Suitability Assessment and Operating Guideline for Implementing Leading Pedestrian Intervals in the City of Toronto

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Abstract

The purpose of a Leading Pedestrian Interval (LPI) is to provide pedestrians with the opportunity to begin crossing the street before adjacent through movement vehicles are permitted to proceed. This allows pedestrians to establish a presence in the crosswalk, which increases the visibility of pedestrians to drivers, and thereby reduces conflicts with turning vehicles. An LPI is implemented by adjusting the pedestrian timings to provide a walk display of a minimum of 5 seconds prior to the vehicle green display for that direction of travel. There have been a number of studies on the effectiveness of LPIs in improving pedestrian safety in various North American cities, majority of which suggest positive impacts. This paper provides a thorough review of these past studies in addition to a review of the state of practice in other jurisdictions with regards to implementation and operation of LPIs. The City of Toronto implemented and formally evaluated an LPI in 2005. LPIs have been added to a few additional intersections since, however the process has not been streamlined. In order to roll out LPIs at additional locations the need for an implementation guide and operating standard has been identified. The purpose of the guide is to help traffic engineers identify suitable locations for LPIs using a checklist, determine the appropriate length of time for the LPI using a formula, and consider operation features that would maximize the positive safety effects and minimize any negative impact on vehicular capacity. Lastly the guide suggests a method for measuring improvements in intersection safety as a result of LPIs. Details of this guiding document are provided in this paper.

BACKGROUND

The City of Toronto has implemented a handful of Leading Pedestrian Intervals (LPIs) in the past decade but has not had a suitability assessment and operating guideline for this pedestrian safety tool to date. Lack of a city-wide guide is one of the reasons for the relatively slow uptake of this proven low cost safety countermeasure. To respond to this need the Pedestrian Projects Unit in Transportation Services at the City of Toronto has developed a City of Toronto LPI guideline under the review of the Transportation Services Safety and Mobility sub-committee (formerly called Traffic Operations Management). This guideline is currently pending final approval by senior management. The material presented in this paper is based on this guideline.

Purpose of Leading Pedestrian Intervals

The purpose of the LPI is to provide pedestrians with the opportunity to begin crossing the street before adjacent through movement vehicles are permitted to proceed. This allows pedestrians to establish a presence in the crosswalk, which increases the

visibility of pedestrians to drivers, and thereby reduces conflicts with turning vehicles (see Appendix A). The LPI is implemented by adjusting the pedestrian timings to provide a walk display of a minimum of 5 seconds prior to the vehicle green display for that direction of travel.

Children are more negatively affected by visibility and non-yielding behaviour issues since they are shorter than the average pedestrian. Elderly pedestrians and others with physical constraints are slower to react to changing signals. An LPI would especially benefit both of these groups by improving their visibility in the crosswalk.

Existing Leading Pedestrian Intervals in Toronto

As of Winter 2014 four intersections in Toronto have an LPI on at least one pedestrian crossing. These include:

- University Ave and Adelaide St- east-west pedestrian crossings (implemented in 2004)
- St. Clair Ave and Christie St - north-south pedestrian crossings (implemented in 2009)
- Mt Pleasant Rd and Lawrence Ave - north-south pedestrian crossing on west leg only (implemented in 2012)
- Harbour St and Yonge St - east-west pedestrian crossings and north-south pedestrian crossing on east leg only (implemented in 2009)

The duration of the LPI at these four locations ranges between 4 to 8 seconds. Observations and feedback have been positive for these LPIs.

LITERATURE REVIEW

LPIs are a well established safety counter measure and readily used by some jurisdictions. In Cambridge, Massachusetts for instance, almost every traffic signal operates with an LPI. In New York City LPIs have been implemented at over 200 signalized intersections in the past few years.

There have been several studies on the effectiveness of LPIs in improving pedestrian safety in various North American cities, strong majority of which suggest positive impacts. Appendix B provides a summary of these studies including type of study and major findings.

According to the Crash Modification Factor (CMF) Clearinghouse by the U.S. Federal Highway Administration (FHWA), a CMF of 0.55 to 0.63 can be expected for LPIs. This means that if there were 100 incidents at a crosswalk *prior to* an LPI, 55 to 63 incidents are expected *after* implementing an LPI. This translates to a 37% to 45% Crash Reduction Factor (CRF), where

CMF = 1 - (CRF/100).

These figures are based on a 2009 study of 10 intersections with LPIs in State College, Pennsylvania (Fayish, et. Al, 2009), using 63 control sites. The FHWA clearinghouse includes a review process that evaluates each study according to its study design, sample size, standard error, potential bias and data source, and gives ratings. The study noted above is rated "good" with 3 stars out of 5.

