Appendix A

April 4, 2023 **TSD-TRP-23-006**

ROAD USER SAFEY PROGRAM REGION OF WATERLOO

APRIL 2023

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1.0 Executive Summary

The Region of Waterloo manages an arterial road network of 700 kilometres. The prime functions of this network are to:

- Facilitate the safe and efficient movement of people, goods an services; and
- To connect communities within the Region to the Provincial highway network.

The safe movement of people on the Region's road network is achieved through direction provided by the Region's Strategic Plan (2019-2023) which includes the key Objective 2.4: Improve Road Safety for All Users. The instrument through which this Objective is achieved is the Region's Road User Safety Program.

The Region of Waterloo Road User Safety Program is a comprehensive evidence-based and data-driven program that involves the collaboration of a variety of proponents and stakeholders in the community.

The main goal of the Program is to significantly reduce all collisions involving serious injuries and fatalities, with particular emphasis on reducing serious collisions involving vulnerable road users, including pedestrians and cyclists.

Program Key Elements are the Five E's of Road Safety:

Evaluation

Each year, the Region collects data from the Ministry of Transportation regarding the collisions that occurred on Regional roads in previous years. This data includes frequency, severity and location of each collision in addition to other attributes such as the hour, day and month of the collision, the weather, the actions of all parties involved and other details. Staff filter and categorize this collision data publish the results in an Annual Collision Report. Staff use this data to identify behaviours and other conditions that contribute to patterns of collisions. Staff also use this data to assess the frequency and severity of collisions occurring across the network. Given the limited resources available to provide improvements everywhere in the network, this network screening provides a data-driven methodology for staff to identify locations that are the highest priority and would benefit the most from countermeasures. Each year, staff use this screening to identify the top 20 pedestrian and cyclist collision locations in addition to the top locations where vehicle-vehicle collisions are occurring.

Engagement

A successful Road User Safety Program requires ongoing engagement with community members, Regional and area municipality councillors and various other partner municipality staff and organizations both within and outside the Region of Waterloo. Some of the partners with whom Regional staff collaborate include:

- Region of Waterloo Public Health: sharing of injury data and collaboration on public education campaigns;
- Waterloo Regional Police Services: sharing of collision data, coordination of enforcement services and public education programs; and
- Area municipalities: coordination of safety-related initiatives and sharing of data through the Traffic Coordinating Committee (TCC) and membership on various capital project teams.

In addition to the collaboration with partners noted above, the Region's Transportation team frequently engages with the community through concerns raised through Regional and Area Municipality Councillors and via concerns and requests raised by residents through the Region's Service First Contact Centre (SFCC) or other modes such as through social media platforms. These concerns can range from requests for a new traffic control device (stop sign or traffic signals, etc.) to questions about traffic signal timing or posted speed limits. In 2022, Transportation staff responded to over 800 such queries, most of which were safety related. In addition to the day-to-day engagement, staff also engage community members about specific safety initiatives through public engagement for specific capital projects such as road widening's and reconstructions.

For future engagement, staff will be looking for opportunities through development of the Region's 2023-2026 Strategic Plan and new initiatives such as community-specific safety programs.

Engineering

The engineering component of the Road User Safety Program involves design and implementation of a variety of evidence-based proven countermeasures to address systemic collision problems or location-specific collision problems.

Systemic countermeasures include such measures as:

- Pedestrian countdown signals;
- Leading pedestrian intervals;
- Ladder crosswalks; and
- Durable stop bars.

Location-specific countermeasures include:

- Amber beacons or red beacons atop stop signs;
- Pedestrian refuge islands;
- Offset crosswalks; and
- Roundabouts.

In addition to stand-alone countermeasures, site specific safety improvements are incorporated into every road reconstruction or widening project to address systemic

upgrades to address safety problems identified through the network screening or through location-specific evaluations.

Education

The Region has undertaken numerous education campaigns over the years to provide road users with the best up-to-date information and guidance on how to behave safely while using the road network. A particular emphasis was placed on roundabouts for many years as they were a relatively new type of traffic control in the Region. In recent years, a number of the public safety campaigns, such as the “2019 Safe Roads Waterloo Region”, and recent in-school activities partnering with Student Transportation Services Waterloo Region (STSWR), focused on vulnerable road users and, in particular, students. The Region has employed various different mediums to reach out to users, including radio and TV, educational videos, social media, and in-school activities. Staff are always looking for new ways to provide educational information to the public. Staff are planning to develop a new public education campaign in 2023, subject to resource availability.

Enforcement

Regional staff have and will continue to work closely with Waterloo Regional Police Services (WRPS) to assist WRPS in its enforcement efforts. This collaboration is achieved through the Traffic Coordinating Committee and other initiatives such as the Selective Traffic Enforcement Program (STEP).

The Region administers the current camera-based enforcement activities such as Red-Light Cameras (RLC) and Automated Speed Enforcement (ASE). Red-light cameras are employed at fifteen signalized intersections and are an effective tool in reducing collisions caused by drivers failing to stop at red lights. RLC installations have resulted in reductions in turning collisions by as much as 60%. Staff continuously screen the network on an annul basis to identify new locations where a RLC could provide safety benefits.

The Region operates the Automated Speed Enforcement (ASE) Program in school zones on Regional and area municipality roads on behalf of all the municipalities within the Region. There are currently sixteen sites in operation at high-priority school locations. Where ASE has been deployed, there has been an overall reduction in operating speeds of 5 km/h averaged over all sites with improved reductions at rural locations. Through recent direction from Council as part of the 2023 budget process, staff has been directed to explore the feasibility of expanding the ASE Program in 2023 to include 32 sites and to provide a road map to rapidly expand the ASE Program to cover all 175 schools in the Region.

Ongoing Pilot Projects

Staff continue to explore new traffic safety initiatives through research on safety projects performed around the country and around the globe. Another way to explore new safety initiatives for which limited performance data is available is through the implementation of Pilot Projects. A Pilot Project allows staff to implement a methodology or safety measure on a trial basis, including before and after studies to measure effectiveness. One challenge with assessing the collision-reducing performance of a new measure is that the trial period needs to be at least five years in duration in order to obtain statistically significant performance data to accurately assess the performance trends. Currently, the Region is undertaking the following Pilot Projects:

- Time/Day/Month Speed Restrictions in School Zones: to reduce operating speeds near schools;
- Flex Signs: to reduce operating speeds in rural hamlet areas;
- No Right-Turn on Red: To reduce collisions with pedestrians and cyclists;
- Cycling Warning Sign: to reduce collisions with cyclists at intersections; and
- Rural All-Way Stop: to reduce collisions at two-way stops in rural areas.

New Safety Initiatives

In addition to proven and emerging safety enhancing initiatives already underway, the Transportation team is also developing new initiatives for implementation in the coming years. Some examples of these new initiatives are:

- Raised Crosswalk and Rapid Flashing Beacons at Roundabout Pilot Project: to enhance pedestrian comfort and accessibility at roundabouts;
- Illumination Review at existing Roundabouts: to enhance safety of users during low-light conditions;
- Dutch-style Roundabout Readiness: design modifications for new roundabouts to enhance convenience for cyclists;
- Protected Intersection Designs: to enhance the comfort and convenience for active transportation users at signalized intersections;
- Review of Warrants for Pedestrian-Oriented Traffic Controls: to enhance opportunities for pedestrians to cross Regional roads in the urban areas;
- Global implementation of No Right-Turn on Red: to enhance the comfort and safety of active transportation users at signalized intersections; and
- Rural Hamlet Speed Compliance: to explore ways to reduce operating speeds on the approaches to and through rural hamlets.

The scope and speed of development of these new initiatives will depend heavily on the availability of additional resources.

Conclusions and Next Steps

The Region of Waterloo Road User Safety Program is a comprehensive evidence-based and data-driven program that involves the collaboration of a variety of proponents and stakeholders in the community.

The main goal of the Road User Safety Program (RUSP) is to significantly reduce all collisions involving serious injuries and fatalities, with particular emphasis on reducing serious collisions involving vulnerable road users, including pedestrians and cyclists. Collection and analysis of collision data over many years indicates that the RUSP is contributing positively to the downward trend of these types of collisions within the Region's road network.

The Road User Safety Program includes several key elements including Evaluation, Engagement, Engineering, Education and Enforcement. While the effectiveness of each element is important, the ultimate success of the RUSP is closely governed by the successful implementation of all of the key elements in harmony with each other.

While significant achievements have been made, there is much more work yet to be done in order to "move the needle" closer to the ultimate goal of zero serious collisions. A lot of this work includes seeking out new partnerships with various stakeholders, new/improved methods and technologies for analysis, new/improved engineering countermeasures, new/improved ways of connecting with the public and new/improved ways of enforcement.

The ongoing development, implementation and improvement of the Region's Road User Safety Program requires a considerable amount of staff resources. Improvements and expansion to the existing components of the RUSP will require considerable additional staff resources.

Some key next steps are follows:

- Develop progress targets and resource requirements for the implementation of all systemic engineering countermeasures;
- Develop plans and resource requirements for expanded data collection, analysis and reporting on key performance metrics;
- Develop work plans and resource requirements for the expansion of existing programs, such as ASE, and the development of new safety programs, such as the Rural Hamlet Speed Compliance Program;
- Continued research into new methodologies, technologies and engineering solutions; and
- Investigate the potential to leverage ongoing camera-based monitoring /enforcement technology to provide more proactive collision analytics.

2.0 Introduction

The Region of Waterloo provides a vast array of transportation facilities, including 700 km of roadway and an ever-expanding network of active transportation facilities, including sidewalks, trails, and dedicated bicycle lanes. The Region also operates over 530 signalized intersections, over 35 roundabouts, and several stop-controlled intersections throughout the Region.

On a given day, many of the 625,000 residents, plus a steady stream of visitors rely on those transportation facilities to move around the Region. There are also strong industrial and farming components to the Region's identity and the ability to reliably move goods around the Region is imperative to the health of those industries. As the road authority for the Regional roadway corridors, the Region (in collaboration with the local area municipalities) is obligated to ensure that the transportation network provides safe conditions for the movement of people and goods. Regional Council has recognized this obligation, incorporating an objective in the 2019-2023 Strategic Plan dedicated to road safety.

Strategic objectives	Actions
2.4 Improve road safety for all users - drivers, cyclists, pedestrians, horse and buggies.	2.4.1 Continue to implement the Region's road safety program to reduce the number of severe and fatal injury collisions, using elements of engineering, education and enforcement, with a greater emphasis on reducing collisions involving active transportation users.
	2.4.2 Advocate with other levels of government to change legislation and regulations to improve road safety for all users.

A road user safety program is a comprehensive plan that lays out a series of actionable items that have the collective goal of improving safety for all users of a transportation network. There are many layers to a road user safety program and, in general, the effectiveness of the program relies on the combined benefits of the various elements. It's also imperative that the program provides benefit to the users of all modes of transportation, with more emphasis on the most vulnerable modes such as people who choose to walk, roll, or cycle within the public transportation space.

So what exactly is "road user safety?" To start, it's important to note that there are inherent risks tied to the constant demand for people to move around quickly and the associated competition for space and freedom of movement. No matter how well a plan is thought-out and executed, it is impossible to completely eliminate those risks. Thus, it could be said that a road user safety program is a set of processes and measures designed to minimize the risk exposure (starting with the most vulnerable users first) as much as possible, and that reduces the impacts of human error within the transportation realm.

Digging a little deeper into “road user safety”, there are two streams of road safety measures: objective and subjective. Traditional objective safety measures include those which draw their conclusions from real evidence and statistics and set out a plan to address those measurable problems. Subjective safety measures are those which are more visionary in nature and are meant to address perceived safety issues which may affect a person’s overall feeling of safety. In turn, this feeling of safety may influence the travel choices of the public. A good road user safety program should contain elements that are meant to address both objective and subjective safety concerns; that is, there must be plans to mitigate patterns of road user safety concerns that are supported by clear data, and there must also be innovative plans that provide widespread intangible benefits to improve overall transportation safety.

Road user safety and its continuous improvement is not a new concept in the Region of Waterloo. While statistics show an average of 6,000 collisions per year across the Region over the 5 most recent years of data (2016-2020), including 1,500 injury collisions per year, the 20-year trend (Figure 1: below) shows that the collision rate has consistently been on the decline in the Region. This trend provides good evidence that the efforts of road safety initiatives over the last 20 years are having a positive impact on the safety of our network. However, the fact that there are still an average of 1,500 injury collisions per year in the Region indicates that there is still a lot of ground to gain in road user safety.

