SUMMARY REPORT

Vulnerable Road Users and Heavy Vehicles Countermeasures Project

January 31, 2018
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Page 64  Truck Side Guards. Courtesy of TAKLER USA.

Page 83  External Mirrors. Courtesy of Transport Canada.

Page 85  Field of View - Blind Spot Areas from a Heavy Vehicle. Courtesy of Transport Canada.
Foreword

This Summary Report is designed to present a list of potential solutions, or countermeasures, when vulnerable road users and heavy vehicles interact.

Countermeasures have been and continue to be compiled based on an approved literature review, targeted discussions and public consultations. As information and feedback is gathered, so the document continues to be adjusted and improved upon as each phase of the project is completed.

It is expected that additional resources will be identified during the course of the project and, as a result, additional countermeasures or supporting evidence and/or considerations may be added to the report. It should be noted that the report does not include an evaluation of the research identified or documentation reviewed. Furthermore, it does not prioritize one countermeasure or set of countermeasures over another.

The final report to the Minister will serve as a starting point (ideas, references, analyses) for provincial or municipal jurisdictions as they tackle the safety challenges involving vulnerable road users sharing the road with heavy vehicles.
1.0 INTRODUCTION

Project Background, Scope and Governance

Background

Despite evolving technologies and infrastructure changes, heavy vehicles continue to pose a safety risk to vulnerable road users (VRUs). Consequently, in September 2016, a commitment to examine potential countermeasures to protect the safety of cyclists and pedestrians was made during a Council of Ministers of Transportation and Highway Safety (CoMT) meeting.

To encourage a collaborative and inclusive approach, Transport Canada, along with the provinces and territories, created a working group and invited a variety of representatives and stakeholders to participate. Since challenges facing vulnerable road users and heavy vehicle drivers are broad and touch a diverse audience, including different levels of government, it was important to assemble participants with wide-ranging backgrounds and experience. This approach would ensure a balanced and enriched perspective.

For the purposes of this initiative, the scope of this project has been limited to cycling and pedestrian risks in and around large commercial vehicles, specifically buses or trucks over 4,500 kg.

Information on potential countermeasures gathered during this initiative will be made available to stakeholders for consideration; however, implementation or recommendation of any one or multiple potential countermeasures is outside the scope of this project.

Governance Structure

The governance structure, designed to support project objectives and to bring various stakeholders together, encompasses the following roles and responsibilities:

The Steering Committee, co-chaired by the Government of Alberta and Transport Canada, is comprised of individuals with decision-making authority and assembled with representatives from Transport Canada, provincial/territorial governments and jurisdictions including the Transportation Association of Canada (TAC) and Federation of Canadian Municipalities (FCM). The Canadian Council of Motor Transport Administrators (CCMTA) has also agreed to lend their assistance.

The role of the committee is to manage the project schedule and provide strategic oversight. This oversight includes the exchange and review of advice and modal expertise provided by an Advisory Panel, overseeing and approving the public consultation process, and contributing to the development and presentation of reports to the Council of Deputy Ministers (CoDM).

Although the Steering Committee itself reports to the Council of Deputy Ministers of Transportation and Highway Safety, the two co-chairs provide a centralized voice when providing senior management with status updates.
The Advisory Panel is made up of cycling, pedestrian and trucking advocates; functional experts in various areas related to heavy vehicles such as infrastructure and safety technology; experts in related public awareness and educational groups; and representatives of federal/provincial/territorial/municipal jurisdictions.

The role of the panel is to provide advice and expertise related to the safety of vulnerable road users when interacting with heavy vehicles. This group serves in an advisory capacity to the Steering Committee.

**Approach and Methodology**

The approach and methodology for this project was approved by the Steering Committee and the Advisory Panel. They also approved a document list generated from an environmental scan and an Assessment Tool designed to capture the information on countermeasures.

**Environmental Scan**

An environmental scan was conducted to determine the availability of reports and documentation addressing the interaction of heavy vehicles with pedestrians and cyclists, including the existence of supporting evidence. These documents were then compiled to produce a reading list of research literature.

**Document Review and Data Capture**

The Advisory Panel was divided into three (3) sub-groups and assigned a number of documents from the reading list. Each group reviewed the assigned literature, identifying countermeasures based on the gathered evidence. Given the number of documents on the reading list, the VRU Task Force also undertook much of the reading and followed the same methodology.

For consistency purposes, all information was captured in an Assessment Tool; the resulting data was then consolidated into a list of countermeasures.

**Assessment Tool**

The Assessment Tool (Annex IV) was developed to capture data consistently, regardless of the countermeasure. An anchor question placed at the top of the form helped to keep reviewers on track during the document review phase.

*What countermeasures can be implemented to encourage/foster an increasingly safer environment for Vulnerable Road Users (VRUs) – that is, pedestrians and cyclists – as they manoeuver city streets and share space with heavy vehicles?*

This question was followed by a series of sections used to record the name of the countermeasure, the category and considerations, who the countermeasure was intended to affect, and the supporting evidence, if available, in the current list of documents.
Next Steps

The first phase of the project involved compiling and organizing countermeasures identified following the environmental scan. The first draft of the Summary Report presented those countermeasures for review and discussion by the Advisory Panel and Steering Committee.

Following their feedback and approval, attention was given to highlighting the evidence associated with each countermeasure, based on the documentation reviewed to-date, and organizing countermeasures according to their relevance (Specific vs Non-Specific) to the project’s mandate. (See How this Report is Organized)

Facilitated round table sessions, scheduled in Halifax, Montreal and Vancouver, will provide local trucking, busing, cycling and pedestrian stakeholders with an opportunity to offer input and feedback on these countermeasures. In addition, public consultations will be organized electronically via the internet, providing a mechanism for the general public to comment on the subject.

These consultation sessions are designed to provide a forum for stakeholders across Canada to raise concerns and/or issues around countermeasures specific to them while ensuring a regional perspective is reflected in the project findings. They will also help to identify any gaps in the countermeasures listed, including any associated evidence, barriers and/or considerations.

Findings collected during each phase of the project will be reported in January 2018 to the Council of Ministers (CoMT) meeting. A final summary document will be prepared for June 2018.

How this Report is Organized

This Summary Report has been organized to support the review and discussion of countermeasures. It has been divided into five key sections, which have been organized in alphabetical order. In addition, the countermeasures listed within each section are also organized alphabetically. This deliberate approach was chosen to avoid any perception that one countermeasure or group of countermeasures is being prioritized or recommended over another.

Section 2.0 – Countermeasures-at-a-Glance, provides a visual overview of selected data with respect to the countermeasures listed in this report.

Section 3.0 – Road Safety Strategies, offers a summary of the overarching principles and philosophies associated with road safety. Typically, a variety of countermeasures are anchored in these strategies that can be applied to both heavy and other motor vehicles. The strategies are divided into two sub-sections:

- Global and National Road Safety Strategies
- Other Supporting Strategies

Section 4.0 – Countermeasures, is organized into a number of sub-sections, based on their type, and further subdivided into two parts:
- **Part 1: Specific** includes those countermeasures that specifically address vulnerable road users and heavy vehicles
- **Part II: Non-Specific** includes those countermeasures that address vulnerable road users and other motor vehicles, but the principles presented could also apply to heavy vehicles.

Since most countermeasures can be applied to both heavy and other motor vehicles, you will notice that more countermeasures appear under Part II.

**Annexes** include additional information for reference purposes. These include:

- New countermeasures identified as a result of the project’s ongoing document review.
- Canadian references of best practices and guidelines associated with certain countermeasures.
- The Assessment Tool used to gather information about countermeasures.

**Additional References** at the end of the report include a list of Acronyms, a Bibliography and an alphabetical Index to Countermeasures.

**NOTE:** This report provides a listing of potential strategies and countermeasures that could be utilized to reduce serious injuries and fatalities when vulnerable road users share the road with heavy vehicles. However, it does not make any recommendations or favor one approach over another as the recommendation of any one or multiple potential countermeasures is outside the scope of this project.

In addition, this version of the report represents findings documented to this stage of the project. It will remain evergreen, thereby allowing for new technologies and/or research to be incorporated into the report as the project unfolds.
### 2.0 COUNTERMEASURES-AT-A-GLANCE

#### Specific and Non-Specific Countermeasures

*Total Number of Countermeasures: 53*

- **Specific, 33%** (16)
  - Side Guards and Side Skirts
  - 4%
  - Rules of the Road
  - 2%
  - Roadway and Cycling Infrastructure
  - 2%
  - Visibility and Conspicuity
  - 15%
  - Communications, Awareness and Education
  - 8%
  - Intersection and Crosswalk Design
  - 2%

- **Non-Specific, 67%**

*Road Safety Strategies (Section 3.0) presented in the report were not classified as specific or non-specific and were therefore, not included in the following diagram. However, the count for total number of countermeasures (53) does take these strategies into account.*

**Figure 1**
The Assessment Tool (Annex III) was used to categorize the countermeasures. The chart below summarizes the distribution of all countermeasures presented in the report by category.

