# Ottawa Pedestrian Safety Evaluation Tool

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## ABSTRACT

The Pedestrian Safety Evaluation Program was launched in April 2010 as a three year pilot project. The objective of the project was to develop a customized process that combines traffic engineering with public engagement, for prioritizing and programming road safety improvements for pedestrians crossing roadways at signalized and non-signalized intersections within the City of Ottawa.

During the pilot project period, a number of intersections will be reviewed from a pedestrian safety perspective. Most of the intersections are being selected in coordination with the Infrastructure Services Department (ISD) staff and the pedestrian safety review is incorporated in the planning and design phases of roadway reconstruction projects.

The Pedestrian Safety Evaluation Program process contains the following phases, which all rely heavily on local community involvement:

- Prioritization or “network screening”;
- Diagnosis or investigation;
- Countermeasures evaluation and programming; and,
- Monitoring.

Analytical tools have been developed to assist staff and the community in the prioritization and countermeasure evaluation phases of the Pedestrian Safety Evaluation Program.

Applying this Pedestrian Safety Evaluation Program will help minimize the frequency and severity of preventable collisions involving pedestrians by providing guidance in the selection of cost-effective countermeasures, improving the speed at which a decision can be reached, and improving the accuracy of the decision that is reached.

Donald Street and Vanier Parkway, and Carling Avenue and Holland Avenue, were the first two intersections in Ottawa to be reviewed from a pedestrian safety perspective with the help of community associations and residents. The analytical tools and guidelines developed were used to identify pedestrian safety risks and issues. Candidate treatments to mitigate the identified risks were identified and selected. The planned improvements are now in the detail design phase, and construction is expected to begin this spring/summer.

## INTRODUCTION

In 2009, the City of Ottawa undertook a project to develop a customized process that combines traffic engineering with public engagement, for prioritizing and programming road safety improvements for pedestrians crossing roadways at signalized and non-signalized intersections within the City. The City retained Delphi/MRC to assist in the development of the Pedestrian Safety Evaluation Program. This paper summarizes the program as well as the analytical tools developed to help implement the program.

The Pedestrian Safety Evaluation Program process contains the following phases, which all rely heavily on local community involvement:

- Prioritization or "network screening";
- Diagnosis or investigation;
- Countermeasures evaluation and programming; and,
- Monitoring.

The Pedestrian Safety Evaluation Program was launched in 2010 as a three year pilot project, during which a total of approximately 23 intersections will be reviewed following the process that was developed as part of this project. At the end of the three year period, City staff will prepare a report for Transportation Committee on the results of the three year pilot project and provide recommendations on sustaining the program on an on-going basis. This rollout strategy allows for the following:

- Validating the process that has been developed;
- Fine tuning the various tools developed according to data collected and experience gained during the evaluation of the 23 intersections;
- Refining the process for community-input into the program;
- Confirming resource requirements to sustain the program; and,
- Collaborating with the Infrastructure Services Department (ISD) staff in order to incorporate this program in the planning and design phases of future roadway reconstruction projects.

This report outlines the development of a new and structured process to address human-centred pedestrian road safety issues at signalized and non-signalized intersections.

## BACKGROUND

In 1996, the former Regional Municipality of Ottawa-Carleton approved a Transportation Environment Action Plan (TEAP) application that initiated the "Walking Security Index (WSI) Project", a joint research project between the former Region of Ottawa-Carleton and the University of Ottawa. In 2002, the Public Works Department undertook a study to assess how to operationalize the WSI, including evaluating how effective this "tool" could be. A technical review to determine the appropriateness of applying the WSI was conducted. The review concluded that the WSI could not be implemented as a tool to measure a pedestrian's sense of security at intersections, as staff found, at that time, that it could not be readily "operationalized" or applied in a practical sense.

This information was provided to the Transportation and Transit Committee on February 5, 2003. At this Committee meeting, the following motion was approved, which was subsequently approved by City Council at its February 26, 2003 meeting:

*"That Council direct staff to continue to pursue the development of methods that can be used to assess pedestrian safety at intersections, using both the information developed by the Walking Security Index, other analytical techniques, and report to Committee and Council."*