Figure one - Motor Vehicle Collision History

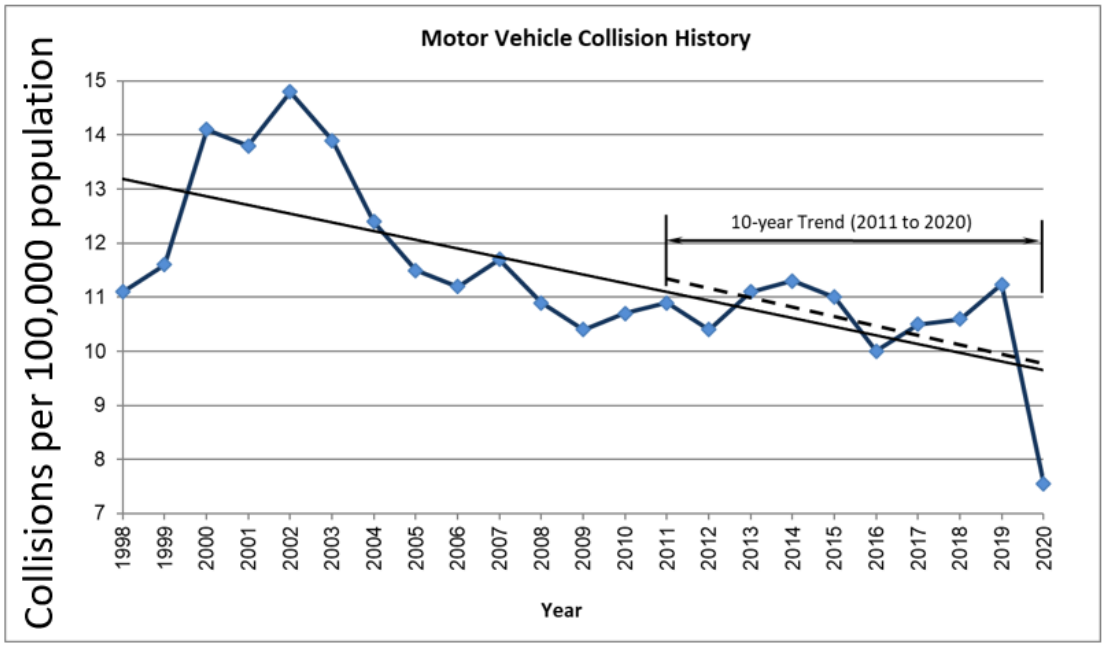

Figure 1: Collision Rates in the Region of Waterloo from 1998 to 2020

When considering the role of a road user safety program, it is important to understand its relationship with other transportation initiatives. In many ways, improvements to road safety – particularly for the vulnerable active transportation users – is an important mechanism for encouraging people to consider walking, rolling or cycling to their destinations. At a time when the Region has declared a climate emergency, the importance has never been higher to provide a safe and desirable space for people to feel comfortable choosing a mode other than personal automobile. In that way, the road user safety program needs to support this concurrent strategic objective with recognition that the end result will be a more liveable Region for everyone.

2.3 Increase participation in active forms of transportation (cycling and walking).	2.3.1 Continue to explore, plan and implement new pedestrian and cycling facilities in coordination with local municipalities as per the Transportation Master Plan to provide good connectivity and close gaps in the current active transportation network.
	2.3.2 Incorporate more cycling and pedestrian amenities (e.g. streetscaping features, street furniture, bicycle repair stands, etc.) into roadway designs to increase the attractiveness of active modes of transportation.
	2.3.3 Increase usage of cycling facilities by enhancing maintenance levels.
	2.3.4 Develop planning policies that encourage more compact, walkable, transit oriented communities in both the built up and greenfield areas of the Region.

3.0 Key Goal of the Region's Road User Safety Program

The main objective of the Region's Road User Safety Program is to significantly reduce all collisions involving serious injuries and fatalities, with particular emphasis on reducing serious collisions involving vulnerable road users, including pedestrians and cyclists. While an ultimate goal to completely eliminate all collisions involving serious injuries and deaths may not be achievable, it is beneficial to maintain such an ultimate goal as a "target" on which all elements of the Program are to be focused in order to ensure the Region continues to "move the needle" in the right direction. The key elements of the Region's User Safety Program fall into the 5 E's of road safety: Evaluation, Engagement, Engineering, Education, and Enforcement.

4.0 Key Elements of the Program

4.1 Evaluation

Each year, staff assess collision attributes to determine the locations with the highest number of pedestrian, cycling and motor-vehicle collisions. Through the assessment, staff rank the top 20 pedestrian collision locations, top 20 cycling collision locations and the top 100 motor vehicle collision locations. The Annual Collision Report summarizes factors associated with traffic collisions that occur during the previous five-year period.

In 2014, the Region of Waterloo adopted the network screening methodology as outlined in the American Association of State Highway and Transportation Officials Highway Safety Manual (HSM). The HSM provides the best factual information and proven analysis tools for crash frequency prediction. The primary focus of the HSM is to provide the analytical tools for assessing the safety impacts of transportation project and program decisions.

The network screening process applies concepts of observed collisions, expected collisions and predicted collisions. None of these concepts are meant to imply that there is an “acceptable” number of collisions at a given location.

Transportation Engineering applies safety performance functions (SPF) to intersections and midblock locations to predict expected collisions. A SPF predicts the average number of collisions per year at a location as a function of exposure and, in some cases, roadway or intersection characteristics (e.g., number of lanes, traffic control, or median type). Observed collisions, expected collisions and predicted collisions are all used to estimate excess social collision costs.

Historically, the Region’s network screening process accounted for all collision severities that occurred on roadways under the jurisdiction of the Region of Waterloo. This included property-damage-only (PDO) collisions. For the 2020 Collision Report, staff have placed a higher emphasis on fatal and injury (F&I) traffic-related collisions. Region staff have adopted a network screening methodology that focuses more on F&I related collisions rather than the less serious property-damage collisions. Staff support this change in methodology because:

- F&I collisions have a higher overall societal cost;
- This methodology is aligned with the “Vision Zero” concept;
- It places a greater emphasis and focus on F&I collisions; and
- Factors that contribute to a fatal collisions or a serious injury are often the same.

The Region’s network screening process is now based specifically on an assessment of fatal and injury related collisions occurring on roads under the jurisdiction of the Regional Municipality of Waterloo or occurring at signalized intersections (including pedestrian and midblock signals) under the jurisdiction of local municipalities and investigated by Waterloo Regional Police Services (WRPS).

The average cost of a collision that results in a fatal injury or non-fatal injury (F&I) to a person is estimated to be $60,500. These estimated costs include property damages and loss of income due to injury etc. The value of the excess social cost provides a weighting of the collisions based on fatal and injury collisions only. This strategic shift in the ranking of locations under Regional control helps Regional staff to focus its

countermeasure program and resources on locations that are most likely to see future injuries and fatalities.

Pedestrian and Cycling Ranking

Pedestrian and cyclist collision ranking is based on the difference between observed collisions and predicted collisions and resulting annual excess social collision cost estimated at each Regional intersection and midblock location. For the Region's collision analysis, pedestrian collisions refer to any collision involving a pedestrian (would have also included a motor vehicle or bicycle), and cyclist collisions refer to any collision involving a cyclist (would have also included a motor vehicle or pedestrian).

Vehicle Collision Ranking

The excess social costs metric is used to identify locations that are the highest priority for review and most likely to benefit from collision countermeasures. This methodology for collision ranking involves the consideration of the number and severity of collisions at a particular location and comparing that data to similar collision data from all other similar locations in the Regional road network.

Roundabouts

Collisions at roundabouts follow the same methodology as pedestrian, cycling and vehicular ranking previously noted. However, roundabouts that have less than five-years of data are not included in the overall ranking. Roundabout locations that have less than five-years of data will be added to the screening once five-years of data are available.

Collision Summary and Trends

Overall, collisions per 1,000 population is trending lower across the Region. The overall 10-year trend of annual collisions and fatalities per capita is continuing downward. As a result of the 2020 pandemic provincial lockdown, vehicular travel declined and there was a 20-year low in total collisions (Table 1). The large fluctuations that can be seen between 1996 and 2003 were likely related to legislation that changed collision-reporting procedures. Similarly, the previous 10-year period (2011 to 2020) is also showing the same pattern of trending lower.

Table 1: Vehicle Collision History on Regional Roads

Year	Total Number of Collisions	Collisions Per 1,000 Population	Year	Total Number of Collisions	Collisions Per 1,000 Population
1999	5138	11.6	2010	5809	10.7
2000	6374	14.1	2011	6031	10.9
2001	6330	13.8	2012	5795	10.4
2002	6976	14.8	2013	6275	11.1
2003	6657	13.9	2014	6462	11.3
2004	6061	12.4	2015	6319	11
2005	5748	11.5	2016	5791	10
2006	5688	11.2	2017	6263	10.5
2007	5980	11.7	2018	6370	10.6
2008	5823	10.9	2019	6942	11.2
2009	5547	10.4	2020	4715	7.6

During the previous 10-years (2011 to 2020), fatal collisions on a per capita basis were trending downward as shown in Figure 2**:**.

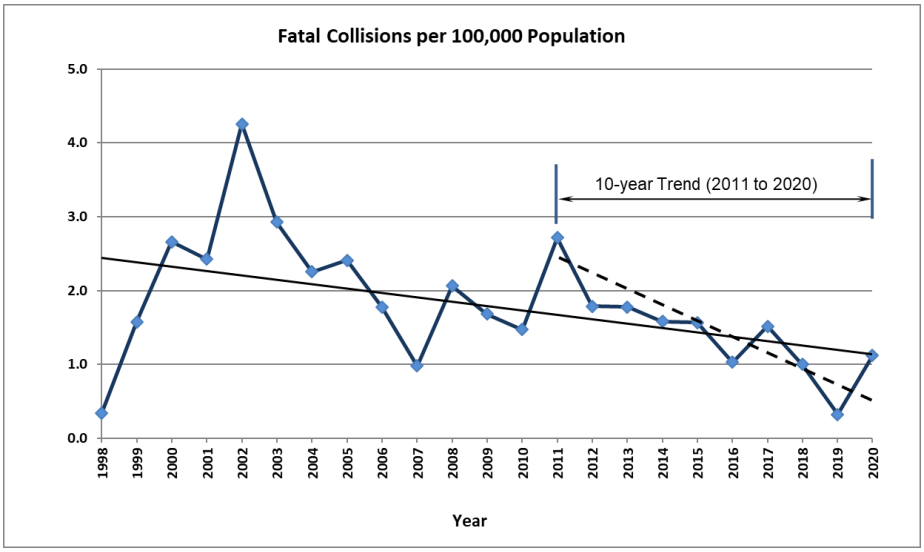

Figure 2: Fatal Collision Rates in the Region of Waterloo from 1998 to 2020

Pedestrian-related collisions decreased 26 per cent from 107 in 2019 to 79 in 2020. Staff note that pedestrian-related collisions are trending lower, with 2020 showing the lowest number of pedestrian-related collisions since 1997. Reference Figure 3 below.

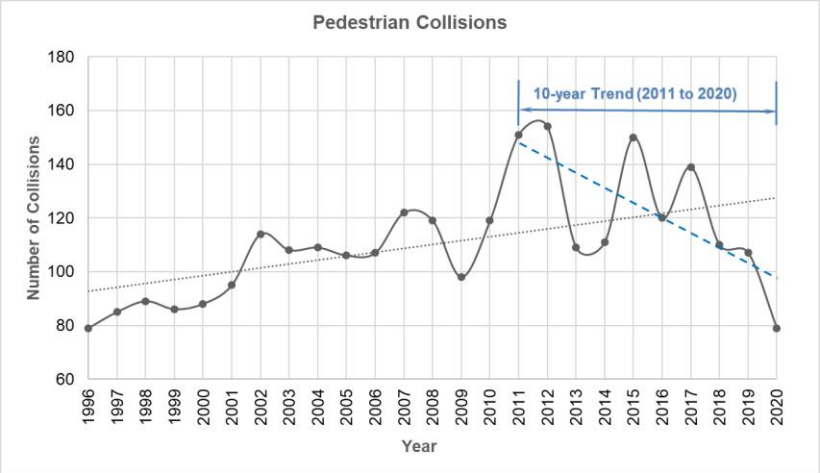

Figure 3: Pedestrian Collisions in the Region of Waterloo from 1996 to 2020

The long-term 1996-2020 trend for pedestrian collisions shows an upward trend as seen in Figure 3. However, the trend-line for the last 10-years (2011-2020) following the implementation of a pedestrian countermeasure program illustrates a significant trend reversal and reduction in pedestrian collisions. This would suggest that the Region's road safety program is having a notable and positive impact on pedestrian safety.

Even with the growing number of cyclists using the Regional transportation network, the number of cyclist collisions in 2020 continues to show a lowering trend (over a 10-year period), indicating that the Region's road safety program is also having a positive impact on cycling safety. Reference Figure 4 below.

