slow down upon detection of pedestrians waiting at the curb side and especially during congested conditions when eastbound queues often extend past the crosswalk. The median is sometimes used as refuge by pedestrians.

There were 16 mid-block collisions recorded between Paris Street to Lisgar Street from January 1, 2008 to December 31, 2010 (an average of just over 5 collisions per year); one of which involved a pedestrian crossing from the bus depot to the mall.



In January of 2012, the City received another report of a pedestrian being hit at the Elm Street Crossing. The incident involved a pedestrian in a wheel chair. However, a police report and additional details were not known at the time this report was prepared.

2.3 Factors Affecting Pedestrian Safety

Given that the Elm Street crossing is an unprotected crossing, there is an onus on pedestrians to ensure that there is an adequate gap in traffic sufficient for safe pedestrian crossing. Notwithstanding pedestrian responsibilities drivers must exercise reasonable care to avoid a collision with pedestrians. We considered the factors that may affect the pedestrian's ability to make appropriate crossing decisions and / or the likelihood of drivers anticipating and avoiding pedestrians within the crosswalk including:

- Pedestrians' lack of familiarity with the rules of the road and the need to wait for an appropriate gap in traffic (anticipating that all vehicles will stop for pedestrians).
- Pedestrians unable to appropriately assess spacing and speeds of approaching vehicles and opportunities to cross.
- Pedestrians not seeing / anticipating vehicles making the southbound to westbound right turn at the Elm Street / Notre Dame Avenue – Paris Street intersection.
- Drivers making southbound right turn movements at the Elm Street / Notre Dame Avenue – Paris Street intersection who focus on merging with westbound traffic and are not aware of pedestrians in the crosswalk.
- Drivers who are westbound on Elm Street approaching Notre Dame Avenue – Paris Street who's awareness of the pedestrian crossing is limited by the vertical curve in the road and navigation through the signalized intersection.
- Inconsistent driver behaviour where a driver in one lane may yield to a pedestrian, while the vehicle in the adjacent lane may not yield creating a vehicle-pedestrian conflict.
- A driver who's view of pedestrians is obscured by vehicle queues that extend through the crosswalk.
- Outbound bus drivers that do not see / anticipate pedestrians crossing as they are exiting the transit terminal.

If the zebra crossings were not in place, it is anticipated that a large percentage of pedestrians would continue to cross Elm Street mid-block. As such, many of the above factors would continue to be an issue with an unmarked crossing. In addition, without the zebra crossing markings, pedestrian crossing activity may occur within a wider range of locations and drivers may be less aware of pedestrians crossing at any particular location.



2.4 **Opportunities for Improved Safety**

Consideration was given to a range of alternative crossing configurations and features. Alternatives considered included, but were not limited to:

- Traffic control signals or mid-block pedestrian signals
- Relocation of the marked crossing
- Signage and signal phasing modifications
- Removal of the marked crossing
- Grade separation, and
- No modifications.

Each option was assessed to determine positive and negative impacts on safety and potential for implementation.

2.4.1 **Traffic Control Signals**

The feasibility of traffic control signals or pedestrian signals were considered at both the existing crossing location and at a relocated crossing location 35 metres to the west, coordinated with the public parking lot driveway. Current pedestrian volumes would meet warrant thresholds for pedestrian signals, but the spacing requirements are not met. Under typical circumstances the introduction of a signal as a protected crossing:

- Simplifies the rules of the road for pedestrians, since the right-of-way at traffic signals is generally understood.
- Drivers are required to yield to pedestrians reducing the likelihood of inconsistent driver behaviour and the effect of vehicle queues through the crosswalk.

However, in either of the locations considered for traffic signals, the distance between a new traffic signals at the crossing and existing adjacent traffic signals would be well below the general practice for spacing of signals (215 metres). Furthermore the OTM Book 12 notes: “Motorists approaching a signal must be able to see the signal indications in sufficient time to react and to take any necessary actions”; and based on a posted speed limit of 50 km/h, the minimum distance from which signal must be clearly visible is 85 metres.