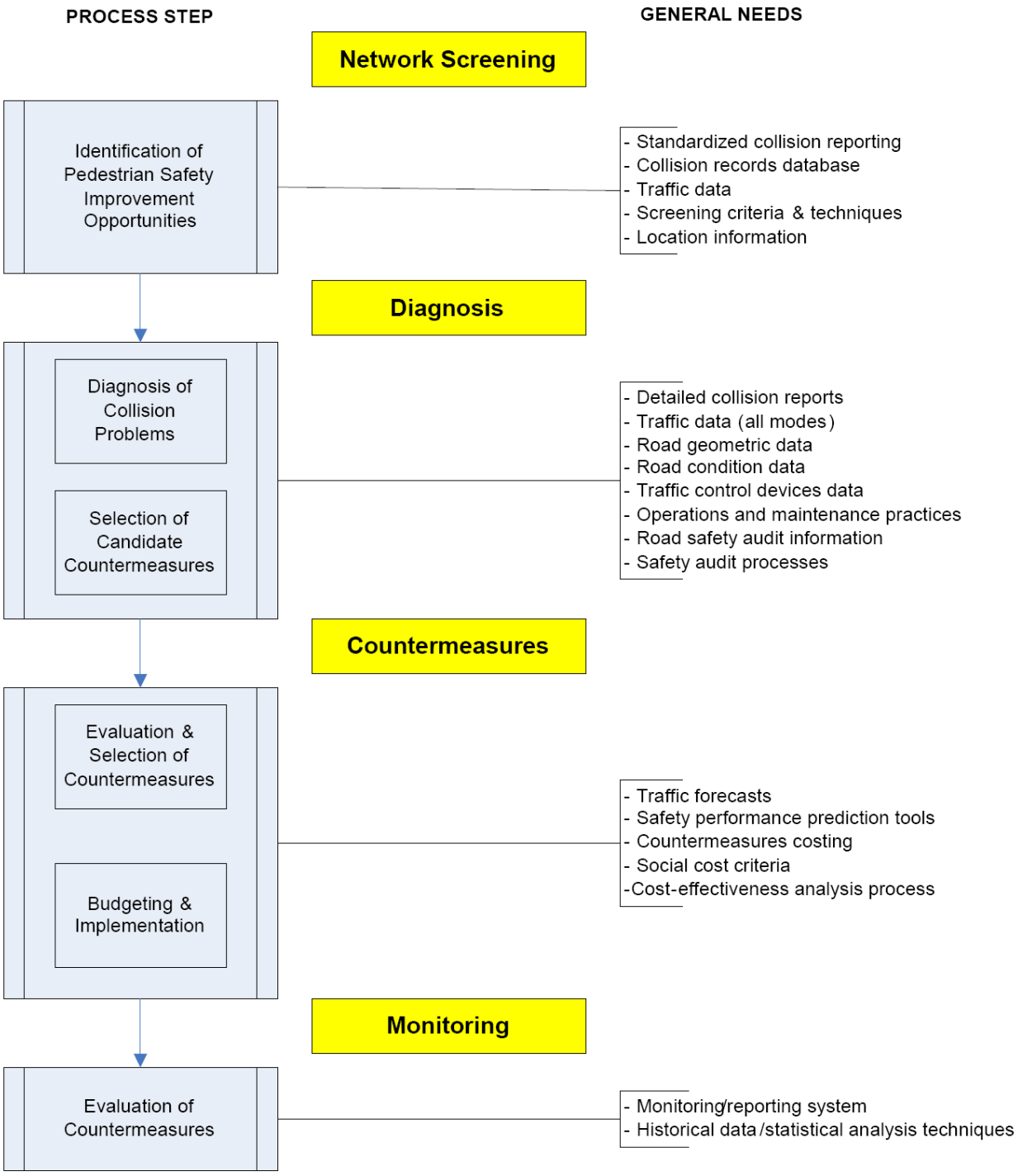
Following the Council motion in 2003, City staff were tasked with developing a process that is cost effective, and yields a sound, consistent, and technically defensible approach to the evaluation of pedestrian safety.

A general road safety improvement or safety evaluation program aims at identifying opportunities for investment in appropriate and cost-effective road safety engineering treatments. Such programs usually include:

- A prioritization or "network screening" phase which is intended to identify high collision and high risk locations;
- A diagnosis or investigation phase in which possible causal factors are identified, and candidate countermeasures are selected (the detailed engineering study – DES);
- A countermeasures evaluation and programming phase in which project specific recommendations are made, a prioritized program of work is finalized, and that program is implemented; and,
- A monitoring phase in which the outcome of the implemented countermeasures on safety risks is assessed, documented, monitored and evaluated.

This basic framework, as illustrated in **Figure 1** was used as the foundation to develop the Pedestrian Safety Evaluation Program.