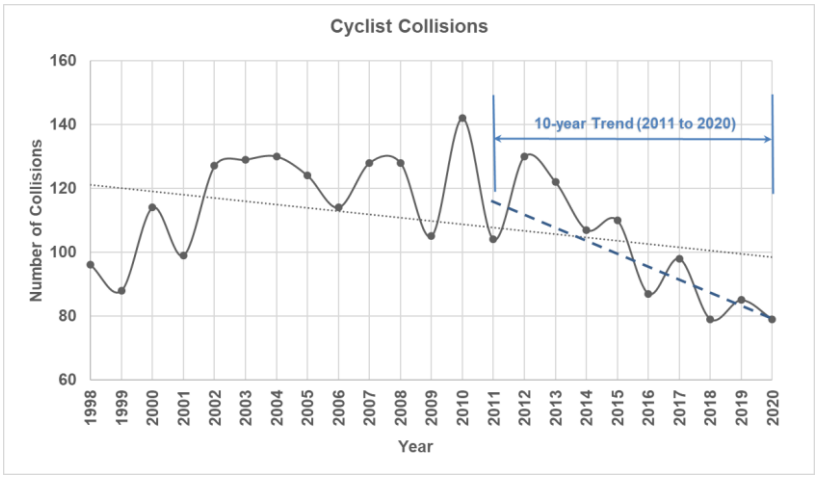

Figure 4: Cyclist Collisions in the Region of Waterloo from 1996 to 2020

Figure 5 compares trends in motor vehicle collisions per 1,000 population between the Region of Waterloo and the Province of Ontario. Overall, the data shows that collisions

on Regional roads occur less often on a per capita basis compared to other municipalities in Ontario.

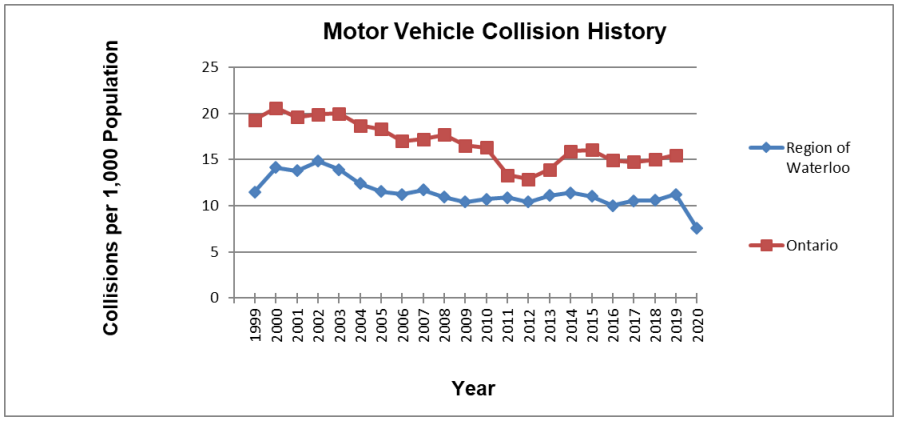

Figure 5: Comparison of Regional Collision Rate vs. Provincial Collision Rate

Collision Report

The full 2020 Collision Report, along with historical Collision Reports dating back five years is available on the Region of Waterloo website. This represents the most recent collision data available. Currently, there is a 2-year lag in populating Regional systems with collision data obtained from MTO. In early 2023, staff received the 2021 collision data and will prepare the 2021 Collision Report later in 2023.

https://www.regionofwaterloo.ca/en/living-here/collision-reporting.aspx#collisionreports

Other Sources of Data: Now and in the Future

Today, many cities contain a variety of smart and connected infrastructure which generate an abundance of data. This data can be processed to improve safety for pedestrians, cyclists and motorists. Conventional efforts to collect data related to traffic or travel is limited. There is a growing need to tap into a host of data sources such as live-traffic video and real-time monitoring. These avenues can generate a high volume of data in very little time, and can be used to further assess safety. Data can be obtained from a wide variety of sources such as:

- Video;
- Mobile Phones;
- Smart Cards;
- GPS Navigation;
- Social Media Records; and
- Connected Vehicle Data.

By bringing together high volumes of data from a wide range of sources, Traffic Engineers can make more accurate, comprehensive predictions and forecasts. Additionally, the cost of surveys and other data collection can be significantly reduced.

The Region of Waterloo has adopted an Advanced Transportation Management System (ATMS). The ATMS is a system that employs cameras and other detection devices connected to the traffic signal controller at a signalized intersection, along with advanced software, uses the data to develop Automated Traffic Signal Performance Measures (ATSPMs).

According to industry standards, ATSPMs, is defined as a suite of performance measures, data collection and data analysis tools to support objectives and performance based approaches to traffic signal operations, maintenance, management and design to improve the safety, mobility and efficiency of signalized intersections for all users.

The ATSPMS tools provided will help staff to monitor:

- Pedestrian, cyclist and motor vehicle volumes/patterns at signalized intersections;
- Pedestrian, cyclist and motor vehicle volume trends over time;
- Traffic congestion;
- Vehicle travel time and speeds; and
- Performance of traffic signal coordination/timing plans.

Other software tools being explored that can operate alongside the ATMS is Safety Analytics. Safety Analytics is a data-driven approach to reducing collisions. Safety Analytics allows users to:

- Review intersection compliance metrics;
- Identify risky pedestrian and driver behavior patterns;
- Know which intersections could benefit the most from safety countermeasures; and
- Measure the impact of safety solutions.

Analytic solutions may be available as an optional safety module to compliment the Region's existing traffic suite applications. Safety Analytics uses machine learning to help accurately predict the likelihood of a collision causing injuries on roads and at intersections. The suite uses video analytics to create digital models, analyze, and understand image and video data. By taking into account speeds, separation, conflict angle and the vulnerability of the user, the software can compute how likely near misses might lead to collisions. The data-driven approach can help identify where risk mitigation efforts can have the most impact.

Regional staff will be reviewing the Safety Analytic options as additional tools to the ATMS that is used for controlling the Region's traffic signals today.

In 2015, the Region of Waterloo retrofitted all the existing luminaires to LED luminaries. During this process, staff also ensured that all luminaires have the capability of collecting and storing data, known as the Internet of Things (IoT). The IoT is a network of objects that are embedded with sensors and software for the purpose of connecting and exchanging data with other devices over the internet. The Region's LED luminaries include a sensor for this purpose; to collect and share data. Such data may include but is not limited to:

- Travel speeds;
- Volume of pedestrians;
- Volume of cyclists;
- Vehicular volume;
- Classification;
- Emergency Assistance; and
- Smart traffic signals.

Staff will explore the option and uses of these sensors with the local area municipalities on uses in transportation operations and safety management.

4.2 Engagement

A successful Road User Safety Program requires ongoing engagement with community members, Regional and area municipality councillors and various other partner departments and organizations both within and outside the Region of Waterloo.

Region of Waterloo Public Health

The Region's Transportation Engineering team has historically worked with the Region's Public Health Department's Injury Prevention Group with regards to the following initiatives:

- Review and analyze road user injury data; and
- Development of Safety Education Programs, including public engagement regarding roundabouts.

Waterloo Regional Police Services

The Region's Transportation Engineering team has an ongoing collaborative partnership with Waterloo Regional Police Services (WRPS). This partnership includes the following activities:

- Collision data collection and review of systemic and location-specific safety problems;

- Coordination of police enforcement efforts through the STEP program;
- Development and promotion of safety education programs; and
- Ongoing collaboration with area municipalities through the Traffic Coordinating Committee.

ION Light Rail Transit (LRT) Safety and Operations Committee

Regional Transportation staff actively participate in the ION Safety and Operations Committee which, among other initiatives, facilitates a collaborative review and assessment of any safety concerns observed in and around the Region's LRT. One example: members of the committee identify and review the factors that may have contributed to collisions involving the light rail vehicles with pedestrians, cyclists, or vehicles. From these ongoing reviews, Region staff identify and implement both location-specific and systemic measures aimed at improving the LRT safety performance and further enhancing the value of the LRT system to the Region's residents.

Student Transportation Services Waterloo Region

The Region's Transportation team works in collaboration with staff from Student Transportation Services Waterloo Region (STSWR). STSWR provides student transportation services for both local School Boards including the provision of bus service. STSWR also develops School Travel Plans for each school. Region staff work with STSWR staff to address barriers to students choosing to walk or bike to school. This work can involve reviewing physical changes to the road network, in-school education for students and the development of self-governed walking and cycling programs at each school.

Area Municipalities

The Region's Transportation Engineering team works in partnership with each of the three cities and four townships on road user safety initiatives, including the following:

- Day-to-day coordination of safety initiatives as part of specific safety and capital projects;
- Data sharing and coordination through the Traffic Coordinating Committee (TCC), which includes WRPS. The TCC shares data and coordinates the implementation of various measures to ensure consistency of application; and
- Membership of area municipality staff on project-specific teams and other coordinating committees, such as the Roundabout Coordination Committee.

Advisory Committees of Regional Council

The Region's Transportation Engineering team liaises regularly with several advisory committees of Regional Council to provide updates and solicit input on new initiatives

and projects. Staff in modifying initiatives and/or projects consider the feedback received at these meetings. Some of these committees include:

- Active Transportation Advisory Committee (ATAC); and
- Grand River Accessibility Advisory Committee (GRAAC).

Community Members

The Region's Transportation Engineering team frequently engages the community on a day-to-day basis through concerns raised through Regional and area municipality Councillors and via concerns and requests raised by residents through the Region's Service First Contact Centre (SFCC) or other modes such as through social media platforms. These concerns can range from requests for a new traffic control device (stop sign or traffic signals, etc.) to questions about traffic signal timing or posted speed limits. In 2022, Transportation staff responded to over 800 such queries, most of which were safety related. In addition to the day-to-day engagement, staff also engage community members about specific safety initiatives through public engagement for specific capital projects such as road widening's and road reconstructions.

Future Planned Engagement Initiatives

The Regions' Road User Safety Program (RUSP) is dynamic in the sense that it is being continuously monitored, reviewed and updated as new data and technologies are discovered and explored by staff and all stakeholders. As part of future major updates to the RUSP, some future community engagement is contemplated as follows:

- Community-wide survey aligned with development of new Strategic Plans; and
- Significant new location-specific initiatives such as local traffic calming, etc.

4.3 Engineering

Introduction

The Engineering component of the Road User Safety Program includes a number of ongoing and annual initiatives such as systemic safety programs and the inclusion of proven safety countermeasures into all capital projects. The Engineering element is a science-based and results-driven approach to safety that evaluates collision frequency, collision severity, and field observations for potential solutions to reduce collision frequency and severity. An Engineering evaluation may include a review of any or all of the following components:

- Field observations and conditions meet current practices and designs;
- Pavement markings;
- Signage;
- Geometric design;
- Traffic control; and

- Roadway classifications.

The locations with the highest collision histories are evaluated to identify factors that are contributing to the identified collision patterns, and countermeasures are selected to address those contributing factors. Figure 6 shows the Region's countermeasure implementation process.

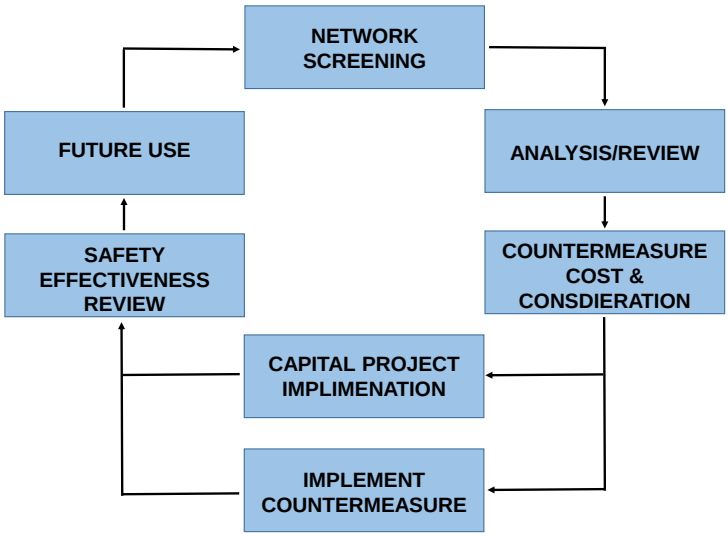

Figure 6: Region of Waterloo Countermeasure Implementation Process

Countermeasures

There are a wide variety of countermeasures that staff consider. Countermeasures vary in application cost and, for the purpose of the Region's Road User Safety Program, the countermeasures are organized into low-cost, medium-cost, and high-cost measures. Low-cost countermeasures are measures that can generally be accommodated within the existing infrastructure and typically cost less than $10,000. Medium-cost countermeasures may at times require additional funding through the Region's capital program, and generally cost in the range of $10,000 to $25,000. Countermeasures that typically cost over $25,000 and require extensive construction are considered high-cost countermeasures. High-cost countermeasures are generally implemented through the Regional Ten-Year Capital Program. A number of countermeasures are organized into Tables 2, 3 and 4 by low-, medium- and high-cost categories while Appendix A provides additional detail and photos for each countermeasure.