![Distribution of Countermeasures by Category](image)

**NOTE:** Some countermeasures apply to more than one category; therefore, the total number of countermeasures identified for each category may exceed the total number of countermeasures presented in the report.
Countermeasures (by category) were identified and counted, based on how they relate to the UN’s Decade of Action pillars.

*A Decade of Action for Road Safety* is a United Nations (UN) / World Health Organization (WHO) recommendation. The idea was to create long-term and coordinated activities over the span of a decade (2011-2020) that would support national and local road safety. Using a *Safe System Approach*, the Decade of Action enlisted the use of 5 pillars to guide these activities: Road Safety Management, Safer Roads, Safer Vehicles, Safer Road Users, and Post-Crash Response.
3.0 ROAD SAFETY STRATEGIES

Road safety strategies are designed to respond to the needs of all road users, with an underpinning philosophy that is focused on saving lives by reducing traffic fatalities and injuries while promoting the mobility of people and merchandise.

To achieve these objectives, a successful road safety strategy will monitor, assess and strive to improve safety standards by drawing on best practices and emerging technologies, creating and/or influencing policy and education, and building relationships. This includes forming partnerships with key stakeholders such as trucking organizations, safety advocacy groups, governments and other subject matter experts.

This holistic and integrated approach encourages the creation of a strategic framework that reflects a broad perspective encompassing the values of safety, quality of life and respect for the environment. For the purposes of this report, the identified strategies have been divided into two groups:

- Global and National Road Safety Strategies
- Other Supporting Strategies

The variety of identified strategies have principles and visions that encompass road safety generally. Some strategies are well documented while others are only just emerging, but each are addressed using the same format consisting of a description and links to additional references, as available.

*Strategies can affect policies that are developed to promote the safety and health of VRUs. This section presents some examples of such road safety strategies.*
Global and National Road Safety Strategies

Complete Streets

Overview
The Complete Streets movement emerged around 2005 in the United States. Although it is gaining technical, political and public importance in Canadian communities, to date it has received little attention at a national level.

Complete streets policies and practices integrate the needs of all road users (including those with disabilities) in right-of-way planning, design, construction, operation and maintenance. They are typically intended to ensure the appropriate consideration and accommodation of walking, bicycling and public transit, as well as the community context.

Considerations
Transport Canada’s Complete Streets: Making Canada’s roads safer for all cites the experience of a variety of North American jurisdictions that have adopted, at least in part, a Complete Streets approach. The experience of these jurisdictions show actual improvements related to reductions in fuel consumption, travel time, collisions and carbon monoxide emissions as a result of implementing the Complete Streets philosophy.1,2

Municipalities may be concerned that adopting a Complete Streets approach will result in cost increases associated with infrastructure. Consequently, there may be opposition from various stakeholders expressing concern over the loss of parking, the ability to conveniently make deliveries, and other related issues.

A Complete Streets approach is not a “one size fits all” approach. Actual benefits will vary and could be affected by the skill, knowledge and experience of the team developing the plan.3

Additional References
Transportation Association of Canada Briefing

Road Safety Strategy 2025

Overview
The Road Safety Strategy (RSS) 2025 vision is “Towards Zero – The Safest Roads in the World” and is based on an international best practice first adopted by Sweden in 1997, Vision Zero, another road safety strategy that was approved by Sweden’s parliament and has permeated that country’s approach to road safety ever since.4

RSS 2025 was created by the Canadian Council of Motor Transport Administrators (CCMTA). This 10-year national road safety strategy is the fourth in a series of national strategies to have been implemented to-date. It provides an inventory of proven and promising best practices to address key risk groups and contributing factors. It continues with a flexible approach to allow jurisdictions to implement road safety programs that meet their own specific needs.5
The purpose of the strategy is to continue Canada’s national effort in addressing important road safety issues by providing a framework for governments and other road safety stakeholders to establish their own road safety plans, objectives and interventions to eliminate road crashes that result in serious injuries or fatalities.

**Considerations**

Although the strategy does not include hard quantitative safety targets, it does not preclude individual jurisdictions or organizations from establishing their own targets when there is government, law enforcement and/or road safety stakeholder support for doing so.

For each risk group and contributing factor, there may be more than one intervention for promoting safer road users, safer infrastructure and safer vehicles. A combination of interventions could result in even great improvements to safety.

**Additional References**


Canada’s Road Safety Strategy 2025

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**Safe System Approach**

**Overview**

A *safe system* approach involves multiple strategies aimed at the road and roadside, the vehicle, the speed limit and behaviour of the road users involved. It provides a logical framework that examines these road safety elements and their interactions to enable practitioners to develop their thinking and understanding around risk and countermeasure possibilities.

The *safe system* approach is derived from the work of the Swedish Road Authority and Road Safety Agencies in the Netherlands and has been adopted as the basis for road safety activity in Victoria, Australia, since 2003. It is also adopted across Australia in the current National Road Safety Action Plan.

**What is the Safe System approach?**

As road users are human, crashes are always likely to happen even though there is a continuing focus on prevention. The safe system approach recognizes that there are limits to the capacity of the human body to survive various crash types above certain speeds of impact. It places a priority on systematically addressing major factors involved in specific crash types to achieve substantial road trauma reduction benefits over time.

The *safe system* approach aims to minimize the severity of injury and is based on the premise that road users should not die because of system failings.

The basic premise for survivability is that when a five star driver (obeying the law), is driving a five star vehicle on a five star road and road side with a five star speed limit for the crash risk on that section of road, then any road user in or outside the vehicle should not – if they or the driver make a simple mistake or error of judgement – be subjected to a crash of such severity that they lose their life.
It assumes that:

- Crash analysis and ongoing development of better understanding of crash causes is a mainstream and continuing activity of road safety agencies.
- Adequate road rules to provide safe travel and the necessary enforcement of those rules to achieve high levels of road user compliance are in place (both areas of great opportunity).
- An adequate driver licensing system exists.
- An informed and aware community is very supportive of the settings required to achieve and maintain an increasingly safe road transport system.

It challenges “system designers” to achieve a balance in the 3 key factors on the physical network – the road and roadside safety, the travel speed as influenced by speed limits and the primary and secondary safety features of vehicles in order to achieve safe conditions, which result in non-fatal crash outcomes.

However, it also anticipates that there are many other “system designers” – beyond the road and vehicle engineers – who impact on safe use of the network and who also carry a major responsibility for safer, survivable outcomes.

### Shared Space Approach

#### Overview

*Shared space* is an international philosophy of urban road design developed in the Netherlands that substantially improves the spatial quality of neighbourhoods. The concept replaces traffic regulations with informal social-minded rules. For example, the removal of traffic signs and traffic lights allow people to settle potential conflicts by eye contact. Traffic in these areas is regarded as a guest and the layout should clearly indicate that the primary function of the area is residential.\(^3\)

This approach results in people and traffic not clearly separated in such urban areas. For example, the shared space has a level, open surface without curbs or road crossing / traffic signals resulting in a space that is not designated for any particular user.

Such an approach is expected to result in lower driving speeds and improved road safety; the latter has not yet been conclusively proven for each example in real use.\(^3\)

#### Considerations

Several cities have experimented with this concept and impact monitoring will be useful in fully assessing its benefits and possible undesired effects.\(^3\) One consideration will be vehicle volumes on the roadway. For example, one model suggests that to facilitate cycling by persons of all ages and abilities, motor vehicle volumes should be 500 vehicles per day and 50 vehicles per peak hour or lower. Otherwise, separated cycling facilities should be provided.

*Shared space* environments with high volumes of motor vehicle traffic have also proved to be problematic for the visually impaired. Unless designs can resolve these types of issues, the *shared space* approach should only be used in low traffic areas.

#### Additional References

[Pedestrian Safety, Urban Space and Health](#)
Speed Management

Overview

Speed management is an overarching, active approach that requires, or persuades, drivers to adopt speeds that offer mobility without compromising safety. It is much more than setting and enforcing appropriate speed limits. It employs a range of measures with the aim of balancing safety and efficient vehicle speeds on the road network. It aims to achieve a road transport system that anticipates and allows for human error, while minimizing the risk of death or serious injury.

In many countries, speed limits are set at levels too high for existing roadway conditions and the mix and volume of road users, particularly where there are many pedestrians and cyclists. The management of speed involves a wide range of measures including setting and enforcing speed limits, engineering measures designed to reduce speeds, and public education and awareness campaigns.

Considerations

While speed management is an international strategy designed to promote the mobility of people and merchandise, at the same time, it recognizes the potentially negative effects with respect to road safety, quality of life and the environment.