The spacing would be as low as 50 metres to 80 metres, which does not allow for decision stopping sight distance between signals and would not address:

- Pedestrians not seeing / anticipating vehicles making the southbound to westbound right turn at the Elm Street / Notre Dame Avenue – Paris Street intersection.
- Drivers making southbound right turn movements at the Elm Street / Notre Dame Avenue – Paris Street intersection who focus on merging with westbound traffic and are not aware of pedestrians in the crosswalk, and
- Drivers who are westbound on Elm Street approaching Notre Dame Avenue – Paris Street who’s awareness of the pedestrian crossing is limited by the vertical curve in the road and navigation through the first signalized intersection.

Furthermore, in these instances, pedestrians will likely cross with less care given that with a traffic signal or pedestrian signal, crossing pedestrians recognize that they have the right of way.



Very closely spaced signals can also result in driver confusion where drivers may focus on downstream signals rather than the signals at the next intersection. The alternative of programmable signal heads may or may not address this operational issue.

Overall there is a potential for increased exposure to vehicle-pedestrian conflicts.

2.4.2 Removal or Relocation of the Marked Crossing

The option of removing or relocating the marked crossing was considered. Alternatives included a shift to the west side of the transit terminal driveway, and a shift to the east more in line with the Rainbow Value Centre doors.

It is anticipated that, with the removal of the crossing markings and signage, a large number of pedestrians will continue to cross mid-block at the gap in the median. As such, the crossing activity may be less focused within the block and drivers may be less prepared for the crossing activity. Fencing off the whole median is not preferred, as noted in the past staff report on the basis of legality – as pedestrians may still cross and travel along the fenced barrier, resulting in increased exposure time and gaps in the fence are still necessary to allow vehicles to turn.

A shift to the east of the marked crosswalk could result in a marginally more direct connection between Rainbow Value Centre and the Transit Terminal, but offers no tangible benefits. A shift to the east would reduce the distance available for westbound drivers to perceive and react to the pedestrian crossing and related activity following their navigation through the Notre Dame Avenue intersection. Pedestrians would also have less distance and time to judge acceptable gaps.

A shift of the marked crosswalk to the west would allow greater distance for westbound drivers to perceive and react to the pedestrian crossing and crossing activity. It would also remove the interaction and potential conflict between pedestrians in the crossing and buses exiting the transit terminal. However a shift of the crosswalk to the west is less convenient for pedestrian flows between the Rainbow Value Centre and the transit terminal (approximately an additional 40-50 metres). Pedestrians may tend to continue to cross at the most direct route, approximately at the existing crossing location, negating benefits of relocating the marked crossing.

2.4.3 Modifications to Signage and Signal Operation

Existing signage provides clear direction to pedestrians that they do not have the right of way at the crossing and that they are to yield to vehicles. Eastbound and westbound approaching vehicles are made aware of the pedestrian crossing through signage at the crossing. However, vehicles turning from the Notre Dame Avenue – Paris Street intersection to westbound Elm Street have considerable workload.

Southbound right-turning (SBRT) vehicles were previously served by a SBRT channel, requiring them to first yield to pedestrians and find gap in pedestrian flows crossing the west leg of the intersection, then to find a gap in the westbound traffic flows, and navigate the turn immediately



prior to seeing and reacting to the pedestrian crossing. The SBRT channel has since been removed and SBRT movements are now under signal control.

2.4.4 Grade Separation

Grade separation was considered as an alternative crossing measure. Grade separation provides the highest form of protection for pedestrians as it allows the opportunity to completely separate pedestrian movements from vehicular movement. For pedestrians who use the grade separation, it eliminates confusion with the rules of the road and the need to search for vehicular gaps to cross.

A grade separated connection across Elm Street would require cooperation from the Rainbow Value Centre and the Transit department. The crossing would need a clearance of 5 metres, plus construction depth of the floor. Pedestrians would have to climb 1 ½ floors to reach the structure limiting accessibility and convenience. It is questionable whether many pedestrians would use the structure with or without the existing crossing in place.

The structure would involve a span of at least 20-25 metres long and would require an independent support on the Mall and transit terminal sides. Construction costs alone would be in the order of \$250,000 to \$500,000. While this option would be considered a long-term option, given the accessibility constraints it is questionable whether the benefits would meet the costs associated with a grade separation.