Table 2: Low-Cost Countermeasures

Type of Countermeasure	Description/Objective	Road Safety Benefit	Implementation
Pedestrian Countdown Signal (PCS)	• A PCS provides a numeric countdown display that indicates the number of	• Staff's analysis suggests that pedestrian collisions	• 97% of traffic signals in the Region have PCS installed.

Type of Countermeasure	Description/Objective	Road Safety Benefit	Implementation
	seconds remaining for pedestrians to cross the street.	are reduced by 20% where implemented.	• The PCS is a systemic measure implemented at all signalized intersections.
Leading Pedestrian Interval (LPI)	• A LPI provides pedestrians a "head start" (3- to 5-second) prior to a corresponding green signal for motorists in the same direction of travel.	• Pedestrians that are established within the intersection are more visible and thus, less likely to be struck by a turning motorist.	• The Region has implemented LPI's at over 55 signalized intersections and plan to expand the program to include LPI's at the top pedestrian collision locations, where appropriate.
Fully-Protected Left-turn Phase (FPLP)	• A FPLP provides left-turning motorists the right-of-way to complete left-turns free of any other conflicts. This permits motorists to execute their left-turns only when the left-turn green arrow is activated.	• The majority of pedestrian collisions occur at signalized intersections. Collisions occur while the pedestrian is in the crosswalk with the right-of-way. • About half of these pedestrians are struck by a vehicle turning left on green.	• There are more than 45 signalized intersections in the Region with at least one fully-protected left-turn phase in operation. • Staff plan to implement more fully-protected left-turn phases even if the use of fully-protected left-turn phases introduces more delays.
Right-turn Overlap Signal	• A Right-turn Overlap Signal comes on at a signalized intersection concurrently with the contra-direction protected left-turn phase. • Right-turn overlap signals provide traffic operational benefits since they enable right-turning motorists to proceed more efficiently through their right-turn.	• Staffs analysis at Regional intersections with a Right-turn Overlap signal shows that collisions involving right-turn motorists have been reduced by approximately 25%.	• Right-turn overlap signals are currently utilized at over 35 signalized intersections. • Staff is planning to install right-turn overlap signals at more locations where geometry and signal phasing allow for their safe introduction.
Ladder Crosswalks	• Ladder Crosswalks are used to provide visual cues and highlight the presence of pedestrians.	• A review of locations with Ladder Crosswalks within the Region have demonstrated that they can reduce	• There are over 210 signalized intersections with Ladder Crosswalks in the Region. • Ladder Crosswalks are a systemic measure

Type of Countermeasure	Description/Objective	Road Safety Benefit	Implementation
		pedestrian collisions by up to as much as 70%.	implemented at all signalized intersections and at stop controlled intersections with Multi-use Trails.
Visual Rumble Strips	• Visual Rumble Strips are painted bars placed across the traffic lane used to alert drivers of a stop control ahead. • They are mostly applicable in rural environments where motorists have been travelling at sustained high speeds for long periods without any need for stopping.	• Visual Rumble Strips are used when there is a history of disobey traffic control type collisions on a given approach to an intersection. • Visual Rumble Strips have shown to provide minimal benefits, they are not considered a critical countermeasure within the Region's Road User Safety Program.	• The Region of Waterloo currently has three locations with Visual Rumble Strips. Staff will continue to assess each stop-controlled approach to determine where Visual Rumble Strips may be most effective in minimizing disobey-control type collisions.
Overhead Beacon	• The Overhead Beacon is installed aerially above the travel lanes or intersection. • The Overhead Beacon will have amber and/or red flashers. The amber flasher denotes a hazard while the red flasher denotes stop control.	• The Overhead Beacon is used when sightlines approaching an intersection may not be optimal or there is a pattern of disobey control collisions.	• The Region has five sets of red/amber Overhead Beacons and two sets of red only overhead beacons (all-way stop control) installed at 7 intersections. • Staff will continue to assess each stop-controlled approach to determine where Overhead Beacons may be most effective.
Red Beacon atop a Stop Sign	• A Beacon placed above a stop sign includes a red flasher. • The Red Beacon serves as an additional warning to the approaching driver of the presence of stop control at the intersection.	• The Red Beacon atop a stop sign may be used to address fail-to-stop collisions; the pattern is likely evident in one direction of travel.	• There are six intersections that have a Red Beacon installed atop of a stop sign. • Staff will continue to assess locations and implement Red Beacons atop Stop signs as warranted.

Type of Countermeasure	Description/Objective	Road Safety Benefit	Implementation
Amber Beacon (Warning Sign)	• When an Amber Beacon is placed with a warning sign, it usually indicates that there is a potential hazard ahead, and drivers should proceed with caution. • The Amber Beacon serves to alert drivers of the potential danger.	• Amber Beacons are used when sightlines approaching an intersection are not ideal, or there is a pattern of disobeying the control.	• The Region has 10 sets of Amber Beacons that are tied to traffic signals (advanced warning flasher). In addition, there are 12 Amber Beacons installed on other hazard signs, such as “curve” warning signs, “stop ahead” signs or “pedestrian crossing” ahead signs.
Tiger-Tail (Hazard Markers) Under the Stop Sign	• The purpose of Tiger-Tail sign is to increase awareness by providing clear and visible warnings to drivers and other road users. • The Region considers installing Tiger-tail signage under stop signs as an additional countermeasure to the “disobeying stop control” collision type.	• The tiger-tail is used as a measure when there is evidence of motorists disobeying the stop control. Collisions are considered per leg of the intersection for the past 5 years.	• The Region has more than 80 intersections that have at least one approach to an intersection with the Tiger-tail Hazard sign.
Durable Stopbar Pavement Markings	• Durable Stopbar pavement markings are a form of longer-lasting pavement markings. • Durable markings remain visible and fade free for three to five years where paint may fade after just one year; dependant on the volume of vehicular traffic.	• The durable stopbar is used as a measure when there is evidence of motorists disobeying the stop control and further evidence of the painted stopbar being faded.	• There are over 50 unsignalized intersections with at least one approach with a Durable Stopbar pavement marking. Staff will continue to review collisions annually and implement durable stopbars on a priority basis.

Table 3: Medium-Cost Countermeasures

Type of Countermeasure	Description/Objective	Road Safety Benefit	Comments
Pedestrian Refuge Island	• A pedestrian refuge island is a raised median island that provides a location for pedestrians to safely wait for a gap in the traffic so they can finish crossing the road. • This makes crossing the road easier for pedestrians by allowing them to cross in two stages and deal with one direction a time.	• Pedestrian Refuge Islands are used at locations where there is 1 to 99 pedestrians crossing the road. • Collisions involving pedestrians have been reduced by as much as 80% where pedestrian refuge island installed.	• Regional staff have installed over 55 pedestrian refuge islands to date. Staff will continue to install pedestrian refuge islands throughout the Region where the existing geometry permits and enhanced traffic control is not warranted.
Audible Rumble Strips	• Audible Rumble strips are grooved patterns milled in the pavement which are intended to alert motorists of potential danger ahead through vibration and noise created when a vehicle's tires contact the rumble strips.	• Generally, the Region avoids implementing audible rumble strips within 200 metres of a residence because of the noise nuisance impacts to the residence.	• The Region currently has one location with Audible Rumble Strips. Staff will continue to implement Audible Rumble Strips as warranted.
Offset Crosswalks	• Offset crosswalks relocate traditional crosswalks 5 to 7 metres back from the intersection to provide left and right-turning motorists additional time and space to observe and react.	• Offset Crosswalks are another systemic measure that is being implemented at all new or modified signalized intersections.	• Staff anticipate that all signalized intersections will be retrofitted with Offset Crosswalks within 10 years. • Offset Crosswalks can also at times be a High Cost Countermeasure depending on the extent of the civil work.
Illumination	• Illumination can be proposed singularly, one luminaire as required, or on a large scale (mid-	• Studies have shown that installing illumination on roadways will reduce night-time	• The Region's Illumination program will prioritize locations requiring new or enhanced illumination based on the night / day

Type of Countermeasure	Description/Objective	Road Safety Benefit	Comments
	blocks). Large-scale illumination falls under High Cost Countermeasures and is normally completed through reconstruction projects.	collisions by as much as 75%.	collision ratio and actual vs. expected low-light collisions in combination with other warranting factors as stipulated in the Region's Illumination Policy.

Table 4: High-Cost Countermeasures

Type of Countermeasure	Description/Objective	Road Safety Benefit	Comments
Roundabouts	• Roundabouts are circular intersections designed to maximize safety and move all users through the junction with optimal efficiency. • These intersections are useful in their intrinsic ability to reduce severe collisions and reduce delay to all users.	• A review of intersections on Region of Waterloo roads replaced with a roundabout indicates that the number of collisions involving injuries or fatalities have been reduced by approximately 51%.	• The Region of Waterloo has more than 38 roundabouts under its jurisdiction, and are planning an additional 19 roundabouts before the end of 2026.
Right-Turn Smart Channels	• Smart Channels are a modified right-turn channel that enhances safety for pedestrians and motorists. • The approach angle improves a driver's ability to see motorists approaching from the left that they intend to merge with.	• Smart Channels have resulted in an 86% reduction in rear-end collisions and a 73% reduction in rear-end collisions causing injury, compared to historical free-flow right-turn channel designs. • Concerns have been raised in recent years by accessibility groups	• Smart Channels are typically installed through road rehabilitation projects where a right-turn channel is justified or where an existing traditional right-turn channel needs to be updated. • Staff are taking accessibility group concerns into consideration in making decisions on future channel installations.

Type of Countermeasure	Description/Objective	Road Safety Benefit	Comments
		who believe that the channels make intersections less accessible.	
Traffic Control	• Traffic control is used to provide the right-of-way for conflicting movements. Forms of traffic control consist of yield control, stop control, traffic control signals, Level 2 PXO's Currently, the Region follows the methodology outlined by provincial guidelines when assessing the need for additional traffic control.	• When considering whether traffic signals or all-way stop control is the most appropriate form of traffic control for an intersection, there is a need to balance the benefits to side-street traffic against the costs of increased collisions and main-street delay.	• Currently the Region has over 485 Traffic Control Signals, over 40 locations with Pedestrian Traffic Control Signals and over 6 locations with a Level 2 PXO. There is an additional 17 locations with all-way Stop control. • Staff review all intersections counted under the Regions count program to determine if any intersections meet provincial warrants.

Annual Initiatives and Systemic Countermeasures

Each year, staff implement a number of countermeasures through a variety of programs and initiatives. This is considered a proactive approach which serves to minimize collisions before they can occur. The following summarizes the Region's annual assessments and systemic programs.

Pedestrian Enhancement Fronting Schools

Without the presence of active speed enforcement, current research clearly shows that reducing the average operating speed of motorists can only be accomplished through physical changes to the roadway to influence motorist behaviour. In general, physical changes to the road environment that reduce driver comfort, generally causes drivers to slow down. Table 5 and Table 6 provide a summary of the physical measures to reduce average operating speeds on Regional roads fronting schools for both pedestrians and cyclists. For every Regional road project that includes a school zone, staff endeavour to reduce operating speeds with the use of physical measures that have a positive effect, where applicable and feasible.

Table 5: Effectiveness of Measures to Reduce Speeds and Improve Pedestrian Safety

Effectiveness of Measures to Improve Pedestrian Safety				
Measure	Effectiveness			Comments
	Positive	Negative	Neutral	
Ladder crosswalks	●			
Pedestrian countdown signals	●			Device displays available time left to complete crossing
Leading pedestrian intervals	●			Allows pedestrians to start crossing for a period of time before motorists are allowed to proceed
Raised intersections				Not an appropriate device to maintain function of a Regional road
Medians	●			
Pedestrian refuge island	●			
Crossing guards	●			
Offset crosswalks	●			
Pedestrian Traffic Control Signals (IPS)			●	A controlled crossing for pedestrians however likely increase in motor vehicle collisions
Roundabout Installation	●			
Education			●	
Illumination	●			
Signs warning of pedestrians and cyclists			●	

Table 6: Effectiveness of Measures to Reduce Speeds and Improve Cycling Safety

Effectiveness of Measures to Improve Cycling Safety				
Measure	Effectiveness			Comments
	Positive	Negative	Neutral	
Reserved Cycling Lanes	●			
Bike boxes	●			
Protected Cycling phases	●			Protected movement at signalized intersections for cyclists

Regional Ten-Year Capital Programming

It is well known that motorists require visual messages or queues before they slow down. Unless there is some physical change in the road or surrounding environment,

travel speeds will remain the same; changing posted speed signs alone will not reduce travel speeds.