An evaluation of one of the four existing LPIs in Toronto at University Ave and Adelaide St is consistent with the general findings of the literature review and revealed that there was a statistically significant reduction of 34% in non-yields immediately after and 61% 4 months after implementation of the LPI (City of Toronto, 2005) as illustrated in Figure 1.

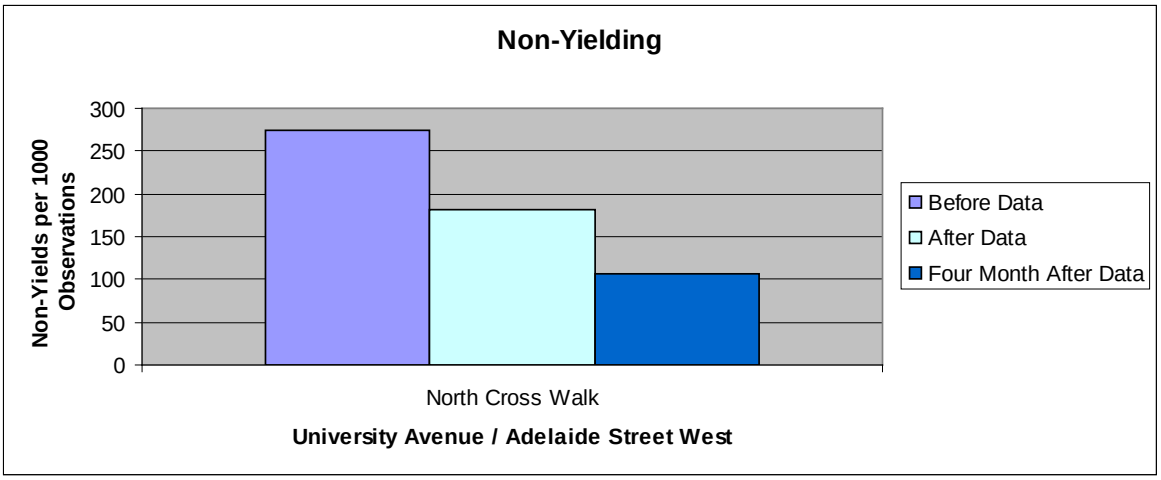

Figure 1 – Non-yield Behaviour at University Ave and Adelaide St Before and After the LPI (City of Toronto, 2005)

In rare occasions, evaluations have shown an increase in non-yield behaviour. Toronto's LPI at Harbord and St. George was removed within 3 weeks of implementation due to increased non-yielding. Further evaluation of this location suggests that the skewed nature of the intersection and visibly of signal heads to parallel moving traffic may have contributed to this initial increase in non-yielding. In addition it is possible that operating the LPI for an additional few weeks and better user education could have addressed this issue. Other studies suggest that better context-sensitive analysis and decision-making, application of Right-Turn on Red prohibition and user education could address the effectiveness of LPI selection and implementation.

SUITABLE CONDITIONS FOR A LEADING PEDESTRIAN INTERVAL

LPIs are suitable when there are conflicts between pedestrians and left and/or right turning vehicles. When one or more of the following conditions are present an increased benefit can be expected from implementation of an LPI:

- T-Intersections, where through movement is not an option and all approach vehicles make left and right turns during green time without the need to yield to opposing vehicular traffic;
- Presence of pedestrian safety issues raised by staff, councillor or residents at the pedestrian crossing due to non-yielding behaviours;
- Presence of visibility issues due to irregular intersection geometry, wide turning radius, crosswalk placement, obstructions such as buildings or base of a bridge, blinding sun angle during sunrise or sunset, etc;
- High volume of pedestrian crossings;
- High rate of historical collisions between pedestrians and turning vehicles or observed non-yield or near-miss incidents during a conflict analysis;
- Proximity to elementary schools; and
- High level of activity by elderly residents.

The above list has been developed based on the literature review and studies on existing LPIs in Toronto and elsewhere, as well as correspondence with other jurisdictions that have implemented several LPIs such as New York City and City of Chicago.

Appendix C provides an LPI suitability assessment worksheet that aims to assist traffic engineers in quantifying the above conditions. In addition, the worksheet quantifies any negative impact on vehicular traffic as a result of the signal changes and provides a methodology for determining a single suitability score based on the negative and positive consequences. The methodology recommends that if the final score exceeds a threshold then the LPI is a suitable solution.

RECOMMENDED DESIGN FEATURES

Signal operations

The Ontario Traffic Manual Book12 on Traffic Signals (Ontario Ministry of Transportation, 2007) states that the duration of LPIs typically ranges between 4 to 6 seconds.