2.5 Conclusions and Recommendations

It is concluded that the pedestrian demand of the current crossing is a function of existing land use (Rainbow Value Centre and the Transit terminal) and that there is no simple solution to change pedestrian desire-lines. The location of existing signals does not permit a protected (signalized) crossing with adequate sight distance.

It is recommended that the existing unprotected pedestrian crossing point be retained. The zebra markings offer greater benefit in terms of driver awareness of crossing pedestrians than any confusion it may represent in terms of pedestrian and driver right of way. Existing pedestrian signage, which addresses the need to alert pedestrians of the fact that they do not have the right of way and encourages caution, should also remain.

As previously noted, the City has removed the existing channelized southbound right-turn lane on Notre Dame Avenue at Elm Street. As such, southbound right-turning (SBRT) motorists now operate under signal-control and can either make a SBRT movement during a southbound green-phase (yielding to pedestrians crossing the west leg of the Notre Dame / Paris Street & Elm Street intersection) or after stopping at a southbound red phase and waiting for an acceptable gap in westbound traffic along Elm Street, to make their turn.



3. STE. ANNE ROAD CROSSING



Exhibit 5: Ste. Anne Road Crossing

The original scope of this study included an assessment of the formerly unprotected pedestrian crossing across Ste. Anne Road at 200 Ste. Anne Street, between Notre Dame Avenue and Ignatius Street. This crossing has since been converted into a signalized intersection on Ste. Anne Road at 200 Ste. Anne and the access to the Radisson Inn, as per the recommendation in this report. The following subsections provide a description of the former crossing and issues, which led to the recommendation to signalize the intersection.

3.1 Site Description

The Ste. Anne Road crossing was an unprotected, mid-block crossing located just west of the Radisson Inn / 200 Ste. Anne (Apartment complex) driveways as shown in **Exhibit 5**. The crossing was located approximately 170 metres west of the Ste. Anne Road / Notre Dame Avenue signalized intersection and approximately 260 metres east of the Ste. Anne Road / Elgin Street signalized intersection.

It should also be noted that another marked, unprotected pedestrian crossing is provided across Ste. Anne Road, located immediately west of Ignatius Street.

Ste Anne Road is a 4-lane road from Elgin Street to Ignatius Street and is a 6-lane road from Ignatius Street to Notre Dame Avenue. The transition commences at the beginning of the horizontal curve at Ignatius Street with the introduction of a raised median (from Ignatius Street to Radisson Inn driveway) and centre left turn lane (from the Radisson Inn driveway to Notre



Dame Avenue). The centre left turn lane provides access to 200 St Anne Road (Apartment complex). In addition, an eastbound through lane is also introduced east of Ignatius Street.

Surrounding land use and buildings are illustrated in **Exhibit 5**. They include the following:

- Rainbow Value Centre (southwest corner of Ste. Anne Road / Notre Dame Avenue)
- Residential and senior's home
- Hotels (Radisson Inn)
- Schools.

The former crosswalk extended across the west leg of the Ste. Anne Road / Radisson Inn driveway intersection at the end of the median. Curb depressions were located at both ends of the crosswalk. The crosswalk lines were identified through zebra markings and signed with "Seniors Crossing" warning signs. There were two signs facing each direction of traffic, as well as "Yield to Traffic" warning signs facing each curb side. See **Exhibit 6**.

Exhibit 6: Former Ste. Anne Road Crossing Facing East

There was a painted, but unsigned crosswalk at the west leg of the Ste. Anne Road / Ignatius Street intersection approximately 45 metres west of the subject crossing at the crest of the vertical curve and at the starting portion of the horizontal curve. See Exhibit 7.



Exhibit 6: Former Ste. Anne Road Crossing Facing East



The posted speed on Ste. Anne Street is 50 km/h and carries a daily traffic of 7,100 vehicles. There are sidewalks along both sides on Ste. Anne Street with roadway illumination. Parking is prohibited within the vicinity of the crossing.

There are a number of driveways between the crosswalk and Notre Dame Avenue, connecting from the south side to the Rainbow Value Centre parking lot and loading area.