Given the complexity of speed issues, it is not always easy to target the most effective intervention. Some solutions, such as roadway infrastructure, can represent significant investments. Conversely, the simplest solutions are not always effective. The mere reduction of speed limits, considering the redesign of roadways or traffic control devices, often does not have a significant effect on the speed of the drivers.

Australian jurisdictions have adopted the use of an ‘expert’ computer system to assist with setting speed limits that considers a variety of factors including the nature and level of road user activity (pedestrians, cyclists and heavy vehicles), etc.

Additional References

Speed Management, A Road Safety Manual for Decision Makers and Practitioners
Gestion de la vitesse sur le réseau routier municipal en milieu urbain (French only)

Sustainable Development Goals

Overview

Sustainable Development Goals (SDGs); otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

These 17 goals build on the successes of the Millennium Development Goals, while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The SDGs highlight the need for safer roads and the creation of more sustainable and resilient communities. Goal 3.6 indicates the target to cut road traffic deaths and injuries by half by 2020. Various other goals also strive to improve road safety by expanding public
transportation and paying closer attention to vulnerable demographic groups. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another.

The SDGs work in the spirit of partnership and pragmatism to make the right choices now to improve life, in a sustainable way, for future generations. They provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large.

**Additional References**

Sustainable Development Goals
Sustainable Development Knowledge Platform

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**Vision Zero / Sustainable Safety**

**Overview**

*Vision Zero* is a national traffic safety policy originally developed in Sweden. Launched in 1997, it adopts a radically different paradigm of traffic safety where the focus is on implementing failsafe roads and vehicles. The “zero” refers to the target goal of zero deaths by 2020 supporting the premise that “No loss of life is acceptable”. The policy itself is based on four elements: *ethics, responsibility, a philosophy of safety,* and *creating mechanisms for change*.

Working from the same premise, the Netherlands launched a similar initiative in 1998 called *Sustainable Safety*. The intent of this three-year program was to develop a safe and sustainable road traffic system with features that includes an infrastructure adapted to take into account human limitations; using/developing proper road designs; vehicles equipped with technology; and road users provided with adequate information and education so they will be deterred from engaging in undesirable or dangerous behaviour.

While other European countries have implemented this strategy during the late 1990s, Edmonton was the first Canadian city to officially adopt it in 2015. Since then, other Canadian municipalities have joined the movement.

**Considerations**

Unlike other important *Vision Zero* strategies that require longer-term investments in infrastructure and culture change (both internally within city agencies and amongst the public), making relatively simple, inexpensive technology, policy, and training improvements with respect to large vehicles can be a quick and easy win for cities, including those in the early stages of *Vision Zero*. In most cases, cities, regional governments and transit providers have some degree of jurisdiction over their vehicles, whether in the form of contract agreements with vendors, procurement practices, or by operating and maintaining their own fleets. Early-adopter *Vision Zero* cities such as New York, Boston, Washington D.C., and San Francisco have experienced success in recent years, following cities in Europe, Asia, and Latin America that have documented safety improvements after implementing similar policies. (2)

Rather than trying to change human behaviour to fit the system, *Vision Zero* changes the system to fit human behaviour.
**Other Supporting Strategies**

**Bicycle Plan**

**Overview**

A Bicycle Plan or strategy incorporates bike-friendly protocols and standards when building or reviewing any jurisdictionally-funded infrastructure initiatives. It is a consultatively written plan that is evidence-based and may result in the review of existing policies, guidelines and actions. As such, it can include the design of bicycle infrastructure, such as Segregated Bicycle Lanes, to address the potential conflict between heavy vehicles and cyclists.

**Considerations**

A Bicycle Plan requires leadership and collaboration with relevant stakeholders, strategic policy development and planning, and a need to examine capacity for research, program delivery and knowledge transfer. One advocacy group has proposed a National Bicycling Strategy.

There is unclear authority as to what level of government would be the lead on such a strategy.

**Additional References**

Towards A Bike-Friendly Canada - A National Cycling Strategy Overview

**Monitoring Strategy – Forensic Review of Collision Data**

**Overview**

An annual forensic review of all pedestrian (and cyclist) deaths (and injuries) occurring within each respective jurisdiction will identify collision-prone areas. Findings would be included as a component of capital planning for road reconstruction and resurfacing projects to proactively seek ways to improve pedestrian safety.

**Considerations**

Targeted enforcement strategies require data on collision factors and frequencies to enable agencies to prioritize behaviours. Knowledge of the behaviour and traffic patterns of a community also help the police to develop countermeasures that address specific behaviours of both drivers and pedestrians.
Measurement, reporting, and monitoring pedestrian (and cyclist) mobility and injuries inform and support development of government policy and research strategy to better understand mobility trends / behaviours.\(^3\)

Decision-makers rely on evidence regarding personal travel behavior to formulate strategic transport policies and to improve the safety and efficiency of transport systems. Limited published data, however, results in its exclusion from analysis and policy discourse.\(^3\)

The Ontario Ministry of Transportation suggests that an annual forensic review include full collision investigation / reconstruction reports to determine at-fault. Based on this data, more thoughtful evidence-based policies and considerations can be developed to target those typically at-fault collisions.

**Sharing Interests / Collaboration Strategy**

**Overview**

The *sharing interests* strategy is an approach that looks at the urban environment from a high-level community safety and amenity viewpoint. It targets two key objectives – keeping pedestrian mobility and pedestrian planning at the top of the political agenda – as core strategies informing any plan of action. The *sharing interests* strategy places emphasis on the achievement of common goals within different policy settings through combining efforts and resources.\(^3\)

**Considerations**

The collaboration of bicycle and freight interests in cities has resulted in joint planning of bicycle and truck facility networks to best serve both user groups.\(^9\)

Research indicates that bicycles and trucks can exist successfully in the same city and travel corridors, if not on the same streets. Seattle has the framework in place to make this happen, such as a bicycle planning committee and a freight advisory board. However, collaboration between these groups has been minimal and somewhat contentious. Seattle can learn from other cities that have developed avenues for collaboration between the bicycle and freight communities so the needs of both are addressed and Seattle’s city streets are optimized.\(^9\)

A *sharing interests* strategy can help to gain financial support for the implementation of safety programs and packages of safety measures.\(^3\)

While sound in concept, building relationships with multiple stakeholders governed by different agendas will require good coordination, communication and a willingness to collaborate. Inter-sectorial policies will deliver better results than separate policies within sectors.\(^3\)
Walking Strategy

Overview

A *walking strategy* builds a physical and cultural environment that supports and encourages walking by envisioning a city where high-quality walking environments are seamlessly integrated with public transit, cycling and other sustainable modes of travel. A *walking strategy* sets out a plan that produces tangible environmental, health and social benefits for city residents and visitors.

A *walking strategy* promotes social inclusion. As the “International Charter for Walking” states, witnessing pedestrians on streets is a key indicator of a healthy, efficient, socially inclusive and sustainable community.\(^3\)

Considerations

Canada is joining other jurisdictions from around the world in adopting ambitious strategies for increased active transportation, cycling, walking, and active school travel. The collaborative action plan will address real-world barriers and incentives. Solutions include infrastructure, community design, place-making, and high engagement community programs like school travel planning designed to make active transportation safe, practical, and inviting, and to re-establish a culture of self-mobility.

Unlike stand-alone promotional campaigns, improved walkability [a national walking strategy] generates lasting increases in walking rates and transforms behaviour.\(^1,1\) Land use planning is the key to helping promote pedestrian safety and accessibility – particularly for those with impaired mobility. “Design for all” or “universal design” is an important component of urban transport planning.\(^3\)

Countermeasures to address pedestrian safety are only as good as the overall vision of the pedestrian network and mobility. The Organisation for Economic Co-operation and Development (OECD) study indicates that “current knowledge points to the importance of an overarching vision, consisting of clear policies and targets, with tailored communication, supportive research and technical advice to effectively promote walking.”\(^3\)

A concern is the cost of building / maintaining infrastructure required to support road / transport systems and the urban sprawl it engenders.\(^3\) A study undertaken for the government of New South Wales in Australia has developed an approach for the economic appraisals of significant spending proposals to develop strategies for walking (PricewaterhouseCoopers, 2011).

Generally, the benefits identified and quantified within a cost benefit appraisal framework for this study include savings in health and vehicle operating costs, among others. Further, it changes the level of road and pedestrian safety.\(^3\)

Additional References

*Let’s Take Action to Make Canada a Great Place to Walk*
*Active Transportation for Canada. Now!*
*Walking Strategy – City of Toronto*
4.0 COUNTERMEASURES

Countermeasures are organized into a number of sub-sections, based on their type, and further subdivided into two parts:

- **Part 1: Specific** includes those countermeasures that specifically address vulnerable road users and heavy vehicles.
- **Part II: Non-Specific** includes those countermeasures that address vulnerable road users and other motor vehicles, but the principles presented could also apply to heavy vehicles.