Regional roads are designed to carry higher volumes and, in places, at higher travel speeds. Some vertical traffic-calming devices such as speed bumps, speed humps, or speed tables are generally not appropriate along sections of roadways with higher volumes, significant amounts of heavy trucks or transit buses, or sections where higher vehicle speeds are appropriate. When considering such traffic-calming measures, there are a number of factors that must be included in the feasibility assessment.

The Region considers the practicality of deploying traffic calming measures such as installing curb and gutter, medians, sidewalks and cycling lanes when the road is completely reconstructed. These measures are implemented through the Regions Ten-year Capital Program.

Site-Specific Safety Improvements

The implementation of safety improvements is not just limited to the Region's top collision locations. As part of the Region's Transportation Capital Program, staff consider site-specific safety countermeasures at every intersection and road segment that comes up for reconstruction or widening, including small stand-alone projects. For every project, staff review the collision history and prepare road designs with a view to improve safety for all users. In addition to the countermeasures highlighted under the Engineering Countermeasure Program, staff also consider safety improvements such as:

- Reduced lane widths;
- Reduced turning radii;
- Enhanced lighting;
- Median islands; and
- Removal of unnecessary turning lanes.

4.4 Education Programs

Region of Waterloo staff recognize that education is one of the key components of the five E's which is why it is important that the Region continue to educate residents in road safety.

Since the Region's first roundabout in 2004, the Region has undertaken numerous educational campaigns in a variety of forms listed below:

- Social Media such as You Tube;
- Brochures and Pamphlets;
- Radio;
- T.V. Commercials and Video;

- DVD's; and
- Public Engagement (including local schools).

Transportation Services led the following Educational Campaigns specific to roundabouts:

Social Media Campaigns

- "How the heck do you drive in a roundabout?!"
- Safe Roads Waterloo Region (Safe Roads Website)

Brochures and Pamphlets

- "A Yield Collision You Can Avoid" Brochure
  - https://www.regionofwaterloo.ca/en/living-here/resources/Roads-and-Traffic/Roundabout-Yielding-Brochure.pdf
- "How To Drive, Walk, and Bike in a Roundabout" Brochure
  - https://www.regionofwaterloo.ca/en/living-here/resources/Roads-and-Traffic/How-to-drive-walk--bike-in-a-roundabout.pdf
- "Pedestrians Take the Lead" Brochure
  - https://www.regionofwaterloo.ca/en/living-here/resources/Roads-and-Traffic/Pedestrians-take-the-lead-Brochure.pdf
- "Let's Improve, Signal your Move" Brochure
  - https://www.regionofwaterloo.ca/en/living-here/resources/Roads-and-Traffic/Lets-Improve-Roundabout-Brochure.pdf

Radio Commercials

The Region held the "Great Roundabout Radio Contest". This Campaign included local high school students producing radio commercials that aired on 91.5 The Beat in February 2012.

T.V. Commercials and Video

- "Don't be a Dinosaur" Training Video
- "How the Heck do Drive in a Roundabout?!" Training Video
- "Learn the Turn! ... Roundabout Essentials". An education campaign that included a roundabout training video. The video taught the essential skills needed to drive a roundabout properly, safely and easily.
- "Practice makes Perfect!" Education Campaign, included a series of four instructional television commercials highlighting proper driving habits at roundabouts.

DVD's

- "How the heck do you drive in a roundabout?!" Education DVD.

Public Engagement (including local schools)

- Education materials distributed to schools, companies, and government;
- Roundabout display boards put up at local municipalities and local businesses;
- Staff went out into the community and held information sessions for residents and business owners;
- Portable Variable Message Signs (PVMS) used at various roundabouts to display a variety of different messages. The messages have been based on different types of collisions occurring in the roundabout; and
- Staff presentation to community groups as requested. The presentation was developed to discuss the main questions pertaining to roundabouts which includes interacting with participants via printed roundabout graphic and model cars and model signage.

Many of the above engagements and education materials remain available to residents today.

In 2019, staff partnered with a variety of community agencies like Student Transportation Services Waterloo Region (STSWR), Cycling into the Future, Walking School Bus, Block Parents, Safety Village, Public Health and the Waterloo Region District School Board (WRDSB) developed an education piece that is now used in the school learning environment called “Sidewalk Smarts”. This program was rolled out in a number of elementary schools in Waterloo Region. The program, a combination of in-class and in-field learning, teaches grade 3 and 4 students safe walking behaviour in their neighborhoods. Parents and caregivers are supplied with materials to help the students practice and reinforce the new learning. Equipping students to walk safely can have a variety of positive outcomes and when parents are assured of their children’s safety, they are more supportive of more active forms of transport including walking and biking.

Also in 2019, staff initiated a Road Safety Education Campaign targeting all modes of travel including pedestrians, cyclists and motorists. **Safe Roads Waterloo Region** was developed to make citizens aware of and reduce collision types that often result in

injury. Through an assessment of the Region's collision data, the following key areas that the Safe Roads Waterloo Region Education Campaign focused on included:

- Rear-end-type collisions;
- Turning motorists striking pedestrians within crosswalks at signalized intersections;
- Turning motorists striking cyclists within crosswalks at signalized intersections; and
- Failing-to-yield collisions when entering roundabouts.

The following three key messages were the focus of this education campaign and was launched using various formats such as social media, radio, and newspaper advertising:

- All it takes is one split second to change everything;
- Do the extra "sec" check: Take a second; Take a look. Give everyone a safe journey; and
- We all share the Region's roads and roundabouts. Let's get there safely together.

The Safe Roads Campaign used Video, Social Media, Website Development, Surveys, Signage and Enforcement to share our messaging.**Error! Reference source not found.** Figure 7 shows the dashboard of the Safe Roads Waterloo Region website.

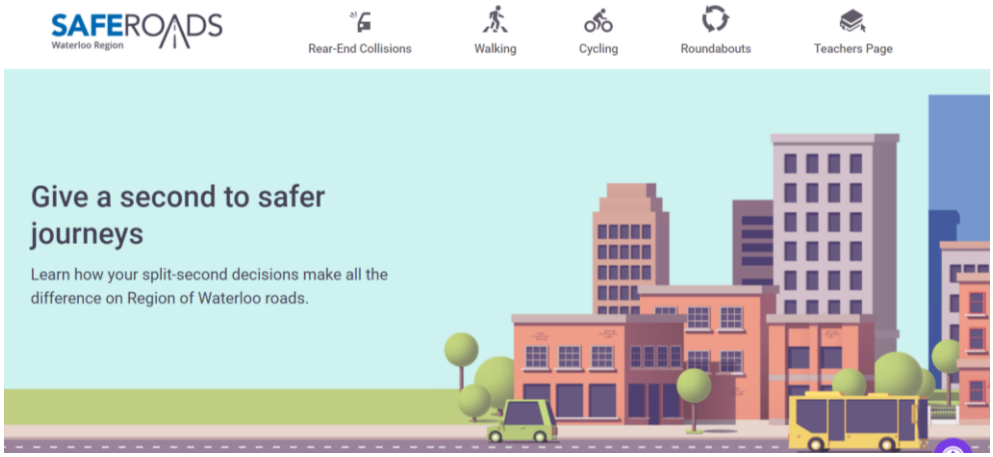

Figure 7: "Safe Roads Waterloo Region" Website Dashboard

In 2018, staff launched the Bike Awareness Campaign. This campaign included staff from Transportation Services attending a number of schools sharing key safety messages when biking. The campaign included handing out bicycle lights to students.

Future Public Education Campaigns

All of Transportation Services educational material will remain available through the Region's website. Other channels that have been previously used will also continue to share educational material. These channels include social media, websites, DVD's, public engagement (presentations), and brochures.

Staff will continue to work with various stakeholders to educate Waterloo Region residents focusing on key messages obtained through scientific analysis of collisions on Regional roads or through engagement with Regional Council and the public.

4.5 Enforcement Initiatives

Regional staff work closely with Waterloo Regional Police Services (WRPS) with its ongoing Selective Traffic Enforcement Program (STEP). The STEP is dedicated to improving road safety through an ongoing program of traffic enforcement at selected locations. As part of the program, Regional staff provide WRPS with the top locations for collisions and the top locations where travel speeds are higher than desired.

Other enforcement programs Transportation Services employs includes Automated Speed Enforcement (ASE) and the Regions Red-light Camera (RLC) programs.

Automatic Speed Enforcement (ASE)

The Region's Automated Speed Enforcement (ASE) program was launched in September 2021. To date, there are 16 locations with ASE sites in operation, and there are plans to expand the program in the coming months and years. All ASE units have been deployed at priority school zones across all municipalities within the Region. The use of ASE in Waterloo Region supports the Region's comprehensive Road User Safety Program goal to eliminate road-related injuries and deaths that occur where excessive speeding is an important contributing factor.

Overall speeds have been reduced when compared to speeds before the introduction of ASE. Depending on the location, early data analysis shows that reductions range from 1 km/h (2%) to 9 km/h (15%) with an overall average reduction of 5 km/h (9%). Rural school zones equipped with ASE have seen a higher speed reduction on average compared to urban school zones. Table 7 identifies the Region's 16 first ASE locations.

Table 7: Initial 16 ASE Locations within the Region of Waterloo

School	Roadway	Muncipality
Laurentian Public School	Westmount Road	Region of Waterloo
New Dundee Public School	Bridge Street	Township of Wilmot
Foundation Christian School	Katherine Street	Township of Woolwich
St. Clements Public School	Lobsinger Line	Township of Wellesley
Cedar Creek Public School	Hilltop Drive	Township of North Dumfries
St. Gabriel Catholic Elementary	Guelph Avenue	City of Cambridge
Keatsway Public School	Keats Way	City of Waterloo
Franklin Avenue Public School	Franklin Avenue	City of Kitchener
Sandhills Public School	Victoria Street	Region of Waterloo
Sir Adam Beck Public School	Snyder's Road West	Township of Wilmot
Wellesley Public School	Queen's Bush Road	Township of Wellesley
Clearview Mennonite School	Three Bridges Road	Township of Woolwich
St. Brigid Catholic School	Broom Street	Township of North Dumfries
Elgin Street Public School	Elgin Street North	City of Cambridge
Westheights Public School	Westheights Drive	City of Kitchener
St. Nicholas Catholic School	Laurelwood Drive	City of Waterloo

Regional Council has approved the expansion of the ASE program as part of the 2023 budget approval. The expansion of the program will include an additional eight locations to the existing 16 locations, bringing the ASE program to a total of 24 locations by the end of 2023.

In addition, per Council direction, staff will be bringing reports to Regional Council detailing the options for a rapid expansion of the program for 2023 and beyond. As part of the feasibility assessment, Transportation staff will be working with the Region's

Legal staff to assess the opportunity for an Administrative Penalty System (APS) and a Regionally-operated processing centre.

Regional Red-light Camera (RLC) Program

Red Light Cameras (RLC) are a tool to help reduce the number of collisions related to vehicles failing to stop at red lights. The camera will take photographs of vehicles that enter the intersection against a red signal. Photographs are not taken when vehicles enter the intersection on a yellow light, or when the signal turns red while crossing the intersection. An example of an RLC is shown in Figure 8.

Figure 8: Red Light Camera at Franklin Boulevard & Elgin Street / Saginaw Parkway

The Region of Waterloo has been deploying red-light cameras since 2000. The program started with four locations and one camera being rotated through the four initial locations from 2000 to 2007. In 2008, the Region began to install fixed red-light cameras, moving away from the rotation scheme. ***Currently, the Region has 15 active, full-time, Red-light Cameras in operation***. For a list of locations where Red-light Cameras are deployed, please refer to Table 8.

Table 8: Current RLC Locations within the Region of Waterloo

Location	Direction	Municipality
King St. at Bridgeport Rd.	Northbound	Waterloo
Weber St. at Union St.	Northbound	Waterloo
Frederick St. at Duke St.	Northbound	Kitchener
Park Hill Rd. at Water St.	Eastbound	Cambridge
Homer Watson Blvd. at Pioneer Dr.	Southbound	Kitchener
Franklin Blvd. at Saginaw Pkwy	Southbound	Cambridge
Weber St. at Bridgeport Rd.	Southbound	Waterloo
Erb St. at Regina St.	Eastbound	Waterloo
Bridgeport Rd. at Regina St.	Westbound	Waterloo
Weber St. at Lincoln Rd. /Bridgeport Plaza	Northbound	Waterloo
Bridgeport Rd at Albert St	Westbound	Waterloo
University Ave. at Dale	Eastbound	Waterloo
Weber St. at Erb St.	Southbound	Waterloo
Hespeler Rd at Langs	Northbound	Cambridge
Ottawa St. at Sunrise Shopping Centre	Eastbound	Kitchener

Staff have analyzed the collision data at 12 locations where a camera was installed in 2008 or later to assess the before/after impacts of the program, and found that the RLC program has:

- Reduced angle collisions caused by disobeying traffic control by 27 per cent;
- Reduced turning collisions caused by disobeying traffic control by 60 per cent; and
- Increased rear-end collisions by 23 per cent.