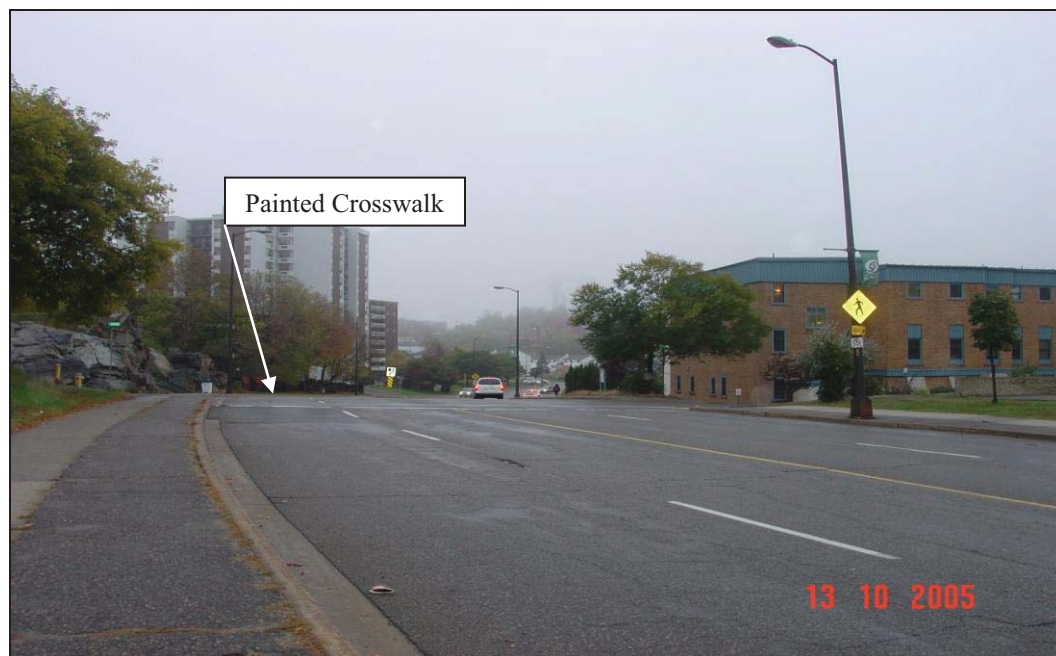


Exhibit 7: Former Ste. Anne Road / Ignatius Street Crossing (West of Subject Crossing)

3.2 Traffic Conditions

The interaction between the residential area/schools to the north and the Elm Street downtown area to the south results in several pedestrian desire lines along Ste. Anne Road as illustrated in **Exhibit 8**.