**Figure 1 : General form of a Pedestrian Safety Evaluation Program**



Technical Research

The technical research and development elements of this study included a detailed and carefully focused literature and research-in-progress review that provided much of the technical groundwork. Delphi/MRC was retained by the City of Ottawa to undertake the review and research as part of the development of the Pedestrian Safety Evaluation Program which has been documented in a Technical Foundation report. Findings of the review and research conducted are summarized as follows:

1. There is a strong and well-documented relationship between pedestrian safety risks and site-specific characteristics such as the width of an intersection and the volume of pedestrians or vehicles.

   Road users are limited in their attention and information processing, visual and perception-reaction skills, and hence make frequent mistakes. These errors often do not result in collisions because road users compensate for errors of others or because the circumstances are forgiving (e.g., there is room to manoeuvre and avoid a crash). Near misses, or conflicts, are much more common than collisions and this information is not typically reflected in "technical evaluations".

   Based on an understanding of the road user tasks at an intersection, in combination with knowledge of road user limitations, it is possible to identify ways in which intersection design can lead to error, and to identify countermeasures likely to reduce these errors. These design flaws can often be identified with the help of residents who are familiar with the intersection in study, hence facilitating the process for selecting countermeasures most likely to reduce safety risks for pedestrians.

   Improvements to pedestrian crossings, at signalized and non-signalized intersections, can be achieved by introducing intersection design elements that:
   - Shorten pedestrian crossing distances;
   - Increase pedestrian and vehicle visibility;
   - Simplify the crossing task;
   - Control vehicle speeds; and,
   - Control vehicle and pedestrian path.

2. It was determined that the FHWA processes for prioritization and selecting candidate countermeasures are appropriate for use in the context of the City of Ottawa. The prioritization tool with the pedestrian intersection safety index (Ped ISI) was developed using statistical analysis of data gathered from relevant pedestrian crosswalk sites. In addition, both the Ped ISI and the countermeasure selection (PEDSAFE) tools use readily available site-specific data, and do not require onerous amounts of effort or resources to carry out the analyses. In addition, the simplicity of the tools adds to their user-friendliness and the ability to develop customized versions in a spreadsheet environment specific to the City of Ottawa.

   Given that there are many similarities between Canada and United States roads and infrastructures, review of research and literature in the United States was found to be the most applicable to the City of Ottawa context. Research and methodologies developed in recent years, are well founded and technically defensible. The methodologies and

tools developed by the US Federal Highway Administration (FHWA), the National Cooperative Highway Research Program (NCHRP) and other sources were used to form the basis of a customized Pedestrian Safety Evaluation Program for the City of Ottawa.

The FHWA began studying pedestrian safety countermeasures in 2002 and produced an initial document called the *Pedestrian Facility User Guide: Providing Safety and Mobility* (Zegeer, et.al, 2002). This work was later updated and out of these efforts came PEDSAFE, a pedestrian safety guide and countermeasures selection system. This tool facilitates the countermeasure selection process by requiring the user to identify the key safety risks (from a list of eight risk types) and predominant collision types that are occurring at a given site (from a list of 12 collision types). The countermeasures identified in the PEDSAFE tool are based on past research efforts and these treatments have been shown to improve pedestrian safety at crosswalks.

Following the efforts in producing the PEDSAFE tool, the FHWA determined that there was a need to develop a technical process to proactively identify and rank sites for safety upgrades. The subsequent study (Carter, et.al, 2006) compiled data from multiple sites and a statistical regression analysis was carried out to determine which site-specific characteristics demonstrated the strongest relationship. From this study an equation calculating a pedestrian intersection safety index (Ped ISI) was developed.

NCHRP Report 500 provides guidance when implementing the AASHTO Strategic Highway Safety Plan. The focus of the Report 500 series is to identify potential safety countermeasure strategies, classify them, provide an indication on implementing timeframes, and the relative cost of implementing the strategy. Volume 10 of this series provides guidance on reducing collisions involving pedestrians. The researchers (Zegeer, et.al, 2004) identified 4 key strategies to address potential pedestrian safety risks which include:

- Reducing pedestrian exposure to vehicles;
- Improving sight distance and visibility between vehicles and pedestrians;
- Reducing vehicle speeds;
- Improving pedestrian and driver awareness and behaviour.

3. The use of pedestrian collision history is not well suited to the prioritization process as the frequency of pedestrian-related collisions is too sparse.

4. Although there are issues with the use of pedestrian collision history, it is still a valuable piece of evidence during the diagnostic stage of a Pedestrian Safety Evaluation Program, as the patterns and trends gleaned from the data help identify the key safety risks at a given site.

These points were taken into consideration when developing the Program's processes and tools.