Staff will continue to implement red-light cameras where warranted. Each year staff assess all signalized intersections to determine if a red-light camera is warranted to minimize the disobey control collision action.

Overall, staff will continue to work with partners, including WRPS and the seven municipalities, to ensure that we continue to deliver effective enforcement strategies.

5.0 Ongoing Pilot Projects

Regional staff continue to assess measures to reduce collisions and improve safety for all road users. The following are measures that staff are assessing under pilot programs to determine their effectiveness at reducing collisions and improving overall safety.

5.1 Time/Day/Month Speed Restriction in School Zones

The Province of Ontario recently passed regulation allowing municipalities to vary posted speed limits by time, day and month along roadway sections that have been designated as school zones in the local Traffic & Parking By-law. This regulation permits a reduction to the posted speed limit in designated school zones by time of day, day of week and month of year using regulatory signs only. Regional staff lobbied and met with Provincial staff to develop new school zone regulatory signage without the use of flashing beacons. The new regulation, with the use of signs only, is the result of Regional staff's contributions on the ASE Committee.

In 2022, Regional staff implemented modified posted speed limit signs near 31 schools fronting along regional roads. School zones had the posted speed limit lowered by 10 to 20 km/h, depending on the location. Existing school zones having posted speed limits of 40 km/h remained at 40 km/h. Table 9 summarizes the speed limits by time, day and month. Please reference report TES-TRP-22-06 for further details of the Time, Day and Month Speed Limits.

Table 9: Speed Limit Reductions by Time, Day and Month

Previous School Zone Speed Limit	School Zone Time of Day Speed Limit	Hours	Days	Months
40	N/A	N/A	N/A	N/A
50	40	7am – 5pm	Mon – Fri	Sept – Jun
60	40	7am – 5pm	Mon – Fri	Sept – Jun
70	50	7am – 5pm	Mon – Fri	Sept - Jun
80	60	7am – 5pm	Mon – Fri	Sept – Jun

During the three-year period after the implemented modified posted speeds (2023 to 2025), staff will be conducing speed surveys during each respective year and assessing the effectiveness of the speed restriction fronting schools with the use of signs only.

5.2 Flex Sign Pilot Project

In 2019, Regional staff implemented a pilot study to determine the effectiveness of centre road signs along regional roads entering and exiting settlement areas. The goal of the pilot study was to assess the effectiveness of centre-road signage on the lowering of average travel speeds entering and exiting rural settlements. Since the initial rollout in 2019, the study has expanded to include 22 locations. Staff will be assessing the before

and after results of the centre-road sign pilot study in 2023 to determine if the program has been successful in reducing average travel speed entering and exiting rural settlements. Should the results of this pilot program be positive, staff will determine a warrant process for selecting future locations. As with most traffic safety measures, there are drawbacks to this implementation that need to be considered when determining the contextual suitability. Table 10 lists the 22 centre-road sign locations included in the pilot program.

Table 10: Centre-Road Sign Pilot Locations

Centre-road Sign Pilot Study Locations	
Settlement or Munciplaity	**Road(s)**
Cambridge	Myers Road west of Branchton Road
	Myers Road west of Franklin Boulevard
Cambridge	Cedar Street east of Grand Ridge Drive
Erbsville	Erbsville Road south of Conservation Drive
St. Clements	Herrgott Road north of Lobsinger Line
	Lobsinger Line near Herrgott Road
New Dundee	Bridge Street east of Queen Street
	Queen Street north of Bridge Street
Shingletown	Bleams Road between Sandhills Road and Queen Street
St Agatha	Erbs Road near Notre Dame Drive
	Notre Dame Dive north of Erbs Road
Philipsburg	Erbs Road west of Nafziger Road
Heidelberg	Lobsinger Line east of Kressler Road
Winterbourne	Katherine Street north of Lundy Road
Conestogo	Northfield Drive north of University Avenue
	Sawmill Road east of Northfield Drive
	Sawmill Road west of Northfield Drive
North Dumfries/Cambridge	Branchton Road betweeen Myers Road and Cambridge/North Dumfries Boundary
Bamberg	Weimar Line west of Moser Young Road
Bloomingdale	St. Charles St east of Sawmill Road
Roseville	Roseville Road east of Fischer-Hallman Road
Clyde	Clyde Road west of Village Road

5.3 “No Right-turn on Red” (NRTOR) Pilot Project

One of the Region-wide collision patterns identified by staff is turning motorists striking a pedestrian or cyclist within the crosswalk at signalized intersections. Staff suspect that

the majority of these collisions occur when motorists are attempting a left-turn or right-turn maneuver and, in some cases, when a right-turning motorist collides with a pedestrian during a red traffic signal indication.

In 2020, Regional staff implemented a pilot study that implemented “NRTOR” restrictions at three intersections from the top ten 2018 pedestrian and cycling locations.

Staff will assess this countermeasure during the next three years to determine its effectiveness to address pedestrian and cycling related collisions. Regional staff, depending on the effectiveness, will look to expand the use of this countermeasure.

5.4 Cycling Warning Sign Pilot Project

Regional staff have been piloting a new sign warning cyclists to watch for turning motorists. The sign was developed and implemented to address the pattern of collisions involving cyclists riding in crosswalks with turning motorists. Similar to the other ongoing pilot projects, staff will be reviewing their effectiveness to reduce collisions involving cyclists over the course of the next three years. If positive, staff will implement a warrant for the inclusion of the signs within our Safety Program as a low cost countermeasure.

5.5 Rural All-Way Stop Pilot Project

The Region initiated a rural all-way stop pilot project in August 2017 at selected rural intersection locations that would not have met general installation requirements for all-way stop control, but were seen as candidates for potential safety improvements. The pilot project is outlined in Report TES-TRP-17-12 presented to Regional Planning and Works Committee on June 20, 2017. In 2021, staff expanded the all-way stop pilot project to include four additional locations outlined in Report TES-TRP-21-04. The following list highlights the six locations under the all-way stop pilot study.

1. Erb’s Road at Sandhills Road, installed in 2017;
2. Queen Street at Huron Road, installed in 2017;
3. Bleams Road at Sandhills Road, installed in 2021;
4. Erbsville Road at Conservation Drive, installed in 2021;
5. Herrgott Road at Lobsinger Line, installed in 2021; and
6. Fountain Street at Menno Street, installed in 2021

Staff will report to Regional Planning and Works in 2027 sharing findings and next steps concerning the all-way stop pilot program.

6.0 Proposed New Initiatives for 2023 and Beyond

In addition to some of the more proven road user safety initiatives identified in Section 4, Regional Transportation staff has plans to investigate the potential for a series of other safety initiatives that may be appropriate for application in the Region of Waterloo.

6.1 Improved Pedestrian and Cyclist Safety and Accessibility at Roundabouts

Collision statistics in the Region from 2016 to 2020 indicate good overall performance for roundabouts in the area of pedestrian safety. Some of this good statistical performance is likely attributable to informed improvements that have been incorporated into roundabout designs.

Nevertheless, Regional staff have heard general concerns around pedestrian safety at roundabouts through various forms of engagement and it is plausible that these concerns hinder the Region's efforts to encourage more people to walk, roll, and cycle around the Region. In addition to proving safe for active transportation users, roundabouts need to feel safe in order for people to feel comfortable choosing a non-car mode for their travels. To that end, Regional staff are investigating several design enhancements, both for future roundabout designs and for retrofitting existing roundabouts, which would be aimed at improving the safety, desirability and accessibility of roundabouts for active transportation users.

Raised Crosswalks

The Region will be looking into the possibility of implementing raised crosswalks at roundabouts across both the approach and exit lanes. The goal of a raised crosswalk is to raise driver awareness around the requirement to yield to pedestrians, and to lower vehicle speeds at these critical junctions. Regional staff will be looking for opportunities to retrofit at least one existing intersection with raised crosswalks (particularly at a location with higher pedestrian volumes), and to incorporate raised crosswalks into at least one new roundabout scheduled for construction in the near future. These implementations would be supported by data collection efforts (e.g. vehicle speeds, driver yield compliance) to measure the effectiveness of the design feature and assess their candidacy for wider use across the Region. An example of a raised midblock pedestrian crossing – which could be adapted to a roundabout pedestrian crossing – is shown in Figure 9.

Figure 9: Raised Mid-block Pedestrian Crossing (Source: FHWA)

Rapid Flashing Beacons with Accessible Pedestrian Signals

Similarly, the Region will be investigating the feasibility of installing Rectangular Rapid Flashing Beacons (RRFB) at roundabout crosswalks. One of the goals of the RRFB implementation would be to raise driver awareness of the requirement to yield to pedestrians. Additionally, RRFB can be further enhanced with the inclusion of Accessible Pedestrian Signals (APS) which would provide audible cues for users with visual impairments, increasing the accessibility of roundabout crossings. Regional staff will be looking for opportunities to retrofit at least one existing intersection with RRFB and APS (particularly at a location with higher pedestrian volumes). Since there are concerns that RRFB may have unintended consequences that actually worsen pedestrian safety, the implementation of RRFBs with APS at roundabout crossings would be combined with extensive data collection to ensure that compliance improves with respect to drivers yielding to pedestrians. An example of a midblock pedestrian crossing with RRFB – which could be adapted to a roundabout pedestrian crossing – is shown in Figure 10.

Figure 10: Mid-block Pedestrian Crossing with RRFB

Staff will also look at the feasibility of combining a raised pedestrian crosswalk with an RRFB and APS implementation to understand the effect of both pedestrian safety and accessibility features in tandem.

Illumination Improvements

Staff are working to review the illumination of pedestrian facilities at roundabouts to ensure that pedestrian visibility is adequate during low-light conditions. A fulsome illumination review of all existing roundabouts is planned for 2023 and, where necessary, staff will develop a plan to install street lighting improvements for consideration in the future Regional Capital Budget Program.

Dutch-Style Roundabout Design Readiness

A modern, more bicycle-friendly roundabout design has emerged in the Netherlands that involves a bicycle ring around the outside of the roundabout's vehicle lanes that allows cyclists to safely and efficiently navigate the roundabout within the confines of their own operating space. This design, which has been given the colloquial name "Dutch-Style Roundabouts", has gained popularity globally as a way to improve conditions for cyclists at roundabouts. Figure 11 shows a Dutch-style Roundabout that has been designed and implemented in Cambridge, England.

Figure 11: Dutch-Style Roundabout in Cambridge, England
(Source: Forbes / Getty Images)

Currently, there is no way to facilitate a Dutch-style roundabout in the Region of Waterloo since the Ontario Highway Traffic Act (HTA) does not allow the introduction of a crossing where motorists must yield to bicyclists (other than at signalized bicycle crossings). The Region – and other municipalities around the province – continue to lobby for changes to the HTA that would allow a protected bicycle crossing at roundabouts. In the short-term, Regional staff are looking to design roundabouts where possible in a manner that they can be adapted to a Dutch-style design in the future, when and if changes to the HTA support this design.

6.2 Protected Intersection Designs

The Region will be looking to incorporate the “Protected Intersection Design” at suitable signalized intersections. Figure 12 from the City of Ottawa’s Protected Intersection Design Guide illustrates shows the key corner elements of this design type. This design is intended to provide an intuitive intersection that prioritizes the safety of the vulnerable active transportation users. Some intersections in the Region have already been equipped with protected intersection elements, and Regional staff will be looking to incorporate this intersection design into all new intersection designs on a go-forward basis.