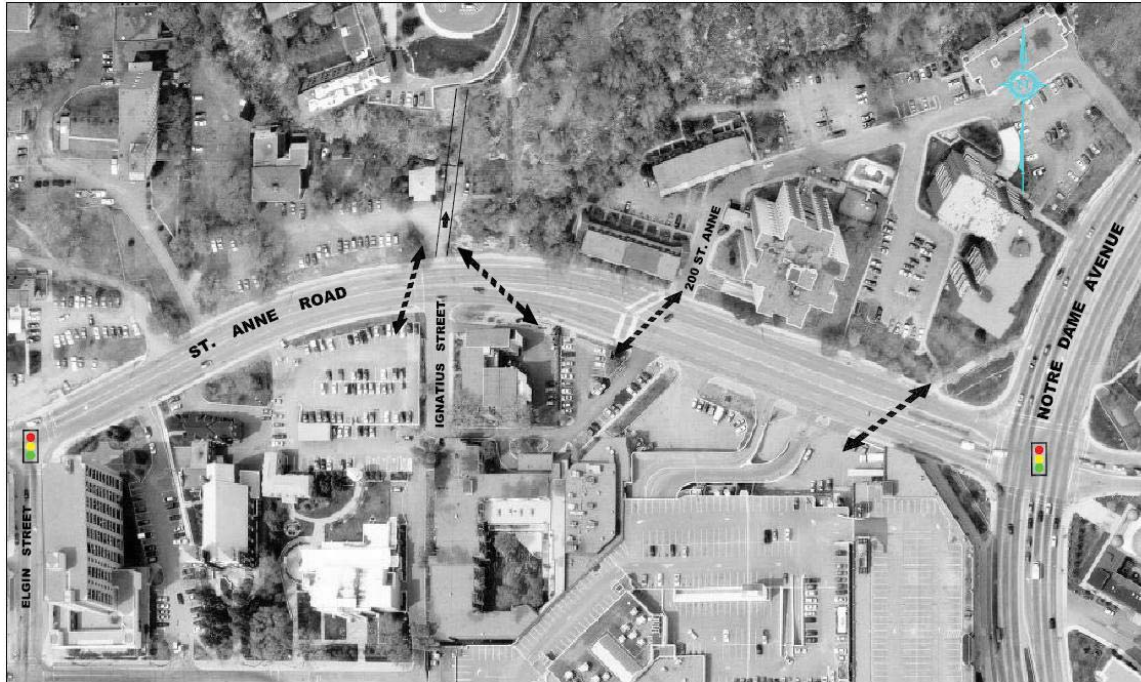


Exhibit 8: Pedestrian Desire Lines

Crossings at the subject crosswalk are generally to/from the 200 Ste. Anne Road (Apartment complex). The pedestrian activity at the crossing as indicated in a June 20, 2003 count shows a pedestrian volume of 55 during the peak hour from 3:15 p.m. to 4:15p.m.

Meanwhile, there is high frequency of mid-block pedestrian activities outside of the marked crosswalks and in particular, at the foothill of the staircase, east of Ignatius Street crossing, leading to the schools on the hilltop on the north side; and at the east end of Ste. Anne Road, where crossing at mid-block between the Seniors home and the Rainbow Value Centre were observed. The daily traffic volume of 7,084 vehicles at Ste. Anne Road is considered low.

There was only one collision reported during the period of January 1, 2008 to December 31, 2010 and it did not involve a pedestrian.

3.3 Factors Affecting Pedestrian Safety

Given that the Ste. Anne Road crossing was an unprotected crossing, there was an onus on pedestrians to ensure that there was an adequate gap in traffic, sufficient for safe pedestrian crossings. Notwithstanding pedestrian responsibilities, drivers must exercise reasonable care to avoid a collision with pedestrians. We considered the factors that may affect the pedestrians' ability to make appropriate crossing decisions and / or the likelihood of drivers anticipating and avoiding pedestrians within the crosswalk including:

- Pedestrians' lack of familiarity with the rules of the road and the need to wait for an appropriate gap in traffic (anticipating that all vehicles will stop for pedestrians)
- Pedestrians not seeing eastbound vehicles due to the vertical and horizontal curvature of Ste. Anne Road



- Drivers eastbound on Ste. Anne Road may not anticipate the crosswalk or be able to see pedestrians due to the horizontal curvature of Ste. Anne Road
- Visibility limitations at night
- Pedestrians unable to judge the adequacy of gaps in traffic for crossing, and
- The level of care taken by student pedestrians and the abilities of senior citizens crossing.

3.4 Opportunities for Improved Safety

Consideration was given to a range of alternative crossing configurations and features. Alternatives considered included, but were not limited to:

- Traffic control signals
- Relocation of the marked crossing
- Realign staircase
- Removal of the marked crossing, and
- Modifications to signage.

Each option was assessed to determine positive and negative impacts on safety and potential for implementation.

3.4.1 Traffic Control Signals

The feasibility of traffic control signals or pedestrian signals were considered at both the existing crossing location and locations 70 to 90 metres to the west, coordinated with the Ignatius intersection and driveway. At either location, spacing to the closest intersection would be approximately 170 metres, which would allow adequate time for drivers to perceive and react to signal controls.

Vehicle and pedestrian volumes (expanded to 8 hours) based on the October 2005 traffic count did not meet warrant thresholds based on the OTM 12 Pedestrian Traffic Justification. The pedestrian and vehicle volumes are approximately 90% of the warrant threshold. However, taking into consideration the potential for the re-routing of pedestrians from the adjacent traffic signals and the potential for higher pedestrian demands under spring conditions, it is anticipated that under spring conditions, the need for signals can be justified at the existing marked crossing location.