## THE PROCESS

In developing the Pedestrian Safety Evaluation Program for the City of Ottawa, the objectives were to enhance the processes used for selecting candidate intersections for detailed pedestrian safety analysis and for selecting appropriate and cost-effective countermeasures to be implemented. These objectives included:

- Improving the understanding of the relationship of pedestrian needs and safety issues in the context of signalized and non-signalized intersections;
- Developing an overall approach to prioritizing and programming road safety improvements for pedestrians crossing roadways;
- Providing a community-based tool for proactive input to help in the identification of intersections requiring detailed study;
- Setting up a defined and documented ongoing process to build and maintain a program, thereby increasing overall safety for pedestrians within the City;
- Creating a dedicated team of City staff with resources to carry out the necessary data collection, collation, analysis, and community consultation;
- Developing technical tools for prioritizing intersections and identifying countermeasures to improve pedestrian safety; and,
- Providing related technical and user guide documentation.

Developing a Collaborative Process

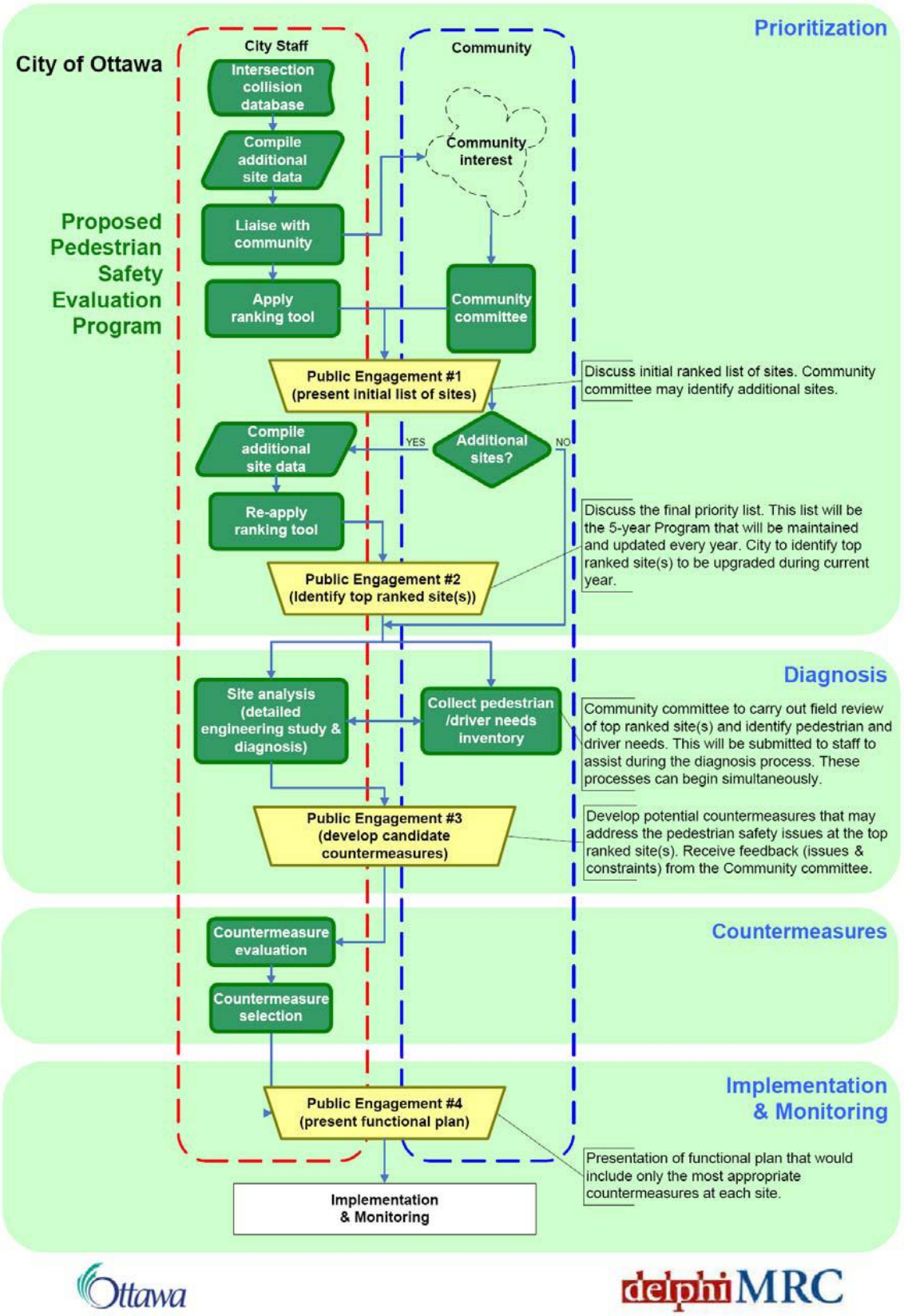
Addressing pedestrian safety issues at signalized and non-signalized intersections requires the involvement of residents in the gathering of data and decision components of the process. Based on these requirements, and following the framework of a safety evaluation program as previously discussed, a programming process, illustrated in **Figure 2**, suited to the City of Ottawa context was developed. The new program was named Ottawa's "Pedestrian Safety Evaluation Program" (PSEP).