The United States Federal Highway Administration Manual on Uniform Traffic Control Devices states that:

> *"[LPI should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is released*" (U.S. Department of Transportation, Federal Highway Administration, 2009)

Based on the authors' literature review and analysis the following formula has been developed as the City of Toronto standard for duration of LPIs:

LPI = greater of 5 seconds, or (TL/2 + PL)/W

, where:

LPI = seconds between onset of the WALK signal for pedestrians and the green indicator for vehicles;

TL = distance on the crosswalk to clear the total width of all moving lanes between the curb and the centreline, not including the parking lane;

PL = distance on the crosswalk to clear the parking lane, if any; and

W = walking speed of 1 m/s.

For visual illustration of TL and PL please refer to Appendix A.

The rationale for this formula is to allow enough time for pedestrians to clear at least half the crosswalk in one direction of moving traffic in order to increase visibility to turning traffic. This is similar to New York City's informal formula.

Intersection of Major Roads with Minor Low-Volume Roads

At semi-actuated signals at the intersection of minor roads with major roads, an LPI for crossing the major road would not add to the total cycle time or increase wait time for pedestrians if the vehicular volumes on the minor road are low. Rather, the Vehicle Max time in the minor traffic direction would be reduced by the duration of the LPI. In other words:

Without LPI: Pmax (minor road) = Vmax (minor road)
With LPI: Pmax (minor road) - LPI = Vmax (minor road)

,Where

Pmax = Maximum duration of pedestrian WALK and Flashing Don't Walk (FDW) signal
Vmax = Maximum duration of vehicular green signal

This is illustrated visually in Figure 2.

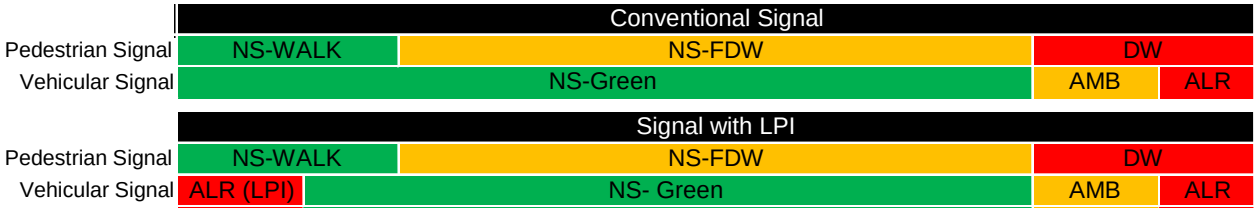

Figure 2 – Suggested LPI Timing at Intersection of Major Roads with Minor Low-Volume Roads

Signal heads

At skewed intersections, where it is easier for drivers to see the signal head of the perpendicular direction there may be an issue with drivers using the signal changes of the perpendicular direction to anticipate the start of their green signal. If such intersection is equipped with an LPI drivers may incorrectly be anticipating the green signal and potentially make a false start. In such circumstances provisions such as visors should be put into place to block the view of the signal head and countdown timer from drivers.

An example is an LPI that was implemented in Toronto at the skewed intersection of Harbord St and St. George St in 2004. An increase in false-starts resulted in a decision to revert back to a regular signal after only 3 weeks of operation. It is possible that adjustment of signal head visibility, longer operation of the LPI and better user education could have addressed this issue.

Turn restrictions

All LPIs must be accompanied with Right-turn-on-red (RTOR) prohibitions for right turn movements coming from the approach parallel to the crosswalk with the LPI. As evident from the review of existing studies RTOR prohibitions contribute significantly to the effectiveness of LPIs. This provision would ensure that right turning vehicles waiting at the red light are not entering the pedestrian right of way as soon as the opposite direction gets the red light and during the LPI.

According to the Highway Safety Manual (American Association of State Highway and Transportation Officials, 2010) allowing RTOR has a Crash Modification Factor of about 1.7 for pedestrians and cyclists, meaning that crashes are 70% higher at intersection without RTOR prohibition.

LPIs will be added to the list of criteria for implementation of RTOR restrictions as per the City of Toronto Right Turn on Red Restrictions Traffic Services Operating Practices (TSOP) approved in 2010.

Protected Left Turn Phase

Signal operations that have a protected leading left turn signal would need to be modified, in order to be considered for LPIs. A potential modification is to operate a fully protected lagging left turn. Lagging left turn signal operations are not common practice in the City of Toronto, therefore an investigation into the feasibility of a fully protected lagging left turn is required prior to an LPI consideration.