Since most countermeasures can be applied to both heavy and motor vehicles, you will notice that more countermeasures appear under Part II.

4.1 Automated Enforcement

*Automated traffic enforcement technology, combined with other speed enforcement methods, including education and awareness, can help reduce the number and severity of collisions on our roads in all vehicles, including heavy vehicles.*
Part I: Specific to VRUs and Heavy Vehicles

NIL

Part II: Non-Specific to VRUs and Heavy Vehicles

**Speed and Red Light Cameras**

**Category:** Policy/Legislation/Regulation; Enforcement; Communications/Awareness

**Description**

Groups Affected

- Drivers

Speed cameras, also called photo radar or automated speed enforcement devices, record a vehicle’s speed using radar or other instrumentation. It captures the license plate information of vehicles that exceed the speed limit. Owners of these vehicles are automatically contacted and required to pay a fine.\(^1\) (Definition taken from Ottawa Citizen, November 8, 2016)

Red light cameras are designed to prevent motorists from running red lights and are tied to the intersection’s signalization. They can also be used as speed cameras; however, speed cameras cannot be used as red light cameras.

**Issues / Evidence**

**Jurisdictions Studied**

- Canada
- U.K.
- OECD Paris

Seven out of ten drivers in Canada admit to speeding. There is an exponential increase in the risk of death for vulnerable road users as speed increases. It is estimated that a pedestrian struck by a vehicle travelling at 50 km/h is eight times more likely to be killed than a pedestrian struck at 30 km/h.\(^1\)\(^0\)

Research consistently shows that speed cameras are an effective intervention in reducing road traffic collisions and related casualties.\(^1\)\(^0\)

A systematic review examined the impact of fixed or mobile speed cameras and, based on 14 observational studies, found that all but one showed effectiveness of cameras up to 3 years or less after their introduction. One study concluded that there are no reasons to doubt the effectiveness of speed cameras as a road safety measure. A second study also found consistency of reported positive reductions in speed and crash outcomes across all studies.\(^1\)\(^0\) (See Speed Limit Reductions)

**Barriers / Considerations**

While the studies have focused on reductions in overall fatalities and injuries, and confirm that any countermeasure effective in reducing vehicle speeds will improve pedestrian injury outcomes,\(^1\)\(^0\) collisions between heavy vehicles and vulnerable road users generally take place at lower speeds, which may not be subject to speed violations.

Purely imposing fines on the owner of the vehicle (not all heavy vehicle drivers are owners) may have little effect in changing driver behaviour, which is the ultimate outcome desired from this technology. If mechanisms can be designed to assign penalties to the driver, this may have a better outcome.

Barriers to successful implementation, therefore, may encompass these and/or other considerations.
Video Surveillance

Description

Groups Affected
- Pedestrians

Video surveillance is potentially one of the fastest spreading technologies amongst International Transport Forum (ITF) / Organization for Economic Cooperation and Development (OECD) member-countries. Video surveillance systems involve the placement of traffic cameras, generally situated atop traffic signals, and/or placed along busy roads and at busy intersections of the highway. They can be used to record traffic patterns for future study and observation, monitor traffic, and issue tickets for moving violations. (Definition taken from VideoSurveillance.com.) (See Speed and Red Light Cameras, Improved Crosswalk Design, Speed Limit Reductions, Walking Strategy)

Issues / Evidence

Jurisdictions Studied
- Canada
- U.K.
- OECD Paris

Video surveillance appears to work best when integrated as part of a package of safety measures, particularly in town centres. Camera systems may work better when fully integrated into police command and control strategies, and could be used to assist decisions concerning the deployment of officers and how best to coordinate a response to incidents.

Other than presenting this countermeasure as part of an integrated approach to pedestrian safety, the evidence presented in the documentation reviewed is limited to what is stated here.

Barriers / Considerations

The application of this countermeasure to heavy vehicles is limited by the same considerations that apply to all motor vehicles and the safety of vulnerable road users.

When placed at high-risk intersections, this technology can support monitoring as well as the design and/or refinement of other pedestrian safety countermeasures.

Achieving urban safety and developing effective safety-related policies requires the input of various professionals in the community. The skills and experience of those in charge of public order and crime prevention, technical services, socio-educational organisations, public transport personnel, residents, architects, planners, urban designers and decision-makers are required.

Video surveillance is controversial due to legal issues related to protecting the integrity and privacy of people. The cost for implementing such technology may be high. (See Monitoring Strategy – Forensic Review of Collision Data)
4.2 Communications, Awareness and Education

Changing behaviours and increasing road safety for vulnerable road users depends on effective communications and training that is equally supported by strong enforcement programs.
Part I: Specific to VRUs and Heavy Vehicles

An Overview – Communications, Awareness and Education Programs

**Description**

Most Western countries have acknowledged that to achieve a substantial decrease in the number of fatal and serious injury collisions, there is need for greater education, awareness and advocacy programmes, along with improved legislation and policies to reduce injuries and fatalities to the minimum level. Adopting a Vision Zero approach is necessary to help achieve these targets.\(^{(13)}\)

**Issues / Evidence**

A 2007 study found that Public Service announcements are a relatively inexpensive way to deliver road safety messages, but they tend to be aired infrequently, miss target audiences, and have little or no effect. High-quality programs have had limited success in changing individual behaviour when used alone. Some characteristics of successful mass media campaigns include careful pre-testing, communicating previously unknown information, being long-term, having substantial funding, and carried out in conjunction with other ongoing prevention activities such as law enforcement programs.\(^{(4)}\)

A 2011 study examined the effectiveness of road safety campaigns and cited the findings of a 2004 study. This study concluded that road safety campaigns were able to influence behaviour when carried out in conjunction with legislation and law enforcement, but information and publicity generally did not result in tangible and sustained reductions in serious casualties when used in isolation. A further 2009 study undertook a meta-analysis, which showed the effects of mass media campaigns as being minimal when compared with the effects of campaigns that were combined with other measures. Mass media alone that focused on a specific targeted area would actually increase traffic collisions by 1%, whereas mass media + enforcement, mass media + enforcement + education, and local individualized campaigns would reduce collisions by an estimated 13%, 14%, and 39%, respectively.\(^{(4)}\)

Ottawa’s Strategic Road Safety Action Plan includes a variety of integrated countermeasures to combat pedestrian and cyclist fatalities and injuries. Communications, advocacy, and education have little impact on their own. When these are supported by enforcement vehicles, higher success ratios can be anticipated.\(^{(4)}\) (See Selective Traffic Enforcement Programs (STEP))

**Barriers / Considerations**

Awareness and safety campaigns used alone tend to have limited success in changing behaviour. There is a need for an integrated approach that also encompasses education, and a strong enforcement component. Awareness programs need to be linked to trends and timing of pedestrian collisions and to the most frequent areas of collisions.\(^{(1)}\)
Changing the attitudes and behaviour of drivers and pedestrians is a complex, long-term undertaking, requiring a variety of interventions to be implemented. Practical training interventions and programs designed as a sequence of modules over a longer period of time is more effective than administering single interventions.\(^\text{3}\) To produce the desired effects, education should be viewed as a long-term strategy rather than a quick win.\(^\text{3}\)

### Best Practice Guidance – Protecting VRUs from Vehicle Blind Spots

**Description**

Best Practice Guidance is a communications and awareness document prepared by the Brake Road Safety Charity group in the U.K. in response to the significant number of fatalities and crashes involving trucks and vulnerable road users. This document outlines steps to be taken by drivers and fleet managers to help mitigate these collisions. It also includes a one-page checklist for truck and bus drivers: Protecting Vulnerable Road Users from Blind Spots.\(^\text{15}\)

**Issues / Evidence**

**Jurisdictions Studied**
- Europe

The most common incident involving cyclists and heavy goods vehicles (HGVs) in London is where the vehicle is turning left and the cyclist is beside the vehicle in a blind spot. In the five years from 1999-2004 a U.K. company, with a fleet of over 300 HGVs, was involved in several of these types of incidents, causing two deaths and four serious injuries. From 2004 to 2012, following the initial awareness campaign and safety improvements, CEMEX achieved a significant reduction in collisions with vulnerable road users.\(^\text{15}\) (See countermeasures under Visibility and Conspicuity)

**Barriers / Considerations**

Fleet drivers should receive formal education and training – as a minimum – on recruitment, when a driver changes the vehicle they drive, if a driver is involved in a collision, or if he/she incurs points on their licence. Driver training should cover the importance of slower speeds when driving or manouevring and ensure that blind spot devices are never seen by drivers as a substitute for safe and careful driving.\(^\text{15}\)

### Bus Driver Training – Mitigating Blind Spots

**Description**

This training was developed and implemented in Montreal by the Société de Transport de Montréal (STM), in conjunction with a series of other measures in accordance with a Vision Zero approach.\(^\text{16}\)

**Issues / Evidence**

**Jurisdictions Studied**
- Montreal, Canada

The exercise is specific to the challenges associated with blind spots and offers techniques to counter them, such as: proposed reduced turning speed (15 km/h) and active checking of blind spots. So far, the reaction from STM drivers has been positive.
The results of dynamic tests, conducted to better understand collision scenarios, have led to the development of the training/awareness exercise.