Residents often have a good understanding and feel for the operations and existing safety risks at a given intersection in their community. City staff conducting a detailed engineering safety review of an intersection may overlook this "human-centred" component of pedestrian safety risk. For this reason, Ottawa's Pedestrian Safety Evaluation Program has been designed as two separate work streams to be carried out by City staff and residents, respectively. The work streams are generally carried out independently and concurrently.
During the course of the entire programming process, there are a number of consultation meetings between City staff and residents to discuss findings and results. This provides collaborative opportunities to explain and discuss the decisions made (to that particular point in the process) as well as gather input for the next steps.

It may be challenging, in some communities, to engage groups of individuals to assist City staff in assessing safety issues and risks at the selected intersections. The City will be undertaking the following activities to help engage groups of individuals in this program, such as:

- Organizing campaigns and distributing flyers in order to promote the program;
- Conducting surveys in target locations such as near parks, residences for the elderly, hospitals and health care centres, etc, to gather data on public opinion related to pedestrian safety issues at intersections; and,
- Developing a collaborative website to serve as a direct link between residents and City staff.

**Figure 2 : Ottawa's Pedestrian Safety Evaluation Program Process**



## THE TOOLS

Based on the literature review and research conducted, two distinct phases of the Pedestrian Safety Evaluation Program proved to be easily improved with the help of analytical tools. As such, the prioritization tool (Ottawa Ped ISI) and the countermeasure selection tool (Ottawa PEDSAFE) were developed.

The User Guide for Technical Tools report, prepared by Delphi/MRC, provides information concerning the technical foundation for the tools and guidance on their use. The concept for each tool and the technical background behind them are briefly described below.

The Prioritization Tool (Ped ISI):

The FHWA has developed a robust and technically defensible analytical process for prioritizing pedestrian crosswalks and is suitable for application in the City of Ottawa context. The analytical elements of this tool were taken and a customized, spreadsheet-based version for use by City staff was developed and called the Ottawa Pedestrian Intersection Safety Index (Ped ISI).

The Ottawa Ped ISI process calculates a pedestrian safety index (PSI) value for each crosswalk at an intersection and then an overall pedestrian intersection safety index (Ped ISI) based on the average of all crosswalks. A safety index value of 1.0 represents a relatively low-risk crosswalk or intersection and an index value of 6.0 represents a high-risk crosswalk or intersection. An illustration of a typical intersection showing the crossing of interest is shown in **Figure** 3 and a list of data required for the Ped ISI tool is shown in **Table 1**.