Signage

Temporary signage, as illustrated, could be installed next to the permanent RTOR prohibition sign warning intersection users about the new changes to the signal operation.

The temporary signage is only recommended at locations where there is likelihood of false starts due to visibility of the signal heads. This situation is described in section 3.2 above.

Temporary signage should be removed after 3 months of LPI operation once users have gained familiarity with the new signal operation.

Figure 3: Suggested Signage

Implementation

Districts can add LPI requests to their signal modifications priority lists, and consider scheduling data collection for the "before" conditions as outlined in the next section on evaluation of impacts.

Application of LPI is contingent upon budget and scheduling constraints arising from various issues such as traffic signal controller technology.

CAPACITY IMPACTS MITIGATION ALTERNATIVES

There are situations where LPIs could have a negative impact on the road capacity and cause vehicular delay, in particular at intersections with high turning volumes and near or beyond capacity. In such situations engineering judgement and the suitability assessment worksheet presented in Appendix C should be used to assess the tradeoffs between safety benefits of the LPI and the capacity reduction impacts.

This section outlines possible solutions to potential capacity reduction impacts and situations where LPIs could potentially improve both vehicular and pedestrian movements.

It is worth noting that an LPI is an electronic enforcement of the legal responsibility of turning drivers to yield to pedestrians in crosswalks. Turning drivers are already required to wait and find a gap when facing a high volume of pedestrians crossing with the right-of-way. The potential benefit of LPIs is the ability to clear pedestrians more efficiently to enable drivers to then have the gap to turn. This is likely why there is an improvement in yielding behaviours by drivers with the implementation of an LPI, because pedestrians are cleared earlier and drivers can then find a gap; whereas

without an LPI, both drivers and pedestrians are competing to make the most of their right-of-way.

In accommodating the needs of all users, the following are some possible approaches for mitigating vehicular delay:

Trade LPI seconds for seconds at the end of the pedestrian cycle

Queuing of right turning vehicles as a result of the LPI may increase delay for both right turning and through movements at intersections close to capacity. An alternative is to trade the 'head start' LPI seconds in the beginning of the crossing phase for seconds at the end of the crossing phase while keeping the vehicle green (see Figure 4). This would allow for right turning traffic to complete their turns after the pedestrians have finished crossing without having to negotiate with pedestrians for a gap. This may or may not add to the total cycle length compared to the conventional signal depending on whether minimum pedestrian crossing time was the limiting factor for that signal phase prior to introduction of LPI.

Figure 4 - Suggested trading of LPI Period at the End of the Walk Phase

An investigation into technical feasibility of this type of operation is required prior to any recommendations.

Leading Through Interval

A Leading Through Interval (LTI) is similar to an LPI in providing pedestrians a head start, however it allows parallel moving traffic to proceed during the few 'head start' seconds while right and left turn movements remain prohibited. An LTI is an alternative to an LPI at intersections with exclusive right turn and left turn lanes. This alternative would result is a smaller delay to vehicular traffic during the leading pedestrian signal by prohibiting left and right turning movements only.

This type of signal operation for turning movements is a new traffic control option for drivers and requires evaluation of user behaviour before wide spread use. In addition, signal heads would require capacity to clearly indicate the permitted and delayed movements with arrows.

Bulb-outs or smaller turning radii

Reducing the turning radii would shorten the pedestrian crossing distance, reduce the minimum WALK and FDW time required for the crossing, and ultimately shorten the total cycle length. For instance, reducing the turning radii on both sides of a crossing from 15 meters to 10 meters would result in reduction of 6.3 meters in crossing distance. This is equal to a 6-second reduction in cycle length assuming crossing speed of 1m/s. Similarly, a curb extension (aka bulb-out) would reduce the crossing distance.

The number of seconds allocated to an LPI can be offset or minimized by reducing the crossing time by such measures when deemed feasible. Feasibility analysis would include investigation into presence of on-street parking and bicycle lanes, predominant size of turning vehicles, etc.

Smaller turning radii would also encourage slower right turns which would further improve pedestrian safety and decrease severity of injury in case of a collision.

MEASURES OF EFFECTIVENESS

A before-after conflict analysis would be valuable in order to verify the level of impact of an LPI on pedestrian safety and local traffic. While it would be valuable to have more data on the impacts and benefits of future LPIs, it is not a requirement of LPI implementation where Transportation Services has determined that an LPI is a suitable tool for improving pedestrian safety.

In cases where an LPI is not recommended by Transportation Services as per the result of the suitability assessment process, but is implemented, a before-after evaluation is required.

The following measures of effectiveness should be quantified before the implementation of the LPI, immediately after and again 6 months after the implementation. The third measurement should be done in order to evaluate effectiveness once road users have gotten used to the LPI (e.g., after 6 months).