By reducing the bus’ turning speed from 24 km/h to 13 km/h, the pedestrian remains visible to the driver 4 times longer; thus giving the driver time to react.\(^{(16)}\)

Effectiveness is still undetermined. Impact on the frequency and severity of collisions has not yet been demonstrated. Also, evidence of modified behaviour following the training is not yet available.

**Barriers / Considerations**

This training has been specifically designed for city buses; proposed techniques may be applicable to other heavy vehicles but have not been tested.

This type of countermeasure can be easily and immediately implemented by transit operators and is not dependent on the testing of new technologies or new bus designs.

Training must be given to all bus drivers (new and experienced); a three to four-year program is needed to reach all drivers.

The cost associated with the change in the training program remains a consideration. For Société de Transport de Montreal (STM), this was not an issue because they were in the process of updating their training program. However, this may not be the case for others looking to implement training of this nature. The approach to teaching the material may also have an economic impact. For example the Metropolitan Transportation Authority (MTA) New York City (NYC) driver training includes a bus driving simulator, which can be very expensive. (See the Video of the Metropolitan Transportation Authority’s (MTA) training for NYC bus drivers.)

More information about the MTA driver training program is also available in their *Bus Safety Symposium White Paper – 2016*.

### List of Communications and Awareness Products, Campaigns, and Topics

**Category:** Communications/Awareness

**Products and Activities**

**Drivers / Cyclists / Pedestrians**

- The City of Ottawa plans on the following, based on collaboration with Ottawa Police, RCMP, Public Health and Public Works\(^{(14)}\):
  - Distribution of information cards to offending drivers and cyclists by police
  - Community presentations at public health forums
  - Liaison with partners on cycling safety messages (e.g. proper use of bicycle helmets; evidence supporting the use of retro-reflective materials and flashing lights) (See countermeasures under *Visibility and Conspicuity*).

**Cyclists**

- Partner with law enforcement officers and crown attorney (or designated jurisdictional legal office) to foster a safer cycling environment; partner with provincial highway administration and other agencies on road safety messaging. (See *Sharing Interests / Collaboration Strategy*\(^{(17)}\).)

**Cyclists**

- Establish partnerships with existing programs to promote cycling to more diverse socio-economic groups. \(^{(17)}\)
Communications, Awareness and Education

Drivers / Cyclists / Pedestrians

- The use of ads, videos, posters, and leaflets are important; however, audio-visual channels (TV ads) and multi-media (internet-based on demand video) are increasingly used. (18)

- Educational resources for a range of road safety issues, divided into specific learning categories that cover the learning needs of pre-school aged children and up to [Grade 8]. (18)

Events / Campaigns / Programs

Pedestrians

- **Join the Campaign – Endorse the Vision**: A campaign to gather support for Canada’s National Action Strategy for Walking. (See Walking Strategy) (11)

Cyclists

- **Share the Road – Stay Safe – Stay Back**: A campaign emphasizing the importance of recognizing blind spots on large trucks, and the real dangers posed to cyclists if they are not easily seen by truck drivers. (See the Share the Road campaign video.) The campaign was launched in 2013 through a partnership with the Canadian Automobile Association (CAA) and partners in the municipal sector and the heavy trucking industry. (19)

Pedestrians

- **Canada’s First National Walking Summit** (September 2017) (11)

Cyclists / Drivers

- **Exchanging Places Program**: An award-winning program which addresses the most common cause of serious injury and death to cyclists – collisions involving a heavy goods vehicle (HGV). It gives cyclists the opportunity to sit in the driver’s seat of an HGV to see for themselves how difficult it can be to see a cyclist riding close to the truck. Experienced traffic police officers explain how this type of collision often happens and various ways to avoid them. (See the Exchanging Places video.) The number one cause of serious crashes in London, U.K. involving cyclists involve HGVs. (20)

Drivers / Cyclists / Pedestrians

- **A Decade of Action for Road Safety**: is a United Nations (UN) / World Health Organization (WHO) recommendation. Literature states that a decade would allow for long-term and coordinated activities needed to support national and local road safety. (14)

Pedestrians (School-aged children)

- **Outreach – the School-Home Journey**: This is a point of considerable exposure and risk for children. An important question to consider is when – what time of the day, which day of the week, and which month of the year – are children most at risk? (5) Child pedestrians walking alongside or among vehicular traffic are at risk for many reasons; they often lack the ability to gauge vehicle speeds, don’t know about safe crossing methods, or can’t distinguish between safe and unsafe crossing gaps and sites, putting them at risk as they cross the road. (5)

Drivers / Cyclists / Pedestrians

- **Driver Awareness Campaign – Approaching Emergency Response Vehicles***. This City of Ottawa campaign included a variety of products and activities to support uptake. (14) These included:
  - Visual aids to demonstrate and reinforce behaviour (videos, posters)
  - Media events to launch awareness campaign / highlight TV ads, videos, posters
  - Police enforcement blitz
  - Advocating for the province to ensure the topic is adequately addressed in driver training and testing

*Note: While this campaign may not directly apply to project scope, the strategies and principles applied can be adapted to awareness campaigns targeting truck drivers, pedestrians and cyclists.
Cyclists  
- **Cycling ‘roadshow’**: Could incorporate bike-minded rodeos, commuter workshops, bike-friendly program, engineering advice to support cycling safety awareness and promoting any related educational programs. \(^{(12)}\)

Cyclists  
- **BikeMaps.org**: This University of Victoria (UVic) / Traffic Injury Research Foundation (TIRF) program, with funding from Public Health Agency of Canada (PHAC), focuses on many different aspects of awareness, education, infrastructure, etc. (See BikeMaps.org)

**Other Awareness Topics**

Cyclists  
- Safety information regarding collision rates among various types of vehicles (e.g. cyclists and heavy vehicles) / understanding the risks. \(^{(1, 9)}\)

Drivers / Cyclists  
- Truckers perceive themselves as being held to very high, rigid safety standards. Alternatively, they view cyclists as exhibiting unpredictable behavior and not held to operational standards. \(^{(9)}\)

Drivers / Cyclists  
- The safety concerns expressed by cyclists about sharing the road with a large truck seems to be greater than shown by the data, suggesting that large trucks have an image problem that might not be entirely warranted. The fact that collision over-exposure rates are relatively low for large trucks, and for trucks in general, is an important piece of information for the non-motorized community to know, and can inform the dialogue in future discussions. \(^{(9)}\)

Drivers / Cyclists  
- Public awareness campaigns targeted at truck drivers and pedestrians – What can each road user do to help? \(^{(9)}\)

Cyclists / Pedestrians  
- Vulnerable road users and speed. (See countermeasures under Speed)

Drivers  
- Informing drivers about care, prudence, kindness, consideration, speed, pedestrian right-of-way and traffic rules. \(^{(3)}\)

Pedestrians / Cyclists  
- Pedestrian (and cyclist) safety at night / wearing reflective clothing. \(^{(1)}\) (See Increased Conspicuity and Visibility of Pedestrians / Cyclists)

**Part II: Non-Specific to VRUs and Heavy Vehicles**

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**List of Education and Training Products, Programs, and Topics**

| Category: Education/Training |

| Products and Activities |

Drivers / Cyclists / Pedestrians  
- **Safe Bicycling Guidelines Booklet**: There is no known program for educating cyclists to the dangers of riding near trucks; other safety advice. \(^{(8, 11)}\)
  
  Training can help to incorporate safe biking standards. (See countermeasures under Rules of the Road and Visibility and Conspicuity)

Pedestrians  
- **National Pedestrian Guidance** (for local administrations): Guidelines to help local administrators give consideration to the impact of road planning projects on pedestrians and cyclists as part of project appraisals and environmental impact assessments. \(^{(3)}\) (See Walking Strategy)
Communications, Awareness and Education

Drivers
- **Update the official Driver’s Handbooks**: Include a chapter clarifying those traffic scenarios when motorists are most likely to be involved in a collision with a pedestrian (or cyclist).\(^1\)

Cyclists
- **Bicycle network guide**: Identifies gaps in the bicycle networks and suggests areas for connections; proposes new road and road extensions to separate trucks from cyclists and pedestrians and improved road designs to better accommodate trucks.\(^9\) (See [Segregated Bicycle Lanes](#))

**Programs**

Pedestrians
- **Educational body**: Some documents suggest that the creation of such a body would have, as its mandate, the identification and delivery of public education programs directed at preventing pedestrian deaths, including programs for senior citizens, adult pedestrians and drivers.\(^1\)

Pedestrians
- **Mandatory road and pedestrian safety education**: Specific for junior kindergarten through grade eight curricula (children 5 – 14 years of age) (collaboration between Ministry of Education and Ministry of Transportation).\(^1\)

Pedestrians / Cyclists / Drivers
- **Develop high-quality education programs in schools / local community centres**: These should include adult re-training initiatives.\(^9\)

Pedestrians
- **School mobility plans**: These are aimed at producing a safe and supportive environment so children can walk to school.\(^3\)

Cyclists
- **Urban bicycling and truck blind spots workshop**.\(^22\)

Pedestrians
- **Provide police officers with pedestrian-specific training and resource materials**.