**Figure 3 : Typical intersection and location for crossing of interest**

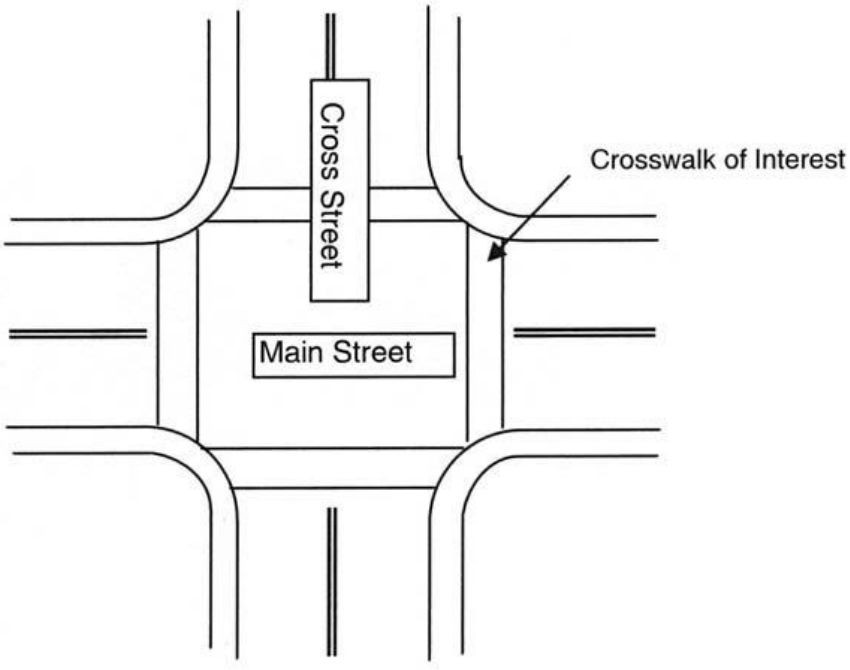


**Table 1 : Ped ISI Prioritization Tool Input Variable Definitions**

| Data Input | Data Format | Notes |
|---|---|---|
| Signal controlled crossing | 0 = no<br>1 = yes | This variable is 1 if movements of vehicles and pedestrians at the crossing of interest are controlled by a traffic signal. |
| Stop-controlled crossing | 0 = no<br>1 = yes | This variable is 1 if vehicle traffic on the leg with the crossing of interest must stop for a stop sign. |
| Number of lanes | 1, 2, 3, 4, etc. | This variable is the number of through lanes in both directions on the street being crossed at the crossing of interest, not including exclusive turn lanes. At the stem of 3-leg T-intersections which has no through lanes in one or both directions, turning lanes are included. |
| Speed | $85^{th}$ percentile operating speed and posted speed limit (km/h) | This variable is the $85^{th}$ percentile operating speed of vehicles approaching the crossing of interest. If different operating speeds are recorded in opposing directions, an average value should be input for both directions / crossings of interest. In the absence of operating speed information, the posted speed limit or an estimate of the 85th percentile speed is used. |
| Traffic Volume | Average daily traffic volume | This variable is the ADT on the street being crossed, in both directions of travel. Average 24-hour volumes for each turning movement from City of Ottawa count sheets should be used to derive an ADT for each approach leg individually, as ADT can vary substantially between two opposing intersection legs on the same street, especially if one is one-way and the other is two-way |
| Land Use | 0 = residential area<br>1 = commercial area | This variable is 1 if the predominant land use of the surrounding area is commercially developed. Commercial development is defined as retail shops, banks, restaurants, gas stations, and other service oriented businesses that tend to generate high pedestrian volumes. |

One of the greatest benefits of the Ped ISI process is that it requires a limited amount of data that is readily available. The data that is used in this process includes type of traffic control, number of through lanes (an indicator of roadway width), vehicle operating speed, the volume of traffic (an indication of exposure) and the type of land use (as an indicator of pedestrian activity). If some of the required data is not available, one individual can easily collect it during a short field visit.

While this methodology provides a consistent and defensible framework for prioritizing locations for pedestrian safety improvements, the Ped ISI index values have limitations as they are based on a regression model that considers only factors that have been shown through research to have a statistically significant relationship to safety performance. This index should not constitute an indiscriminate and concrete prioritization of locations for improvement – rather it should be used in conjunction with detailed study, local knowledge, collision history, and engineering judgement to produce a finalized program of prioritized safety improvement locations.

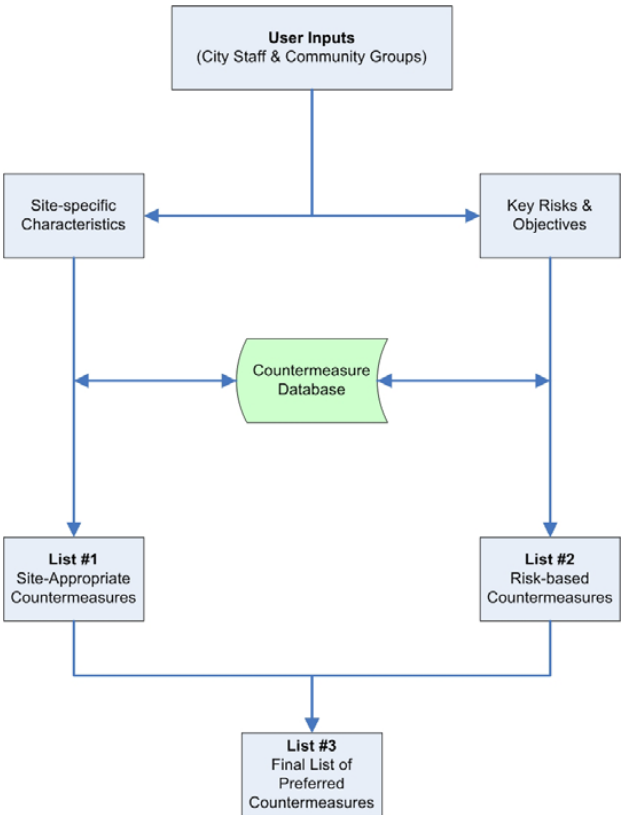
The Countermeasure Selection Tool (Ottawa PEDSAFE):

Once the prioritization of intersections for further detailed engineering study is completed, City staff and residents can complete a field review of the intersections. A Pedestrian Safety Field Guide and Workbook has been prepared to assist City staff and residents during the field review component.