- Rate of non-yield behaviour (frequency of non-yield behaviours normalized by user volume)
- Rate of conflicts between pedestrians and turning vehicles (frequency of conflicts normalized by user volume)
- Percentage of pedestrians beginning to cross during LPI period
- Percentage of pedestrians that press the push button, where applicable

Some of the above measures could be quantified separately for different levels of traffic volume conditions (different times of day) for more detailed investigation.

Sample size and duration of data collection for the conflict analysis should be determined in consultation with the Traffic Safety Unit based on the required significance level and confidence interval.

CONCLUSIONS

Leading Pedestrian Interval is not a new pedestrian safety tool, however, many jurisdictions, such as Toronto, have utilized this low cost safety tool only sporadically. Part of the reason for this slow uptake is lack of a standard assessment and operation guideline.

The resources presented in this paper are based on a recently developed LPI guideline by the City of Toronto. This guideline will help traffic engineers in the City in the process

of evaluating suitability of a location for an LPI and how best to implement one to achieve the highest positive results.

Since the development of the draft guideline in early 2014 suitability of LPI has been investigated for many intersections in Toronto.

ACKNOWLEDGMENTS

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Appendix A: How Does an LPI Work?

Diagram 1

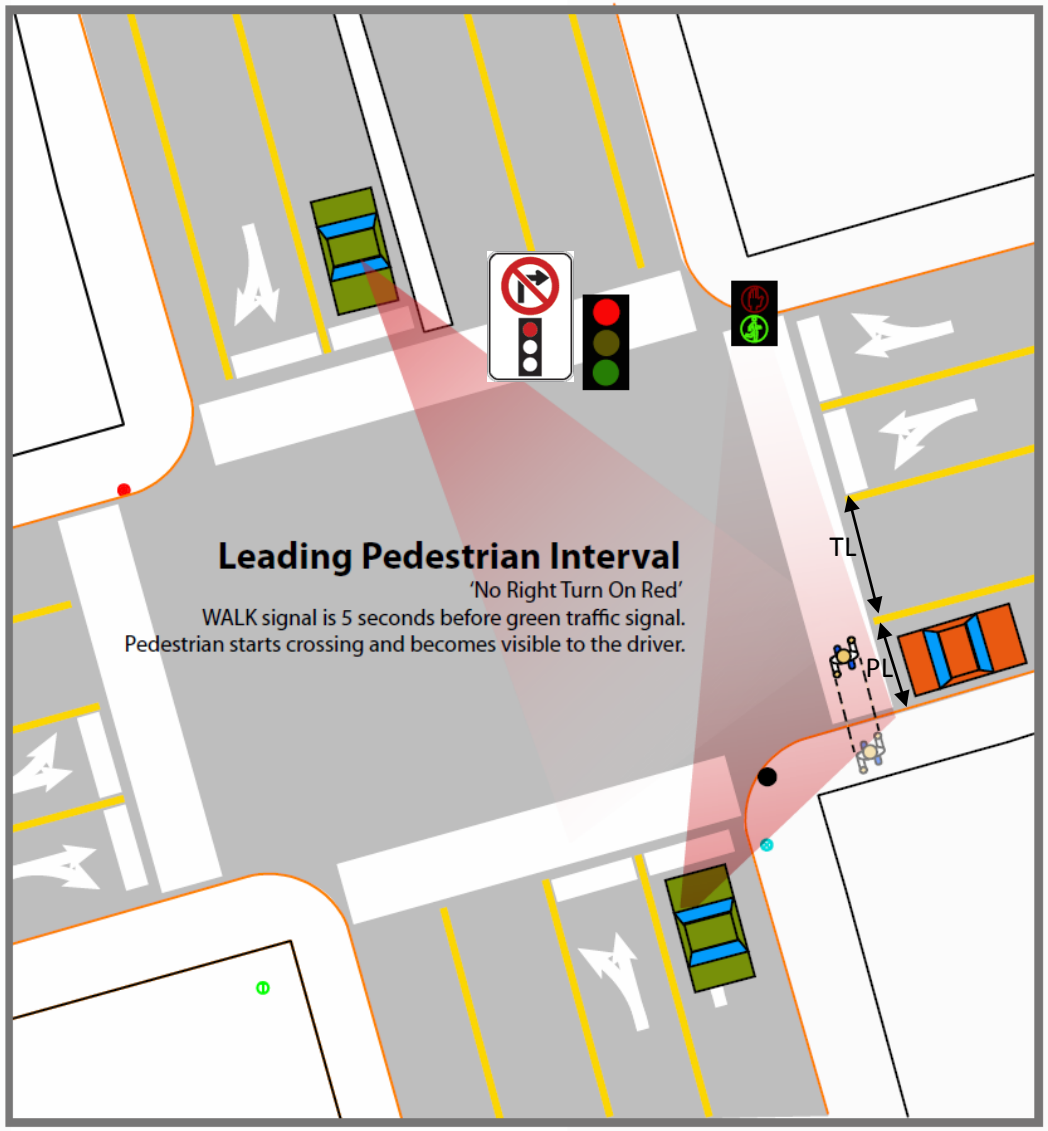
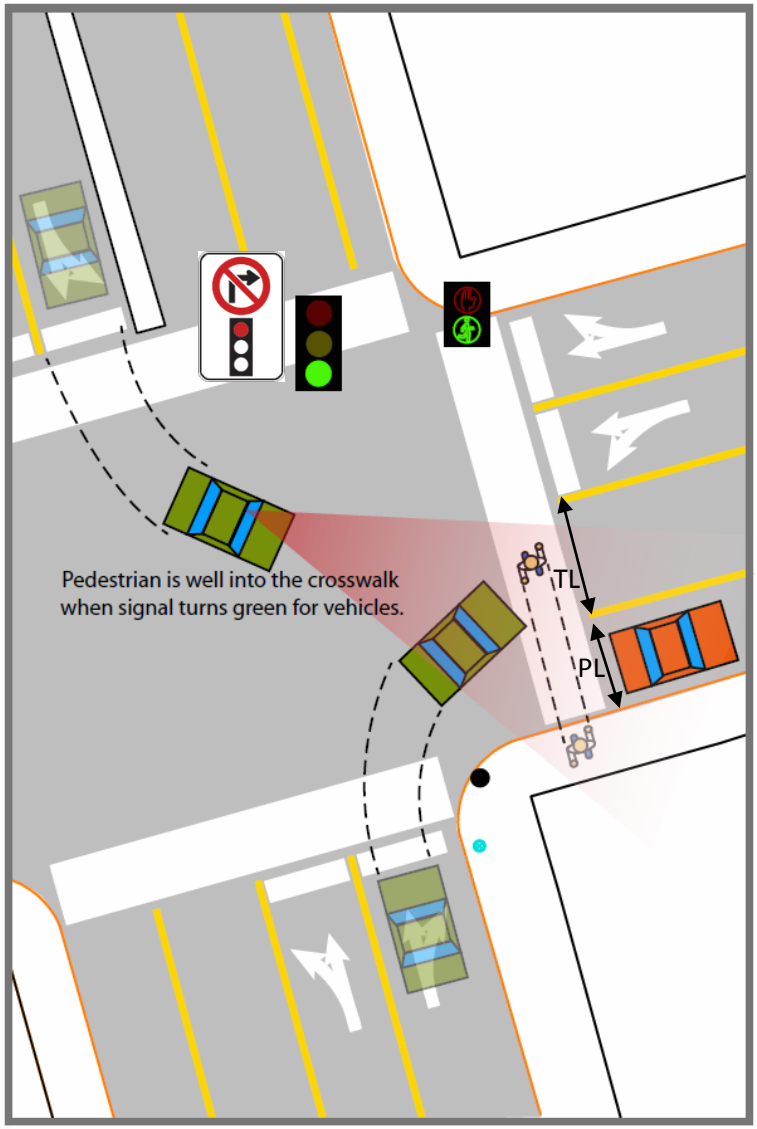


Diagram 2



Appendix B: Summary of Existing Literature

Name of study/author (year)	Location / number of LPIs	Type of study	Right-turn-on-red prohibition	Major Findings