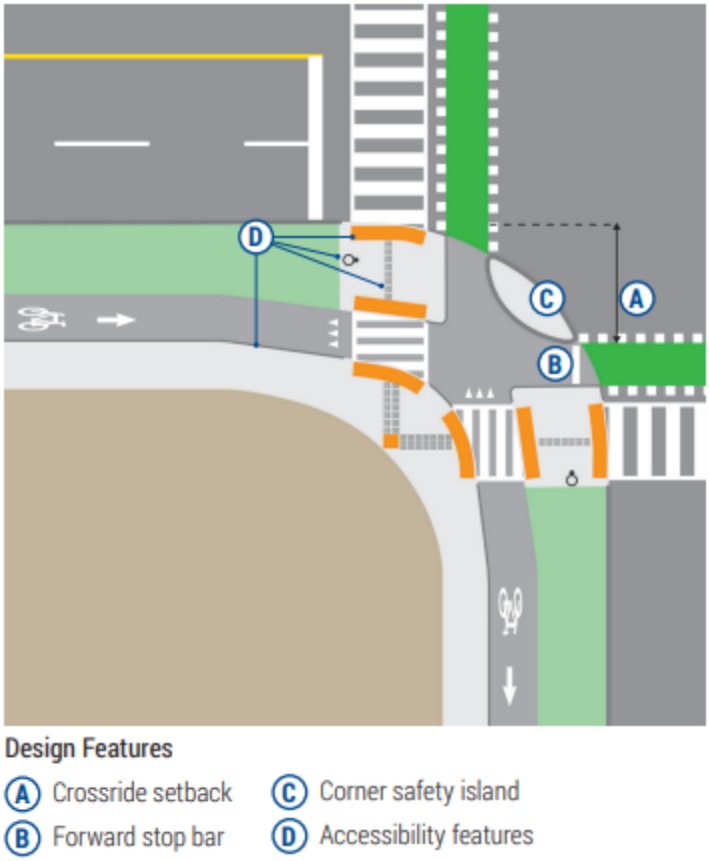

Figure 12: Elements of a Protected Intersection Design
(Source: Protected Intersection Design, City of Ottawa)

The Region has also committed funding and is participating in the development of the provincial Protected Intersection Guidelines, being led by the Ontario Traffic Council (OTC). This project kicked off in January 2023 and is scheduled for completion by June 2023. Following the completion of the OTC guidelines, the Region will look to incorporate best practices outlined in that document in regional protected intersection designs where applicable.

6.3 Review of Regional Traffic Control Warrants for Pedestrian Crossings

A number of traffic control warrants used by Regional staff today follow the guidance set out by the province so that the application of various traffic control devices is consistent with neighbouring municipalities. This includes traffic control devices such as traffic signals, all-way stop controls, and mid-block pedestrian crossing treatments. Moving forward, Regional staff will review these various traffic control warrants and update as appropriate, particularly as conclusions are drawn from pilot projects or other studies. One of the key emphases of these reviews will be to improve conditions for active transportation users crossing Regional roads. The goal will be to continue to use the provincial framework for the Region's traffic control warrants, but ensure that the

provincial warrants are applied in the appropriate manner for the Region of Waterloo context.

6.4 Improved Speed Compliance in Rural Hamlets

Regional staff will be working with local area municipality staff to develop a program aimed to address concerns raised by members of the public around vehicle travel speeds in rural settlement areas. The program, including the setting of the objectives, is scheduled for development in 2023.

6.5 Increased Use of Right-Turn-on-Red (RTOR) Restrictions

Building on the Region's existing pilot project for the deployment of right-turn-on-red (RTOR) restrictions, the Region will also look at the potential for more wide use of RTOR restrictions to address the safety concerns for pedestrians and cyclists crossing at traffic signals. The impetus for this potential visionary improvement is more related to addressing the subjective safety concern and is less data-driven in the absence of a collision data trend that would indicate an objective safety issue across the entire Region. Should eliminating RTOR at critical traffic signals remove an existing barrier that is preventing people from walking, rolling, or cycling, then staff believe it is worth investigating further. A comprehensive study will be required for this potential safety improvement because there are a lot of anticipated significant challenges in enacting this change globally in the Regional and local road network. Staff will be reviewing the timing of undertaking this study in light of many other current priorities and resource challenges.

7.0 Conclusions and Next Steps

The Region of Waterloo Road User Safety Program (RUSP) is a comprehensive evidence-based and data-driven program that involves the collaboration of a variety of proponents and stakeholders in the community.

The main goal of the RUSP is to significantly reduce all collisions involving serious injuries and fatalities, with particular emphasis on reducing serious collisions involving vulnerable road users, including pedestrians and cyclists. Collection and analysis of collision data over many years indicates that the RUSP is contributing positively to the downward trend of these types of collisions within the Region's road network.

The Road User Safety Program includes several key elements including Evaluation, Engagement, Engineering, Education and Enforcement. While the effectiveness of each element is important, the ultimate success of the Program is closely governed by the successful implementation of all of the key elements in harmony with each other.

While significant achievements have been made, there is much more work yet to be done in order to "move the needle" closer to the ultimate goal of zero serious collisions.

A lot of this work includes seeking out new partnerships with various stakeholders, new/improved methods and technologies for analysis, new/improved engineering countermeasures, new/improved ways of connecting with the public and new/improved ways of enforcement.

The ongoing development, implementation and improvement of the Region's Road User Safety Program requires a considerable amount of staff resources. Improvements and expansion to the existing components of the RUSP will require considerable additional staff resources.

Some key next steps are follows:

- Develop progress targets and resource requirements for the implementation of all systemic engineering countermeasures;
- Develop plans and resource requirements for expanded data collection, analysis and reporting on key performance metrics;
- Develop work plans and resource requirements for the expansion of existing programs, such as ASE, and the development of new safety programs, such as the Rural Hamlet Speed Compliance Program;
- Continued research into new methodologies, technologies and engineering solutions; and
- Investigate the potential to leverage ongoing camera-based monitoring /enforcement technology to provide more proactive collision analytics.

Appendix A: Countermeasures

Low-Cost Countermeasures

A **Pedestrian Countdown Signal** (PCS) adds to the typical walk pedestrian signal with a countdown device that provides a numeric countdown display that indicates the remaining number of seconds remaining for pedestrians to cross the street. Staff's thorough analysis of Regional data and the impacts of this systemic countermeasure suggests that pedestrian collisions are reduced by 20% where implemented. The PCS has become a systemic measure implemented at all signalized intersections (new or existing) under the jurisdiction of the Region of Waterloo where appropriate. ***Approximately 97% of traffic signals in the Region of Waterloo have PCS installed***. Locations that do not have PCS are those locations that are under Ministration of Transportation jurisdiction and locations with "heavy rail" pre-emption. An example of a PCS is illustrated in Figure 0-1**Error! Reference source not found.**.

Figure 0-1: Typical Pedestrian Countdown Signal: Typical Pedestrian Countdown Signal

Leading Pedestrian Intervals (LPI) at signalized intersections provide pedestrians a "head start" prior to a corresponding green signal for motorists in the same direction of travel. The change to the signal operation was employed to improve safety for elementary school students crossing at signalized intersections as it allows pedestrians to establish their presence in the intersection prior to vehicles proceeding. The general concept is that pedestrians that are established within the intersection are more visible and thus less likely to be struck by a turning motorist.

Typically, a LPI gives a 3 to 5-second head start so that pedestrians can begin to cross the street before motorists can proceed. Beginning in May, 2017, the Region started a

pilot project to implement a LPI at signalized intersections in close proximity to elementary schools based on school start and end times. ***The Region has implemented LPI's at over 55 signalized intersections*** and plan to expand the program to include a LPI at the top pedestrian collision locations, where appropriate. Refer to Figure 0-2 that shows an active LPI.

Figure 0-2: Typical Leading Pedestrian Interval

The majority of pedestrian collisions in the Region of Waterloo occur at signalized intersections while the pedestrian is in the crosswalk with the right-of-way. About half of these pedestrians are struck by a vehicle turning left on green. A **Fully-Protected Left-turn Phase** removes the conflict between pedestrians and left-turning vehicles. This design permits motorists to execute their left turns only when the left-turn green arrow is activated, and that green arrow is only displayed without conflicting pedestrian walk phases. Regional staff plan to implement more fully-protected left-turn phases at critical signalized intersections to mitigate motor vehicle, pedestrian and cycling related collisions even if the use of fully-protected left-turn phases introduces more delays to the travelling public. ***There are more than 45 signalized intersections in the Region with at least one fully-protected left-turn phase in operation.*** Figure 0-3**Error! Reference source not found.** shows the traffic signal displays and associated signage of a fully-protected left-turn phase.

Figure 0-3: Typical Fully-Protected Left-Turn Phase Signal Display

A **Right-turn Overlap Signal** comes on at a signalized intersection concurrently with the contra-direction protected left-turn phase. Right-turn overlap signals provide traffic operational benefits since they enable right-turning motorists to proceed more efficiently through their right turn. From a safety perspective, the main benefit is that the right-turn green arrow provides positive guidance for motorists and reduces some of the judgment required in executing right-turns at traffic signals. Staffs analysis at Regional intersections with a Right-turn Overlap signal shows that collisions involving right-turn motorists have been reduced by approximately 25%. ***Right-turn overlap signals are currently utilized at over 35 signalized intersections in the Region***. Staff is planning to install right-turn overlap signals at more locations where geometry and signal phasing allow for their safe introduction. An example of a right-turn overlap signal display is shown in Figure 0-4**Error! Reference source not found.**.

Figure 0-4: Typical Right-Turn Overlap Signal Display

Ladder crosswalks are used to provide visual cues and highlight the presence of pedestrians crossing the roadway with a goal of improving the motorist yield rate to pedestrians within the crossing. They have historically been installed where intersections operate with a high volume of pedestrians, near LRT stations, at intersections within the transit corridor, or at intersections where there have been three or more pedestrian collisions within a 5-year period. This measure is likely preventing a number of pedestrian collisions that would have otherwise occurred if no intervention had been implemented. A review of locations with ladder crosswalks within the Region have demonstrated that they can reduce pedestrian collisions by up to as much as 70%. Ladder crosswalks have been implemented in the Region since 2005, and given their positive impact, are now being implemented at all signalized intersections. ***There are over 210 signalized intersections with Ladder Crosswalks in the Region***. These crosswalks are a systemic treatment by which all existing signalized intersections will be retrofitted. All new signalized intersections will receive ladder crosswalk pavement markings. It is anticipated that, within the next 3 to 5 years, all signalized intersections within the Region will have ladder crosswalks. The average cost to install ladder crosswalks on all approaches to an intersection is approximately $10,000 per intersection. Figure 0-5**Error! Reference source not found.** shows a pedestrian crosswalk outfitted with a Ladder Crosswalk treatment.

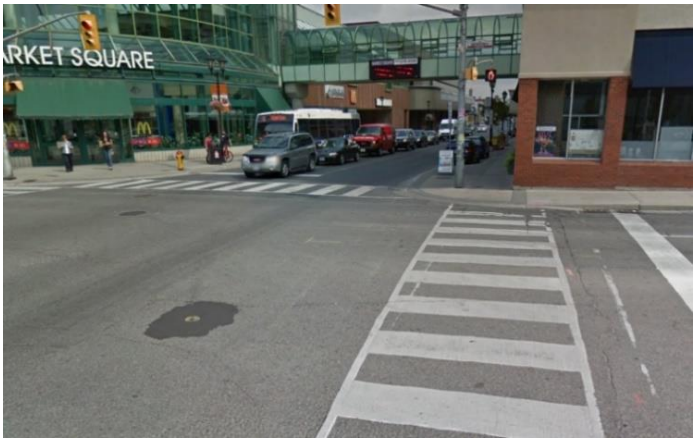

Figure 0-5: Typical Ladder Crosswalk Pavement Marking

A measure to assist with driver compliance when approaching stop controlled intersections is ***Transverse Rumble Strips***. Transverse rumble strips can include both visual (also known as painted) and audible rumble strips. Visual Rumble Strips are painted bars placed across the traffic lane used to alert drivers of a stop control ahead. They are mostly applicable in rural environments where motorists have been travelling at sustained high speeds for long periods without any need for stopping. Typically, Visual Rumble Strips are used when there is a history of disobey traffic control type collisions on a given approach to an intersection. ***The Region of Waterloo currently has three locations with Visual Rumble Strips***. Staff will continue to assess each stop-controlled approach to determine where Visual Rumble Strips may be most effective in minimizing disobey-control type collisions. Given that Visual Rumble Strips have shown to provide minimal benefits, they are not considered a critical countermeasure within the Region's Road User Safety Program. Refer to Figure 0-6**Error! Reference source not found.** for an example location with Visual Rumble Strips. Audible Rumble Strips are detailed under Medium-Cost Countermeasures.

Figure 0-6: Typical Application of Transverse Rumble Strips

Beacons are an application that includes either a red or amber flashing light that is meant to indicate that there is an obstruction, a hazard, or used as an alternate method to improve sign conspicuity, and indicates that drivers should approach with caution.

Beacons are used at intersections when there is a pattern of the 'disobey-control' collision type; meaning motorists fail-to-stop at a stop sign. In these scenarios, a Beacon is used to highlight the control to approaching motorists. There are three types of Beacons used in the Region which are listed below, including a summary of each and their respective use as a countermeasure for collisions.

Overhead Beacon

The Overhead Beacon is installed aerially above the travel lanes or intersection. Typically, the Overhead Beacon will have amber and/or red flashers. The amber flasher denotes a hazard while the red flasher denotes stop control. Generally, Overhead Beacons are installed at rural intersections where traffic on one or more of the intersection approaches is controlled by a stop sign. The Overhead Beacon is used when sightlines approaching an intersection may not be optimal or there is a pattern of disobey control collisions. ***Currently, the Region has five sets of red/amber Overhead Beacons and two sets of red only overhead beacons (all-way stop control) installed at 7 intersections***. Figure 0-7 Refer to**Error! Reference source not found.** below for an example of an Overhead Beacon.