Once City staff has carried out a detailed engineering study, reviewed information submitted by residents, and diagnosed the issues, there is a need to identify candidate pedestrian safety countermeasures. The FHWA countermeasure selection tool PEDSAFE was found to be technically robust, used readily available data and was user friendly. Therefore, some elements of this expert system have been applied, additional safety countermeasures have been added and a customized, spreadsheet-based version for use by City staff has been developed. This adapted countermeasure tool has been called Ottawa PEDSAFE.

The countermeasure selection process is illustrated in **Figure 4**.

**Figure 4 : Countermeasure Selection Process**




Users of the countermeasure selection tool will need to gather data in two areas; site characteristic information (i.e. high or low traffic volumes) as described in **Table 2**, and the key site-specific safety risks that need to be addressed (i.e. the need to reduce vehicle speeds) as outlined in **Table 3**. The majority of the input data for the tool are gathered as part of the detailed engineering study and the residents' pedestrian and driver needs assessment.

**Table 2: Countermeasure Selection Tool Site-specific Characteristic Inputs**

| Data Input | Data Format | Notes |
|---|---|---|
| Type of traffic control | Signalized, Unsignalized | Indicates whether the intersection traffic control is with a traffic signal or with stop signs |
| Pedestrian volume | High, Low | Indicates whether the pedestrian crossing volume at the intersection and crossing of interest is high (≥ 1,200/day) or low (< 1,200/day). |
| Vehicle volume | High, Low | Indicates whether the vehicular volume on the main street at the crossing of interest is high or low |
| Operating speed | High, Low | Indicates whether the 85$^{th}$ percentile operating speed of vehicles on the main street at the crossing of interest is high (≥ 70km/h) or low (< 70km/h). |
| Number of lanes | <4, 4+ | Indicates whether the number of through lanes on the main street at the crossing of interest is less than four, or four or more lanes, considering both directions of travel. |
| On-street parking | Yes, No | Identifies whether or not there is on-street parking upstream of the crossing of interest. |
| Illumination present | Yes, No | Identifies whether or not illumination is provided at the intersection and crossing of interest. |
| Land use | Commercial CBD, Residential, Other | Indicates the type of land use surrounding the intersection and crossing of interest. |
| Target population | All pedestrians, Elderly/children, Special needs | Identifies whether or not any vulnerable pedestrian groups are expected to be routinely using the intersection and crossing of interest. |
| School area | Yes, No | Indicates whether the intersection and crossing of interest are in the vicinity of a school. |

**Table 3: Countermeasure Selection Tool Safety Risk Inputs (i.e. Performance Objectives)**

| Data Input | Notes |
|---|---|
| Reduce vehicle speeds | Selected if the user needs to address risks associated with excessive operating speeds. Example treatments: reducing intersection curb radii or traffic calming treatments like raised intersections. |
| Improve sightlines and visibility | Selected if the user needs to address risks associated with limited or blocked sightlines between drivers and pedestrians. Example treatments: curb extensions, removing on-street parking / street furniture, and installing median refuge islands. |
| Reduce vehicular volume | Selected if the user needs to address risks associated with inappropriately high traffic volumes. Example treatments: reducing the number of through travel lanes, or traffic calming treatments such as speed humps, chokers. |
| Reduce pedestrian exposure | Selected if the user needs to address risks associated with pedestrian exposure at long crosswalks. Example treatments: signalization enhancements (i.e. a scramble or exclusive pedestrian phase), or a pedestrian refuge (i.e. channelization island or centre median). |
| Improve pedestrian access and mobility | Selected if the user needs to address risks associated with pedestrian access and mobility in the vicinity of a crosswalk. Example treatments: enhancements to crossing signals and signs, proper design of sidewalks and refuge areas, or a crossing guard. |
| Vehicle and pedestrian right-of-way compliance | Selected if the user needs to address risks associated with right-of-way compliance issues where drivers don't yield to pedestrians or pedestrians disregard crossing signals. Example treatments: improved crosswalk markings or improved enforcement activities. |
| Reduce high risk behaviour | Selected if the user needs to address risks associated with unnecessary or inappropriate risk-taking by pedestrians or drivers. Example treatments: automatic pedestrian detection (as opposed to push buttons), or adding pedestrian signals and markings at unmarked crosswalks being used by pedestrians. |

Once users enter the data, the tool will search the countermeasure database of over 60 countermeasures and generate two lists of candidate treatments; one list with countermeasures appropriate for the site characteristics (list #1) and another list with countermeasures appropriate for the safety risks (list #2). The tool then will generate a third and final list of candidate countermeasures from the common treatments that address both site characteristics and safety risks.