City of Toronto (2005). "Evaluation of Leading Pedestrian Intervals – We're all Pedestrians program" Prepared by iTrans	2 intersections in Toronto	Before-after conflict analysis	Yes	- 34% reduction in non-yields at University and Adelaide after 1 month and ??% reduction after 6 months - Significant increase in non-yields at Harbord and St George, likely due to skewed intersection geometry.
US Department of Transportation Federal Highway Administration (2008). "San Francisco PedSafe Phase II Final Implementation Report" Prepared by San Francisco Municipal Transportation Agency Pedestrian Program and University of California Traffic Safety Centre	3 intersections in San Francisco	Before-after conflict analysis	No	- "There were significant reductions in the number of vehicles turning in front of pedestrians at three of four intersections (65 to 76%). However, these changes did not lead to a significant reduction in vehicle/pedestrian conflicts." - "Impact of pedestrian head start could possibly be enhanced with red turn arrow." - "(leading pedestrian interval) did not significantly improve yielding by right-turning drivers. (The effectiveness of the Pedestrian Head Starts in San Francisco appeared to vary with the intersection characteristics.)"
Pécheux, K., Bauer, J., McLeod, P (2009). "Pedestrian Safety Engineering and ITS-Based Countermeasures Program for Reducing Pedestrian Fatalities, Injury Conflicts, and Other Surrogate Measures Final System Impact Report" Prepared for United States Department of Transportation	2 intersections in Miami (1 four-leg and one three-leg)	Before-after conflict analysis	Unknown	- 9 to 18% increase in left turn yielding to pedestrians - No change in right turn yielding to pedestrians - 7 to 15% increase in pedestrians pushing the button - 21 to 31% increase in pedestrians starting their crossing during the first 4 seconds