Pedestrians
- **Educational program for seniors and other adult pedestrians**: A program on understanding how to safely navigate arterial streets and high-risk corridors.\(^1\)

Drivers
- **Training program for heavy vehicle drivers**: This program would include topics such as watching for pedestrians at all times; yielding to pedestrians at crosswalks and when making turns; understanding the risks to pedestrians when travelling at higher speeds; parking and leaving parking locations; etc.\(^1\)

**Other Educational Topics**

Pedestrians / Cyclists / Drivers
- Safety information regarding collision rates among various types of vehicles (e.g. cyclists and heavy vehicles) / understanding the risks.\(^6,9\)

Drivers
- Reduce distracted driving.\(^10\)

Drivers
- Vulnerable road users and speed.\(^10\)

Drivers
- Watching out for cyclists.\(^9\)

Pedestrians / Cyclists
- Understanding the visual constraints of heavy vehicles.\(^9\)

Pedestrians
- Professionals (teachers of school-aged children) should receive continuous training about how pedestrians (and cyclists) can benefit from urban and road installation.\(^9\)

Pedestrians / Cyclists
- Pedestrian (and cyclist) safety at night / wearing reflective clothing.\(^1\) (See [Increased Conspicuity and Visibility of Pedestrians / Cyclists](#))
4.3 Intersection and Crosswalk Design

Many pedestrian crashes at intersections involve conflicts with turning vehicles because of blind spots.
Part I: Specific to VRUs and Heavy Vehicles

NIL

Part II: Non-Specific to VRUs and Heavy Vehicles

Bicycle Boxes

**Description**

Groups Affected

- Cyclists
- Drivers

A bicycle box is a right-angle extension of the bicycle lane positioned in front of motor vehicles at a signalized intersection. It allows cyclists to move ahead of motor vehicle traffic when there is a red light, giving them more space to safely and more comfortably clear the intersection.\(^{(23)}\) Located in front of the traffic, cyclists are more visible and are provided with a head start once the lights turn green.\(^{(24)}\)

There are also bicycle boxes that accommodate left-turning cyclists via a two-stage left turn (also known as the “Copenhagen left”). These boxes are located on the inside edges of the intersection, but out of the path of drivers on the cross-street. At the first stage, left-turning cyclists move through the intersection to a bicycle box at the opposite-right end of the intersection, and then turn to face the desired direction of travel. At the second stage, cyclists pass through the intersection as part of the through-traffic and do not have to cross the path of oncoming through-traffic.\(^{(23)}\)

London, UK, has created bicycle boxes (Advanced Stop Lines for Cyclists) to help mitigate collisions between cyclists and vehicles resulting from blind spot manoeuvres. The highly coloured area reminds both motorists and cyclists to watch for each other.\(^{(24)}\)

**Issues / Evidence**

In the U.K. in 2015, 107 cyclists were killed or seriously injured in collisions involving at least one heavy goods vehicle (HGV). Between 2009 and 2013, trucks were involved in almost a quarter of cyclist deaths despite comprising only 5% of traffic. Fifty-five per cent of cyclists were seriously injured when the driver turned left across their path.\(^{(24)}\) In 2014, there were 431 collisions where cyclists were killed or seriously injured on London roads; 50 involved a heavy goods vehicle.\(^{(22)}\)
Bicycle boxes can reduce the overall number of conflicts between cyclists and drivers at intersections and increase drivers’ yielding behaviour to cyclists.\(^{(23)}\) There is no further evidence cited in the documentation reviewed.

**Barriers / Considerations**

*The design of North American trucks compared to their European counterparts may preclude the effectiveness of this countermeasure. Even though a cyclist may be positioned in front of the truck and within the designated area, he/she may still fall within the truck’s blind spot, resulting in a high potential for collision. Other supporting countermeasures may be needed.* (See [External Mirrors to Reduce Blind Spots](#))

Bicycle boxes must be well designed; for example, the reservoir (the space between the cyclist’s stop line and the stop line further back for drivers) should take into account all the manoeuvres cyclists need to make when entering and leaving the bike box, including the numbers of cyclists likely to be using it. In the U.K, there are no national design guidelines for Advanced Stop Lines, although there is published design guidance ([U.K. source](#)).\(^{(24)}\) For Canada, see Annex III: Canadian References – Best Practices and Guidelines.

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**Improved Crosswalk Design**

**Description**

The details of crosswalk design constitute a highly technical and complex area. There are four main factors that influence collisions with pedestrians. These include: the visibility and conspicuity of the pedestrian; the length of the crossing; the predictability of pedestrian behaviour at the crossing; and the moderation of vehicle travel speed.\(^{(3)}\) In addition, traffic control, crossing widths, numbers of lanes and crossing times also drive good design.

There are numerous crosswalk design details and countermeasures that address these areas; many of which are listed in this section.

**Issues / Evidence**

*In Canada, the majority of pedestrian and cyclist fatalities and injuries occur at intersections, with significant incidents involving heavy vehicles moving straight ahead and turning right manoeuvres.*\(^{(25)}\) *Between 33 and 50% of collisions with pedestrians occur at intersections.*\(^{(3)}\)

A U.S. study found that installing raised medians and redesigning intersections and sidewalks reduced pedestrian risk by 28%.\(^{(3)}\)

Further evidence supporting specific crosswalk design features are handled under each respective countermeasure. (See countermeasures under [Intersection and Crosswalk Design](#), [Traffic Control Devices](#), and [Visibility and Conspicuity](#))
Barriers / Considerations

While crosswalk design features address the safety of vulnerable road users and their interaction with all motor vehicles, consideration of how any existing or future designs can increase the safety of pedestrians and cyclists when heavy vehicles enter the intersection warrants attention. (25)

Identified countermeasures are only as good as the overall vision of the pedestrian network and mobility. “... current knowledge points to the importance of an overarching vision, consisting of clear policies and targets, with tailored communication, supportive research and technical advice to effectively promote walking.” (3)

The general knowledge required to improve pedestrian crossings is well documented; however, there are specific measures or situations that require more study or ‘fine tuning’. Implementing measures to improve pedestrian safety often has an impact on the road’s capacity and on levels of congestion in saturated environments. This has an economic impact due to the lengthened time required to reach a destination (people and merchandise). (See Annex III: Canadian References – Best Practices and Guidelines)

To encourage walking, people must feel safe and comfortable. To promote this, jurisdictions must ensure and provide safe infrastructure. (See Walking Strategy)

Other identified considerations include costs, resources, political will and jurisdictional differences.

Lighting at Intersections

Category: Policy/Legislation/Regulation; Infrastructure

Description

Groups Affected
- Pedestrians
- Drivers

Jurisdictions Studied
- Toronto, Canada

Street lighting is essential in areas where there are many pedestrians walking at night including lighting at intersections and crossing lights. Lighting not only makes pedestrians more visible to drivers, but creates a safer environment for walking at night. (10)

Issues / Evidence

In Canada, pedestrians accounted for 14% of all road users killed and 7% of victims injured between 2008 and 2011. A Transport Canada study of fatally injured vulnerable road users found that 59% of pedestrians killed in crashes in Canada between 2004 and 2006 were stuck in dim lighting conditions (dawn or dusk) or darkness. An Ontario study on pedestrian fatalities indicated that twilight or darkness conditions existed for 57% of fatal pedestrian crashes in the province in 2010. (1, 4)

Documents reviewed identified several studies that examined the effect of lighting and vulnerable road user casualties and injuries. A report analyzing the effectiveness of street lighting, indicated that compared to dark conditions without street lighting, daylight lowers the odds of a fatal injury by 75% at mid-block locations and 83% at intersections, while street lighting reduces these by 42 and 54% respectively at mid-block and intersection locations. (10) In addition, Pedestrian Casualties in Ontario: a 15-year Review found that 25% of pedestrian fatalities occurred between 3 - 7 p.m. Potential reasons cited included high traffic levels, darkness and alcohol use. Further supporting this data is the City of Toronto’s Pedestrian Collision Study which found that collisions occur more frequently between 3 - 8 p.m. and most pedestrian fatalities occur in January.
In addition, of the 95 cases reviewed, January had 23 pedestrian fatalities.\textsuperscript{[1]} (See Marked Mid-Block Crossings and Increased Conspicuity and Visibility of Pedestrians / Cyclists)