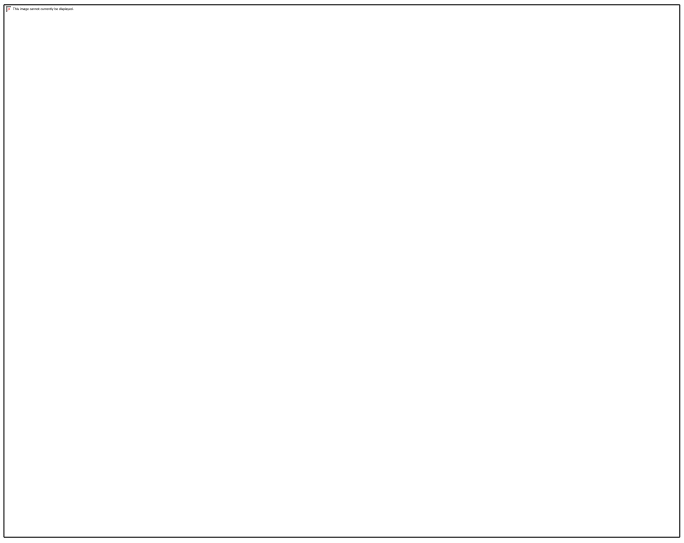

Figure 0-7: Typical Overhead Beacon

Red Beacon atop a Stop Sign

A Beacon placed above a stop sign includes a red flasher. The Red Beacon serves as an additional warning to the approaching driver of the presence of stop control at the intersection. Typically, the Red Beacon atop a sign is used if hazards approaching, such

as curves or grades, are present on only that approach to the intersection. Similar to an Overhead Beacon, the Red Beacon atop a stop sign may be used to address fail-to-stop collisions; the pattern is likely evident in one direction of travel. ***There are six intersections that have a Red Beacon installed atop of a stop sign***. Figure 0-8**Error! Reference source not found.** illustrates an example of a Red Beacon atop of a stop sign.

Figure 0-8: Typical Red Beacon atop a Stop Sign

Amber Beacon (Warning Sign)

When an Amber Beacon is placed with a warning sign, it usually indicates that there is a potential hazard ahead, and drivers should proceed with caution. The amber beacon serves to alert drivers of the potential danger and to encourage them to reduce their speed and take appropriate action to avoid any potential hazard. Typically, Amber Beacons are seen on “control ahead” warning signs or “curve” warning signs. ***The Region has 10 sets of Amber Beacons that are tied to traffic signals (advanced warning flasher). In addition, there are 12 Amber Beacons installed on other hazard signs, such as “curve” warning signs, “stop ahead” signs or “pedestrian crossing” ahead signs***. Figure 0-9 shows an example of Amber Beacons warning approaching drivers of traffic signals ahead and to be prepared to stop when flashing. Figure 0-10 shows an example where the Amber Beacon is used as an alternate method to improve sign conspicuity to caution approaching an intersection.

Figure 0-9: Typical "Prepare to Stop" Flashing Amber Beacons

Figure 0-10: Typical use of Flashing Amber Beacons to Improve Sign Conspicuity

The purpose of **Tiger-Tail (Hazard Markers) under the Stop Sign** is to increase awareness and promote safety by providing clear and visible warnings to drivers and other road users. The Region considers installing Tiger-tail signage under stop signs as an additional countermeasure to the "disobeying stop control" collision type. ***The Region has more than 80 intersections that have at least one approach with the Tiger-tail Hazard sign***. An example of the Tiger-tail sign is shown in Figure 0-11**Error! Reference source not found.** at an intersection with Roseville Road.

Figure 0-11: Typical Tiger-Tail Sign under a Stop Sign

Durable Stopbar Pavement Markings are a form of longer-lasting pavement markings that are inset into the asphalt. The durable stopbar is used as a measure when there is evidence of motorists disobeying the stop control and further evidence of the painted stopbar being faded. Durable markings remain visible and fade free for three to five years where paint may fade after just one year; dependant on the volume of vehicular traffic. ***There are over 50 unsignalized intersections with at least one approach with a Durable Stopbar pavement marking***. Staff will continue to review collisions annually and implement durable stopbars on a priority basis until all intersections are equipped with durable stopbars. All new pavement markings at existing traffic signals include the use of durable pavement markings for stopbars and for other markings within the intersection that are critical to user safety.

Medium-Cost Countermeasures

A **Pedestrian Refuge Island** is a raised median island that provides a location for pedestrians to safely wait for a gap in the traffic so they can finish crossing the road. This makes crossing the road easier for pedestrians by allowing them to cross in two stages and deal with one direction of traffic flow at a time. Collisions involving pedestrians have been reduced by as much as 80% where pedestrian refuge islands have been installed. ***Regional staff have installed over 55 Pedestrian Refuge Islands to date.*** Staff will continue to install pedestrian refuge islands throughout the Region where the existing geometry permits and enhanced traffic control is not warranted. An example of a pedestrian refuge islands illustrated in Figure 0-12**Error! Reference source not found.**.

Figure 0-12: Typical Pedestrian Refuge Island

Audible Rumble Strips are grooved patterns milled in the pavement which are intended to alert motorists of potential danger ahead through vibration and noise created when a vehicle's tires contact the rumble strips. Generally, the Region avoids implementing audible rumble strips within 200 metres of a residence because of the noise nuisance impacts to the residence. If any of the residents object to audible rumble strips, staff may implement visual (painted) rumble strips as an alternative. ***The Region currently has one location with Audible Rumble Strips.*** Staff will continue to implement Audible Rumble Strips as warranted. An example of an Audible Rumble Strip is illustrated in Figure 0-13**Error! Reference source not found.**.

Figure 0-13: Typical Application of Audible Rumble Strips

Offset Crosswalks have been implemented at new or reconstructed signalized intersections since 2014. Offset crosswalks relocate traditional crosswalks 5 to 7 metres back from the intersection to provide left and right-turning motorists additional time and space to observe and react to pedestrians in the crosswalk. Offset Crosswalks are another ***systemic measure that is being implemented at all new or modified signalized intersections***. Offset Crosswalks can also at times be a High Cost

Countermeasure depending on the extent of the civil work that needs to be completed. Figure 0-14**Error! Reference source not found.** that shows an example of an offset crosswalk.

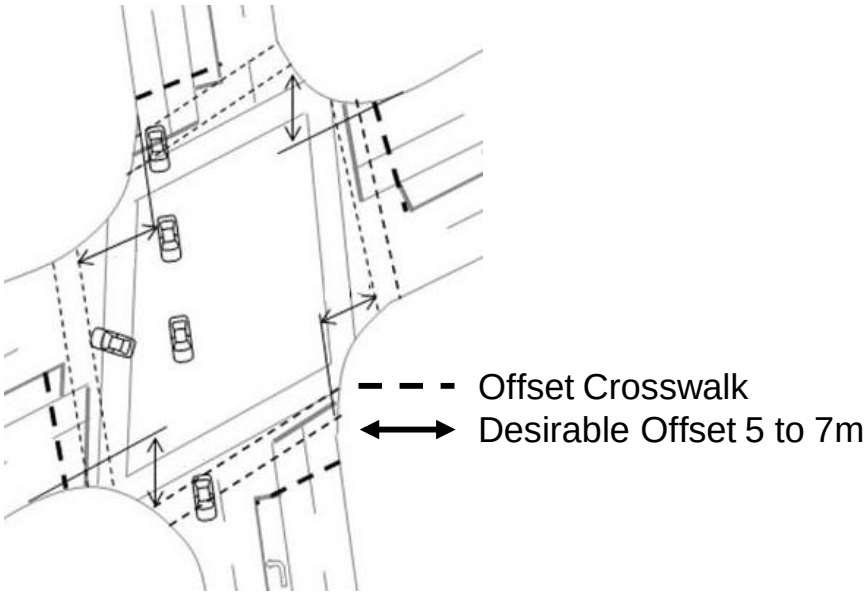

Figure 0-14: Typical Example of an Offset Crosswalk

The Region's **Illumination** program will prioritize locations requiring new or enhanced illumination based on the night / day collision ratio and actual vs. expected low-light collisions (excluding wildlife collisions) in combination with other warranting factors as stipulated in the Region's Illumination Policy. Illumination can be proposed singularly, one luminaire as required, or on a large scale (mid-blocks). Large-scale illumination falls under High Cost Countermeasures and is normally completed through reconstruction projects. Studies have shown that installing illumination on roadways will reduce night-time collisions by as much as 75%.

High-Cost Countermeasures

Roundabouts are circular intersections designed to maximize safety and move all users through the junction with optimal efficiency. Since 2004, roundabouts have been an important part of the roadway landscape in Waterloo Region. These intersections are useful in their intrinsic ability to reduce severe collisions and reduce delay to all users. A review of intersections on Region of Waterloo roads replaced with a roundabout indicates that the number of collisions involving injuries or fatalities have been reduced by approximately 51%. ***The Region of Waterloo has more than 38 roundabouts under its jurisdiction, and are planning an additional 19 roundabouts before the end of 2026***. Figure 0-15**Error! Reference source not found.** shows a typical roundabout within the Region of Waterloo.

Figure 0-15: Roundabout at Ottawa Street & Homer Watson Boulevard

Right-Turn Smart Channels are a modified right-turn channel that enhances safety for pedestrians. The safety benefits also extend to motorists since the approach angle improves a driver's ability to see motorists approaching from the left that they intend to merge with. Smart Channels have resulted in an 86% reduction in rear-end collisions and a 73% reduction in rear-end collisions causing injury, compared to historical free-flow right-turn channel designs. Smart Channels have been implemented in the Region since 2006 and are intended to replace all existing traditional right-turn channels on Regional roads. Smart Channels are typically installed through road rehabilitation projects where a right-turn channel is justified or where an existing traditional right-turn channel needs to be updated. An example of a typical right-turn channel vs a right-turn smart channel is illustrated below in Figure 0-16. While right-turn smart channels provide safety benefits to both automobile drivers and pedestrians, concerns have been raised in recent years by accessibility groups who believe that the channels make intersections less accessible. Staff are taking these concerns into consideration in making decisions on future channel installations.

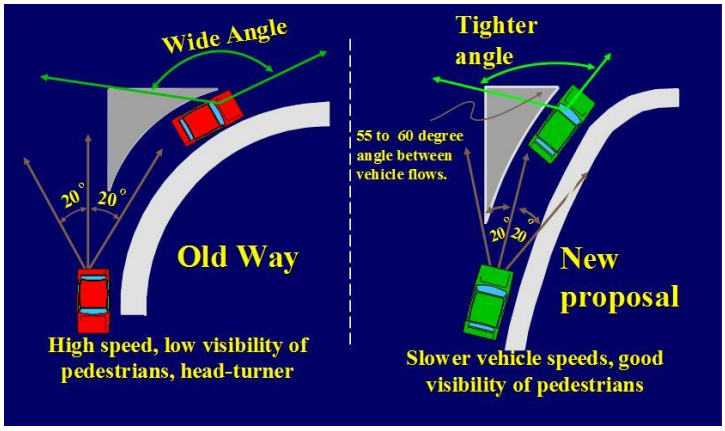

Figure 0-16: Traditional Right-Turn Channel vs. Right-Turn Smart Channel

Traffic Control

Currently, the Region of Waterloo follows the methodology outlined by provincial guidelines when assessing the need for additional traffic control such as traffic control signals, roundabouts, or all-way stop control. Typically, traffic control is used to provide the right-of-way for conflicting movements and are rarely warranted on safety alone. When considering whether traffic signals or all-way stop control is the most appropriate form of traffic control for an intersection, there is a need to balance the benefits to side-street traffic against the costs of increased collisions and main-street delay. For example, traffic signals can reduce delay for side-street traffic and can be effective in reducing angle and turning collisions. However, this is accomplished at the cost of increased delay to main-street traffic and generally **increased overall collisions.**

There are a number of Justification Warrants when considering additional traffic control; pedestrian volume and delay, vehicular volume and delay and Collision Warrant. The Collision Warrant includes a review of collisions during the previous three years and only those collisions that would be susceptible to correction (turning movement and angle collisions) if additional control was installed. Each year, staff review all intersections under Region of Waterloo jurisdiction to determine if any intersections meet the Collision Warrant for either traffic control signals or all-way stop control. ***Currently the Region has over 485 Traffic Control Signals, over 40 locations with Pedestrian Traffic Control Signals and over 6 locations with a Level 2 PXO. There is an additional 17 locations with all-way Stop control.***

The cost for all-way stop control can be considered a low-cost countermeasure where traffic control signals is considered a high-cost countermeasure at over $100,000. Staff will continue to assess collisions susceptible to correction and install additional control when warranted.