It is anticipated that at this location the introduction of a signal as a protected crossing will:

- Simplify the rules of the road for pedestrians, since right of way at traffic signals is generally understood
- Help address visibility constraints given the geometry of the roadway
- Improve visibility at night, and
- Provide for greater protection for pedestrians at the signalized crossing (particularly for children and seniors).

It is noted that visibility of signal heads in the eastbound direction may be an issue that would need to be addressed in any signal design.



The operation of the existing accesses adjacent to the crossing would be influenced by the signals. Full traffic signals are preferred over intersection pedestrian signals as traffic signals will reduce the workload of drivers turning from the side street, given the sight distance of the eastbound vehicles due to the horizontal and vertical curvatures of Ste. Anne Road and would allow the incorporation of adjacent accesses.

3.4.2 Maintain or Relocate the Marked Crossing

The option of maintaining or relocating the marked crossing was considered. In addition to the existing location, we considered shifting the crosswalk to the west coordinated with the Ignatius intersection and driveway 70 to 90 metres west of the existing crossing. At either location the crosswalk markings may lead some pedestrians to believe they have the right of way.

A shift of the crosswalk location to the west may reduce sightline constraints caused by the road curvature. However, this is seen as less convenient for most pedestrians, given the observed pedestrian flows.

3.4.3 Realign Staircase

Much of the pedestrian activity on the existing staircase is related to schools situated to the north and northwest of the Ste Anne Road crossing. Students can access Ste Anne Road via a staircase situated approximately 60 metres west of the marked crossing. Consideration was given to realign the staircase, bringing it further east toward 200 Ste Anne Road to permit more direct access to the crossing for the students.

However, the staircase is built into a rock-face along the slope of the hill. Re-alignment of the staircase would require a significant amount of re-construction, including the need to “blast” the rock currently located along both sides of the staircase in order for it to be re-aligned. In addition, the area where the staircase would need to be realigned is located on private property where an existing residential townhouse complex is currently located. This limits the distance that the realigned staircase could be “shifted” to the east to a maximum of approximately 15 metres, without impacting the existing townhouse complex.

This minimal shift to the east would offer minimal benefit to pedestrians using the staircase, as it would still not lead them directly to the pedestrian crossing. It would also inconvenience pedestrians using the staircase that originate from or are destined to locations to the west of the staircase.

Given the amount of disruption and the high-costs associated with blasting the rock to accommodate the realigned staircase, and the minimal benefits it would offer to pedestrians using the staircase, it is not recommended that the staircase be realigned.

It is recommended that the staircase be maintained in its current position, and a sign be installed at the base of the staircase, with the directional arrow pointing to the crossing location at the signalized intersection to the east.



3.4.4 Remove the Marked Crossing

With the removal of the crossing markings and signage it is anticipated that a large number of pedestrians will continue to cross mid-block. However the crossing activity may be less focused and drivers may be less prepared for the crossing activity.

3.4.5 Modifications to Signage

Existing signage includes Pedestrian Ahead warning signs approaching and at the crossing. The signs at the crossing also include Seniors Crossing tab. There are also signs advising pedestrians that they do not have the right of way at the crossing and that they are to yield to vehicles. Modifications to the signage, such as supplemental signs or larger signs are not anticipated to have a significant impact on safety.

3.5 Conclusions and Recommendations

It was concluded that the presence of seniors and students crossing at this unprotected marked crossing adjacent to a horizontal curve is not desirable. It was also noted that based on current counts that pedestrian and vehicle volumes approach OTM warrants for signals at the crossing and that warrants would likely be met during high volume (spring time) conditions. On this basis, it was recommended that traffic control signals be implemented in the vicinity of the existing crosswalk, coordinated with the adjacent driveways.

Prior to the finalization of this study, the Ste Anne Road crossing has since been converted into a signalized intersection on Ste. Anne Road at 200 Ste. Anne and the access to the Radisson Inn, as per the recommendation in this report. The previous crossing has since been removed.

As part of this study, it is also recommended that the existing unsignalized crossing at Ignatius Street, west of the Ste Anne Road crossing be removed along with the curb depressions since this crossing is in close proximity to the new signalized intersection at 200 Ste. Anne and does not serve any significant pedestrian generators.