**Barriers / Considerations**

The same countermeasures could apply to heavy vehicles interacting with vulnerable road users, although most heavy vehicle traffic in urban areas, where the majority of collisions with vulnerable road users occur, take place during daylight hours. Some jurisdictions (e.g. the U.K.) are studying the experiences of cities (Dublin and Paris) where heavy vehicles over a certain size are restricted from certain parts of the city, or at certain times of the day.\textsuperscript{[18]} New York City is conducting a pilot study of an after-hours delivery program.\textsuperscript{[9]}

The need for single- or two-sided lighting (lighting on one or both sides of the street*) are subject to jurisdictional standards, including permitted crossings at intersections. (* Definition taken from City of Markham document, page N-11)

The location of an intersection and the type of collision may preclude any benefits that result from infrastructure changes. For example, one U.S. study indicated that while a lighted intersection and pedestrian crossing lights were possible countermeasures, changes may be difficult to justify at the particular intersection where the collision took place and where a pedestrian was hit (at the front of a truck that was turning left).\textsuperscript{[26]}

### Marked Mid-Block Crossings

**Category:** Policy/Legislation/Regulation; Infrastructure

**Description**

**Groups Affected**
- Pedestrians

Midblock crossings are marked crosswalks located between intersections that may be signalized or un-signalized. These offer safe and convenient locations for pedestrians to cross in areas with limited intersection crossings. The Ontario Coroner proposed that the Ministry of Transportation for Ontario amend the Highway Traffic Act (HTA) to allow municipalities to erect non-signalized pedestrian crossings in mid-block areas.\textsuperscript{[1]}
Issues / Evidence

Jurisdictions Studied
- Ontario, Canada

Review of pedestrian fatalities in Ontario found that more fatalities occurred at mid-block locations (31%) than elsewhere. The City of Toronto Pedestrian Collision Study reported that this accounted for 22% of all collisions.[1]

Driver eye fixations and yielding behaviour at marked mid-block crosswalks were examined as drivers approached the intersection. Subjects in the control group encountered traditional road markings with stop bars 3 metres before the intersection, while subjects in the experimental group experienced advance yield markings and prompt signs. Subjects in the experimental group looked for pedestrians 69% of the time, while those in the control group looked 47% of the time and began to look sooner. 61% of the advanced yield group yielded or stopped when a pedestrian emerged behind the stopped vehicle while none of the control group drivers yielded or stopped.[10]

Studies did not provide any data on the overall effectiveness of non-signalized pedestrian crossings. Since there are concerns that drivers do not see/are not expecting pedestrians, non-signalized installations may not fully address the visibility issues.

Barriers / Considerations

Based on study results of the advance yield group, it seems likely that this countermeasure would benefit drivers of heavy vehicles, as well.

A recently amended Ontario Highway Traffic Act (HTA) Bill permitted a broader range of pedestrian crossover configurations (mid-block crossings), including a non-signalized version. The Ontario Traffic Manual [OTM Book 15] includes guidelines for these including a selection tool for the type of crossing configuration most appropriate for a given location.

Pedestrian Scramble Operations (PSOs)

Category: Infrastructure

Description

Also referred to as “all exclusive pedestrian phasing”, Pedestrian Scramble Operations, or PSOs are designed to stop traffic in all four directions and provide exclusive walk phases to pedestrians, allowing them to cross diagonally or laterally at any leg of the intersection. During the pedestrian walk phase, drivers cannot turn right or left, eliminating common points of conflict with pedestrians.[10]
Issues / Evidence

In Canada, 60.9% of all bicyclist fatalities and the majority of bicyclist injuries (59.6%) occurred at intersections with public roads. Also, 44.6% of all pedestrian fatalities and the majority of pedestrian injuries (53%) also occurred at intersections with public roads. Further, many pedestrian collisions at intersections involve a left or right-hand turning vehicle. PSOs is one recommended solution to this conflict.

The U.S. Department of Transport (DoT) has reported a 34% decrease in pedestrian collisions where intersections have been converted into PSOs.

Alberta conducted a pilot test (in Calgary) on the effects of implementing PSOs at two intersections in the downtown area and found they significantly reduced the number of pedestrian / vehicle conflicts. Of the total pedestrian violations, 13% were “safe side” crossings (concurrent with vehicle movement), and about 40% of the violations were at the beginning of the “DON’T WALK” phase.

A Diagonal Crossing Scheme, similar to PSOs, was implemented on Oxford Street in London, England. Preliminary findings showed positive results. More recently, Toronto completed a pilot project on this same scheme, also showing positive results in certain situations.

Barriers / Considerations

Considering the high probability of collisions between heavy vehicles and vulnerable road users at intersections, this countermeasure is likely to offer positive outcomes in such circumstances. However, as indicated below, its success depends on all parties following the rules associated with PSOs.

A survey showed that public attitudes to the new signal operation were positive. In addition, a survey found that the majority of pedestrians using these intersections took full advantage of the ability to cross diagonally, a maneuver not available on conventional signalized intersections.

Pedestrians must still observe the “DON’T WALK” phase and must have knowledge and understanding of PSOs, including their purpose and how they work. Benefits may need to be further communicated to the pedestrian community. This practice could interfere with the flow of traffic.

Reduce Crossing Distances and Location of Crosswalks

Category: Infrastructure

Description

To increase pedestrian safety, the widths of crossings can either be minimised or divided into sections. In this way, pedestrians have less oncoming traffic to consider making it easier to select an appropriate gap in traffic.

This can be accomplished using curb extensions, which significantly improve pedestrian crossings by reducing the crossing distance. They also visually and physically narrow the roadway and reduce the time pedestrians spend on the roadway.

In addition, crossing islands consisting of a raised island in the centre of the road, may be used to shorten crossing sections on wider roads and provide a refuge for pedestrians. Central crossing islands allow pedestrians to deal with one direction of traffic.
traffic at a time, enabling them to stop part-way across the street to wait for an adequate gap in traffic before completing their crossing.

**Issues / Evidence**

It has been demonstrated that crossing islands dramatically decrease pedestrian road crossing collisions due to fewer conflicts; they also help reduce vehicle speeds as they approach the island and offer improved crossing conspicuity and shorter exposure time for pedestrians.\(^3\)

Another U.S. study found that 43% of people with safe places to walk within 10 minutes of home met the recommended healthy activity levels, while just 27% of those without safe places to walk achieved healthy activity levels.\(^3\)

**Barriers / Considerations**

*Curb extensions may make it more difficult for trucks to manoeuvre at intersections, impeding the ability of trucks to deliver in urban areas. This could have a negative impact on businesses that rely on trucks for the delivery of goods and services. Trucks are designed according to standard intersection schemes as outlined by the Transportation Association of Canada (TAC). Decreasing the turning radius is not the solution; mid-block crossings or islands are a good alternatives.* (See Marked Mid-Block Crossings)

An international study recommends that streets with a maximum speed of 50 km/h (or higher) and used by pedestrians should offer safe crossing opportunities for pedestrians every 100 metres at a minimum.\(^3\) In Canada, the implementation of this type of intervention would be applicable to appropriate roadways, based on their functional classification.

In constrained environments with high vehicle volumes, the installation of raised medians, pedestrian refuges, redesigning intersections or increasing crossing times can have significant impacts on road capacity. Limiting the number of lanes may also require eliminating on-road parking space.\(^3\)

A reduction in the number of lanes will provide more space for pedestrians, cyclists and parked cars, reducing crossing times and improving the social interaction and neighbourhood feel along the street.\(^3\)

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**Traffic Control / Crossing Times at Intersections**

*Category:* Policy/Legislation/Regulation; Infrastructure

**Description**

The purpose of an intelligent city-wide traffic control system should be to limit dangerous interactions between pedestrians and road traffic. Such an approach can be supported by reducing both traffic volume (by re-routing traffic) and traffic speed, especially in areas with high pedestrian volumes such as schools and intersections, and by allowing sufficient crossing times for pedestrians at intersections.\(^3\)

Different measures are identified for traffic lights offering partially or fully protected phases such as forbidding conflicting vehicle movements when pedestrians are crossing.\(^3\) (Crossing times may either be programmed into the traffic signals or be initiated by the pedestrians using push-buttons.)\(^3\)
Push buttons at pedestrian-friendly traffic lights can be designed to give careful consideration to the time allocated for pedestrians to cross an intersection (an average waiting time of no longer than 40 seconds). These are most often designed assuming a walking speed of 1.2 metres per second, which can be challenging for some pedestrians. A walking speed of 1 metre per second or less is preferred, as it allows pedestrians walking more slowly to cross at their own pace (e.g. young children, older adults or people with mobility impairments).\(^3\) (See Reduce Crossing Distances and Location of Crosswalks)

**Issues / Evidence**

**Jurisdictions Studied**
- OECD countries (35+)
- ITF countries (50+)

*Between 33 and 50% of collisions with pedestrians occur at intersections.*\(^3\)

*Sixty-three percent (63%) of pedestrians killed at intersections were 65 or older.*\(^1\)

There is no evidence of the successful implementation of this countermeasure cited in the documentation reviewed.