Name of study/author (year)	Location / number of LPIs	Type of study	Right-turn-on-red prohibition	Major Findings
King, M (1999). "Calming New York City Intersections" Presented at the Urban Street Symposium, Dallas, Texas.	26 intersections in New York City	10 year before-after crash history study using a control group	Unknown	- Change in absolute rate of vehicle-pedestrian crashes = -12% - Change in rate of vehicle-pedestrian crashes factored by severity = -55% - Change in rate of vehicle-pedestrian crashes relative to control site = -28% - Change in rate of vehicle-pedestrian crashes relative to control site and factored for severity = -64% - "There are about 11,000 traffic signals in the city; about 85% have pedestrian indicators. About 36% of the 14,000+ vehicle/pedestrian crashes in New York City every year involve pedestrians crossing at signalized intersections. If the LPI reduces this number by 12%, then 514 vehicle/pedestrian crashes per year could be prevented."

Name of study/author (year)	Location / number of LPIs	Type of study	Right-turn-on-red prohibition	Major Findings
Van Houton, R., Retting, R., Farmer, C.M., Van Houten, J. (2000). "Field evaluation of a leading pedestrian interval signal phase at three urban intersections" *Transportation Research record 1734, pp- 86-92*	3 intersections in St. Petersburg, Florida	Before-after conflict analysis	Unknown	- Odds of conflict for pedestrians leaving the curb at the beginning of the walk period were reduced by approximately 95% - The likelihood that a pedestrian would yield to a turning vehicle during the LPI condition also decreased by approximately 60% - "There were 44 total pre-treatment observation periods at all three sites. During each of these sessions, the sites averaged between 2 and 3 conflicts per 100 pedestrians, with some periods having up to 5 conflicts per 100 pedestrians. After the LPI was installed, 34 of the 41 sessions had no conflicts, and no session had more than 2 conflicts per 100 pedestrians " - no reduction in intersection effectiveness for motor vehicles was detected - "This intervention was shown to improve pedestrian comfort and perceived safety levels as well" - "There was also a smaller reduction in conflicts during the remainder of the WALK interval. This reduction was likely the result of pedestrians claiming the right-of-way during the earlier portion of the WALK interval"

Name of study/author (year)	Location / number of LPIs	Type of study	Right-turn-on-red prohibition	Major Findings
Fayish, A. & Gross, F., "Safety Effectiveness of Leading Pedestrian Intervals Using the Empirical Bayes Method". *Transportation Research Record 2198, pp 15-22*	10 intersections in State College, Pennsylvania	Using crash statistics for 10 years and empirical Bayes method with 63 control intersections	Unknown	- 46 % to 71% reduction in crashes, and reductions were not significantly greater at intersections with larger volumes of pedestrians - "Given the low cost of LPIs, particularly at locations where pedestrian signals already exist, only a modest reduction in crashes is needed to justify their use (i.e., if the savings in crashes is greater than $115 per year). On the basis of the evidence provided by the aggregate analysis, the necessary crash reduction required to obtain a positive benefit–cost ratio is easily achieved. Therefore, implementation of the LPI has the potential to reduce pedestrian–vehicle crashes cost-effectively."
MetroPlan Orlando (2000). "Orlando Urban Area Arterial Pedestrian Crash Study " Orlando MetroPlan, Orlando	Unknown	Unknown	Unknown	- 5% reduction in crashes

Name of study/author (year)	Location / number of LPIs	Type of study	Right-turn-on-red prohibition	Major Findings
Hubbard, S.M.L, Bullock, D.M., & Thai, J.H. (2008) "Trial Implementation of a Leading Pedestrian Interval: Lessons Learned" *Institute of Transportation Engineers ITE Journal: Oct 1, 2008*	1 intersection in Anaheim, CA	Before-after conflict analysis	No	- "The advantages of an LPI reported in a downtown environment may not be fully transferable to crosswalks in a suburban environment if there is no restriction on RTOR" - "There may also be some adjustment in driver behavior as familiarity with LPI operation increases" - "To address potential conflict between RTOR and pedestrians during the LPI while still providing RTOR capacity at other times during the cycle, it may be appropriate to use a blank-out “No RTOR” sign during the LPI" - Proportion of pedestrians comprised in crosswalk went from 2% to 4% in low right turn volumes, and from 6% to 2% in high right-turn volumes. - Proportion of pedestrians comprised on curb went from 18% to 21% at low turn volumes and 23% to 44% at high turn volumes.