Also, as previously recommended, the existing staircase should be retained with signs installed at the base of the staircase to direct pedestrians to the new signalized intersection to the east.



4. BRADY STREET CROSSING



Exhibit 9: Brady Street Crossing

4.1 Site Description

The Brady Street crossing is located on the west leg of the Brady Street / Shaughnessy Street intersection, at approximately 95 metres west of the Paris Street intersection and 90 metres east of Minto Street intersection. The crossing is on the west leg only since there is a centre left turn lane from Shaughnessy Street to Paris Street.

Brady Street is a 4-lane road with a posted speed limit of 50 km/h. Traffic is stop controlled from Shaughnessy Street, while the adjacent intersections are both signalized and coordinated. Sidewalks are constructed on both sides of the roadway. Streetlights are installed along the south side only. The crossing is painted with crosswalk line, but unsigned. The median on the west leg acts as refuge-island within the crosswalk. There are curb depressions at both ends of the crosswalk and at the median. “Pedestrian ahead” warning signs are also placed along Brady Street on the east and west approaches to the crossing.

There is a public parking lot on the southwest corner of Brady Street and Shaughnessy Street. Parking is prohibited along both sides of Brady Street. Surrounding land use and buildings are illustrated in **Exhibit 9**. They include:

- City Hall (north side on Brady Street)
- Sudbury Theatre Centre (south of Brady Street)
- Commercial retail and restaurants (south of Brady Street), and
- Residential land uses.



4.2 Traffic Conditions

Brady Street currently carries 15,900 vehicles in daily traffic volume. Peak hour condition occurs during the weekday PM peak hour from 4:00 p.m. to 5:00 p.m. Queuing extends past the crosswalk from adjacent intersections during peak hours.

The pedestrian volume at this location is moderate to high during peak times (morning, midday and evening peak hours). There were 217 pedestrian crossings recorded during the weekday afternoon peak. Drivers tend not to yield (or give courtesy gaps) to pedestrians waiting to cross the road at the unprotected crossing.

Pedestrian desire lines are mainly between the parking lots and restaurants located along Shaughnessy Street and two destinations on the north side of Brady Street. One destination is the entrance to City Hall, located on the northwest corner of Brady and Paris Streets; east of the existing crossing. The other destination is the Police Station, located on the northeast corner of Brady and Minto Streets east of the existing crossing. Site observations showed that during peak hours, pedestrians tend to use the crosswalk to cross Brady Street. However, during other off-peak times, many pedestrians were observed crossing Brady Street at various locations between Paris and Minto Streets, with many pedestrians not using the crosswalk.

There were 12 collisions recorded between January 1, 2008 and December 31, 2010 (an average of 4 collisions per year) within the vicinity of Shaughnessy Street; one of which involved a pedestrian. That collision took place at a point 20 meters west of Shaughnessy Street.

4.3 Factors Affecting Pedestrian Safety

Given that the Brady Street crossing is an unprotected crossing, there is an onus on pedestrians to ensure that there is an adequate gap in traffic sufficient for safe pedestrian crossing. Notwithstanding pedestrian responsibilities, drivers must exercise reasonable care to avoid a collision with pedestrians. We considered the factors that may affect the pedestrian's ability to make appropriate crossing decisions and / or the likelihood of drivers anticipating and avoiding pedestrians within the crosswalk including:

- Pedestrians' lack of familiarity with the rules of the road and the need to wait for an appropriate gap in traffic (anticipating that all vehicles will stop for pedestrians)
- Pedestrians unable to appropriately assess spacing and speeds of approaching vehicles and opportunities to cross
- Lack of driver awareness of the pedestrian crossing given limited signage and use of standard crosswalk markings
- Inconsistent driver behaviour where a driver in one lane may yield to a pedestrian, while the vehicle in the adjacent lane may not yield creating a vehicle-pedestrian conflict
- A driver who's view of pedestrians are obscured by vehicle queues that extend through the crosswalk
- Pedestrian visibility and illumination at night, and
- Turning traffic from Shaughnessy Street.



It was also observed that when approaching the crossing from the west, it is difficult to see the crossing pavement markings due to a slight vertical curve or “dip” in the road that obscures the crosswalk.