A Pedestrian Intersection Safety Countermeasure Handbook was also developed as part of this program. This document has been prepared as an aid to select the most appropriate safety treatments once a problem diagnosis has been made. This tool is intended to supplement the countermeasure selection tool and provide background and contextual information for all candidate countermeasures that the software may not provide.

It is stressed that these lists of countermeasures represent those that appear most appropriate to the site based on the characteristics and performance objectives specified after being filtered from the full list of pedestrian countermeasures in the database. Careful consideration of each countermeasure is still necessary to determine its appropriateness in context with the site and other countermeasures being considered. Also, the fact that a given countermeasure is not suggested does not necessarily mean that it cannot be applied effectively to the site. In any case, compatible systems of countermeasures should be developed and implemented according to the detailed application guidelines that are provided in the documentation accompanying this tool. The lists of countermeasures provided by this tool are intended to provide a starting point for this process.

## EVALUATION OF THE PROCESS AND TOOLS

A “charette” consultation event was held on October 26, 2009 with City staff, Roads and Cycling, and Pedestrian and Transit Advisory Committee members and residents to allow prospective users of the Pedestrian Safety Evaluation Program to experience the process, and provide feedback on the procedures, tools and guidelines.

Two intersections were selected for review (Donald Street and Vanier Parkway, and Carling Avenue and Holland Avenue). Existing pedestrian safety issues and risks were identified and evaluated at these intersections. Then, using the tools and guidelines, candidate countermeasures to reduce the pedestrian safety risks were discussed.

The candidate countermeasures identified and discussed through the review of the two pilot intersections included the following:

- Installing countdown pedestrian signals;
- Implementing a leading pedestrian interval (which give pedestrians a slight lead time making them more visible to traffic);
- Providing better access to the push buttons;
- Enhancing crosswalk markings;
- Improving the curb height and ramps with steep grades;
- Providing adequate sidewalk continuity and refuge areas between and at transit stops;
- Improving grades in crosswalk to reduce pooling of ice and water;
- Modifying or removing refuge islands (right-turn channel);
- Installing supplementary signage to identify the presence of pedestrians;
- Formalizing two-stage crossing; and,
- Improving visibility (shrubs/trees to trim or remove).

This meeting helped test the tools developed and helped highlight and identify aspects of the proposed process that may have been overlooked and/or needed improvement.

## THE PILOT

The Pedestrian Safety Evaluation Program was launched as a three year pilot project, based on recommendations by Public Works staff. Construction of countermeasures identified for the two intersections evaluated at the charette are to be implemented in spring/summer of 2012.

In 2011, a further 21 intersections were identified for review in 2011 and 2012. In order to help fund implementation of some of proposed countermeasures, staff identified locations on the prioritization list where upcoming reconstruction of the roadway through a capital works project is planned. Locations were selected through consultation with Ward Councillors.

At the end of the three year period, in 2013, City staff will prepare a report for Transportation Committee on the three year pilot project and will provide recommendations on sustaining this program into future years. The benefits of applying this rollout strategy include:

- Validating the process that has been developed;
- Fine tuning the Field Guide and Workbook and the Countermeasure Handbook based on experience gained during the evaluation of the 23 intersections;
- Refining the process for community-input in the program;
- Confirming resource requirements to sustain the program in future years; and,
- Collaborating with the Infrastructure Services Department (ISD) staff in order to incorporate this program in the planning and design phases of future roadway reconstruction projects.

## CONCULSIONS

The Pedestrian Safety Evaluation Program was developed as a decision support system. Each of its fundamental components (network screening, diagnosis, countermeasures evaluation and programming, and monitoring) contributes to providing information to decision makers, and assists them in making decisions where funding for road safety engineering improvements related to pedestrians is best allocated. For the City of Ottawa, the approval and implementation of the Pedestrian Safety Evaluation Program will result in:

- Improving the speed with which a decision can be reached (efficiency); and,
- Improving the accuracy of the decision that is reached (risk management and quality).

An improvement in the accuracy of road safety investment decisions and priorities returns a great degree of benefits to overall road safety. With this Pedestrian Safety Evaluation Program's process that is formal, accurate and efficient, countermeasures can be selected that will be more economical and minimize the frequency and severity of preventable collisions involving pedestrians.

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