Appendix C: LPI Suitability Assessment Worksheet

Intersection considered: _____
Pedestrian crossings where LPI is being considered: (E / W / N / S)_____
Date: _____
Other safety treatments considered: _____
Other safety treatments implemented: _____

	Data	Score	Score allocation	Justification	Notes
a) Is the pedestrian crossing at a T-intersection (crossing is parallel to a road that ends at the intersection)?		0 to 2	Yes = 2 No = 0	High level of potential safety improvement with LPI at T-intersections compared to regular intersections because all vehicles approaching a T-intersection make a left/right turn and left turning vehicles do not need to wait for vehicles in the opposing direction.	
b) Are there pedestrian safety issues raised by staff, councillor or residents at the pedestrian crossing due to non-yielding behaviours?		0 to 1	Yes = 1 No = 0	High level of potential safety improvement (actual and perceived)	
c) Are there visibility issues identified by staff or residents due to features such as irregular intersection geometry, wide turning radius, crosswalk placement, obstructions such as buildings or base of a bridge, blinding sun angle during sunrise or sunset?		0 to 2	Yes (many of the items) = 2 Yes (one or some of these items) = 1 No = 0	High level of potential safety improvement	

	Data	Score	Score allocation	Justification	Notes
d) 8-Hour volume of pedestrians crossing the leg being considered for LPI (p)		1 to 3	3 if p > 2000 2 if 200 < p ≤ 2000 1 if p ≤200	High level of benefit for the highest number of pedestrians	
e) What is the increase in intersection total or average delay (%) (a) **What is the through phase V/C ratio (b)** **What is the total 8-Hour vehicular volume at the intersection (c)**		0 to -6	Minimum (A or B) x C , where $A=\begin{Bmatrix} 0\ if\ a < 30\% \\ -1\ if\ 50\% < a \geq 30\% \\ -2\ if\ a \geq 50\% \end{Bmatrix}$ $B=\begin{Bmatrix} 0\ if\ b < 0.9 \\ -1\ if\ b \geq 0.9 \end{Bmatrix}$ $C=\begin{Bmatrix} -1\ if\ c < 16{,}000 \\ -2\ if\ c \geq 16{,}000 \\ and < 30{,}000 \\ -3\ if\ c\ \geq 30{,}000 \end{Bmatrix}$	High level of negative impact on traffic operations for a large number of drivers	
f) What is the rate of collisions between pedestrians and left or right turning vehicles at the specific crossing in the past 5 years?		0 to 2	None = 0 Between 0 and 3 [collisions per 1000 pedestrian per year] = 1 Greater than 3 [collisions per 1000 pedestrian per year] = 2	High level of potential safety improvement	

	Data	Score	Score allocation	Justification	Notes
g) What is the rate of conflicts* between pedestrians and left or right turning vehicles at the specific crossing during 8 hours of observation during area specific pedestrian peak and non peak periods?**		0 to 2	None = 0 Between 0 and 3 [incidents per 1000 pedestrians] = 1 More than 3 [incidents per 1000 pedestrians] = 2		
h) How far is the location from the nearest elementary school?		0 to 2	<200m = 2 >200m and <850m = 1 >= 850m = 0	High level of benefit to smaller school children who are more negatively affected by visibility issues Average distance of walk trips to school in Toronto is 850m (TTS). Average distance for the top 6% of school trips is 200m (TTS).	
i) What is the Elderly demand score of the area where the intersection is located? (e)		0 to 2	2 if e = 5 1 if 4≤ e <5 0 if e<4	High level of benefit to slower walking pedestrians: elderly	Look up score using this map
Total score					

- If total score ≥ 5 Consider LPI
- If score is < 5 an LPI is not recommended. Should Community Council choose to recommend an LPI at a location with a score smaller than 5 an evaluation of level of impact is recommended where funds are available.

* Conflicts are defined as two road-users set on a course of collision where an evasive action is required to avoid collision.

** Collect conflict data only if total score without this information is less than 5 but greater than 3

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