4.4 Opportunities for Improved Safety

4.4.1 Traffic Control Signals or IPS

The feasibility of traffic control signals or pedestrian signals were considered at the existing crossing location. The vehicle and pedestrian volumes based on the most recent traffic count meet warrant thresholds based on the OTM 12 Pedestrian Traffic Justification. Under typical circumstances the introduction of a signal as a protected crossing will:

- Simplify the rules of the road for pedestrians, since right of way at traffic signals is generally understood
- Improve visibility at night, and
- Provide for greater protection for pedestrians at the signalized crossing (particularly for children and seniors).

However, the spacing to the adjacent intersections is less than 100 metres, which will not satisfy OTM Book 12 minimum spacing requirements of 215 metres spacing between signals. Closely spaced signals can result in driver confusion where drivers may focus on downstream signals rather than the signals at the next intersection. As a result, signals are not recommended at this location.

4.4.2 Maintain or Enhance the Marked Crossing

The option of maintaining the marked crossing or enhancing the crossing with zebra markings was considered. Either form of crosswalk markings may lead some pedestrians to believe they have the right of way. They may also result in increased frequency of drivers providing courtesy gaps leading to conflicts where a driver in an adjacent lane may not yield to crossing pedestrians.

4.4.3 Median Enhancements

Enhancement to the existing median along Brady Street was considered in an effort to limit the amount of “jay-walking” across the street and to force pedestrians crossing the street to use the existing Brady Street crossing. Median enhancements could include the addition of added landscaping/ planting or a fence along the median to limit the potential for pedestrians to cross at various locations between Paris and Minto Streets’.

Discussions with City staff indicated that pedestrians crossing at various locations along a roadway was a significant problem at the Elm Street crossing, until a fence and raised median, approximately 1.5m high, with landscaping (plants) was installed along the centre of the roadway, with the only remaining “gap” across Elm Street at the pedestrian crossing location.



A similar treatment could be considered along Brady Street to “channel” crossing pedestrians to the crossing location and/or to the two adjacent signalized intersections east and west of the subject crossing.

4.4.4 Remove the Marked Crossing

Brady Street is a major corridor connecting with the Kingsway, accommodating long distance travel. Other than at the crossing, pedestrian activity in the east end of the corridor is moderate and driver awareness of pedestrian activity may be low. Volumes are above the threshold associated with the removal of unprotected crosswalk markings as indicated in the USDOT publication Pedestrian Facilities Users Guide.

However, with the removal of the crossing markings it is anticipated that a large number of pedestrians will continue to cross mid-block. Further, there is a need to heighten driver awareness of the potential for pedestrians in the area. This is best accomplished by consolidating the pedestrian movements to a single location. A crossing similar to that implemented on Elm Street is therefore recommended.

4.4.5 Modifications to Signage

Existing signage does not include Pedestrian Ahead warning signs approaching and at the crossing. There are also no signs advising pedestrians that they do not have the right of way at the crossing and that they are to yield to vehicles. The provision of signage directing pedestrians to yield to vehicles and use caution would help address the understanding of the right of way.

4.5 Conclusions and Recommendations

Considering the high pedestrian volumes that cross Brady Street throughout the day, and the strong pedestrian desire line between the numerous pedestrian generators along Shaughnessy Street and City Hall and the Police station, it is recommended that the existing unprotected mid-block crossing be maintained and enhanced to accommodate this desire line. Recommended crossing enhancements to the mid block crossing include the application of Zebra style pavement markings similar to those used along Elm Street, as well as the addition of “Yield to Traffic” signs at both ends of the crossing.

In order to eliminate jay-walking at random locations across Brady Street, it is recommended that median enhancements be installed along Brady Street to discourage jay-walking and consolidate pedestrians to the enhanced pedestrian crossing. Median enhancements can include the installation of a fence and / or planters similar to the median enhancements applied along Elm Street at the Elm Street crossing.

To ensure pedestrians use the side of the intersection with the crosswalk, no markings should be shown on the east side of the Brady Street and Shaughnessy Street intersections. Further, Ra-9A signs requiring pedestrians to “Cross Other Side” should be posted across this leg of the intersection. It is also recommended that these “Cross Other Side” signs be regularly enforced.