**Barriers / Considerations**

*Options such as re-routing traffic, reducing speed and any countermeasure designed to limit dangerous interactions between pedestrians and road traffic would also apply to the movement of heavy vehicles. In addition, the issues heavy vehicle drivers experience with respect to blind spots, especially at intersections, demonstrates the relevance of this countermeasure.*

Redesigning intersections and increasing crossing times can have important impacts on road capacity. Pedestrian needs and limitations vary – children, older adults, disabled persons. Each have behavioural and psychological drivers that affect road crossing decision-making and judgement.\(^1\) See Annex III: Canadian References – Best Practices and Guidelines, Pedestrian Crossing Control Guide published by the Transportation Association of Canada (TAC).

### Warning Signs / Pavement Markings at Intersections

**Description**

Warning signs provide instructions and/or warnings of potential danger ahead. Placed at intersections, they generally appear as a pictograph of the crosswalk and/or pavement markings with directions for both drivers and pedestrians.

“TURNING TRAFFIC MUST YIELD TO PEDESTRIANS”, “LOOK FOR TURNING VEHICLES”, “WATCH TURNING VEHICLES”, or “YIELD HERE TO PEDESTRIANS” are a few examples.\(^10\)

Pavement markings can indicate the locations of crosswalks and guide pedestrians along a safe path for crossing the road to help eliminate vehicle-pedestrian conflicts.\(^10\) For example, zebra crosswalks tend to reduce motor vehicle speeds and, as a consequence, the severity of pedestrian injuries.\(^2\)

**Note:** New technology at intersections has been designed that activate flashing LED lights to alert approaching motorists and give advanced warning when a cyclist may be approaching the intersection.
Issues / Evidence

In order to study the effects of special signage on pedestrian-vehicle conflicts at signalised intersections, a “LOOK FOR TURNING VEHICLES” accompanying a pictograph of the crosswalk sign and pavement marking which reads “WATCH TURNING VEHICLES”, were installed at threes signalized intersections. Both pedestrian behaviour and pedestrian-vehicle conflicts were recorded before, immediately after and one year after these prompts were introduced. The results showed a dramatic decrease from the period before to the after period. The one year follow-up showed no conflicts, as compared to the earlier 2.7% baseline condition.\(^{(10)}\)

A before-and-after study regarding the impact of signage reminding drivers to yield to pedestrians at marked crosswalks, showed that conflicts between pedestrians and turning drivers were reduced 20 to 65% for left turns and 15 to 30% for right turns. In spite of these improvements, occurrence of conflicts remained relatively high after sign installation – 35% for left turns and 38% for right turns.\(^{(10)}\)

The multiple-threat collision occurs (in a multiple lane scenario) when one vehicle stops to allow a pedestrian to cross while another vehicle travelling in the same direction, fails to stop and strikes the pedestrian. This condition can also occur when a vehicle stops too close to the crosswalk thereby obscuring the visibility of the crossing pedestrian. The effects of “YIELD HERE TO PEDESTRIANS” signage and advance yield pavement markings were studied to determine their influence on vehicle-pedestrian conflicts at multi-lane crosswalks at T-intersections. The findings showed a reduction in the number of conflicts.\(^{(10)}\)

Barriers / Considerations

The Ministry of Transportation Ontario Trucks Handbook and Bus Handbook each includes a brief chapter on pavement markings. Any such warning signs (whether actual signage or pavement markings) would be applicable to heavy vehicles, as well as any resulting safety gains.

The relation of driver age and different perceptions of right-of-way, particularly in left-hand turn situations, may impact compliance.\(^{(10)}\) Certain pavement markings are best suited for multi-lane roads because, with the extra distance, visibility is improved for both pedestrians and drivers. Traffic control devices (TCDs) are not all equally effective because different types of warnings or pavement markings will lead to different rates of compliance by drivers.\(^{(10)}\)

Note: This countermeasure, although technically a traffic control device, was included in this section due to its relevance to Intersection and Crosswalk Design. (See countermeasures under Traffic Control Devices)
COUNTERMEASURES

4.4 Roadway and Cycling Infrastructure

The manner in which the public road network is designed, built and managed can have a significant effect on the utility and safety.
Part I: Specific to VRUs and Heavy Vehicles

Separate Truck and Bike Routes

**Description**

“Truck route” means the set or network of roads or streets that a local government has formally designated for certain trucks to use when traveling through or within that jurisdiction. (Ontario Trucking Association, December 2011)

A bike route is a lane or path specifically designed and/or designated for bicycle travel. Some bike routes are separated from motor vehicle traffic by physical constraints – barriers or bollards as used for bicycle lanes – while others are partially separated by painted markings. (See Segregated Bicycle Lanes)

Some transportation plans (San Francisco, Vancouver) advocate for or manage the routing of trucks and bicycles to separate streets, where possible, and developing “context-sensitive design” when addressing mode conflicts. This reflects Vision Zero and Complete Streets strategies. Not all findings support this approach. (See Restrict Movement of Heavy Vehicles)

**Issues / Evidence**

Safety issues related to mixing freight and bicycle traffic have not been addressed in any analytical framework. The general tendency is to separate facilities for the greatest perceived comfort and safety of all users.

A bikeway class system in Long Beach, CA, separates needed and existing bicycle routes into three classes: Class I facilities – completely separated from vehicular traffic (most of proposed and existing facilities are in this class); Class II – bike lanes; Class III – bicycle routes. While the major strategy appears to be separating out freight movement from other modes, there is not much information regarding freight and bicycle interactions, although there are reports of improved conditions.

San Francisco has limited delivery zones in the downtown area. According to the San Francisco Municipal Transit Agency, problems exist between delivery trucks and bicycles when the trucks park in the bicycle lanes because they are not allowed to park curbside during certain hours.

New York City designates local and through truck routes and requires commercial trucks to use these truck routes and only exit at the intersection closest to their destination. The city is also conducting a pilot study of an after-hours delivery program. The incentive to participate in the program is the reduced time drivers spend stuck in traffic thereby increasing the number of deliveries per unit of time. Participation in this program is voluntary.

In the U.K., many examples of best practices can be identified where the integration of urban and mobility planning has been applied successfully.

**Barriers / Considerations**

Safety concerns expressed by cyclists regarding sharing the road with large trucks seem to be greater than the data shows, suggesting that large trucks have an image problem that might not be entirely warranted. The fact that incident rates are relatively low for
large trucks, and for trucks in general, is an important piece of information for the non-motorized community to know, and can inform future discussions.\(^9\) (See countermeasures under Communications, Awareness and Education)

The strict separation of road user categories has resulted in increased numbers of high-risk crossing points where different road user groups may conflict. While the Buchanan report addresses these problems, its perspective continues to support the concept of modal separation where vehicle circulation is high.\(^3\)

Other considerations include: constrained street widths, limited budgets, topography, and road patterns. Separation of bikes / trucks and the design of road modifications to improve traffic flow would depend on lane width, vehicle speed, availability of alternative routes, proximity to destinations, and importance of route to each user group.\(^9\)

### Part II: Non-Specific to VRUs and Heavy Vehicles

#### Segregated Bicycle Lanes

**Category:** Policy/Legislation/Regulation; Infrastructure

**Description**

**Groups Affected**

- Cyclists

A segregated bicycle lane is physically separated from motorized traffic and distinct from the sidewalk. Although there are different designs, all share common elements – they provide space intended to be used exclusively or primarily for bicycles (although they may be used by skateboarders, inline skaters and, possibly, other non-motorized devices), and are separated from motor vehicle travel lanes, parking lanes, and sidewalks.

By separating cyclists from motorized traffic, they can offer a higher level of security than non-segregated bicycle lanes and subsequently, tend to be more attractive to a wider spectrum of the public. (Adapted from NACTO definition)

![Bicycle Lane Configurations](image)
**Issues / Evidence**

Jurisdictions Studied
- Canada (multiple cities)
- U.S. (9 cities)
- Denmark

Literature review reveals that the creation of well-marked bicycle-specific facilities significantly reduce the risks of bicycle crashes and injury.\(^9\)

One study found that of fourteen types of bicycle routes in Toronto and Vancouver, cycle tracks had the lowest risk of bicyclist injury.\(^2\) According to a Montreal study, segregated cycle tracks along roadways reduced the potential contact with heavy vehicles.\(^28\)

A U.S. study analyzing 23 papers on transportation infrastructure and bicyclist safety found that clearly-marked, bicycle-specific facilities are safer for cyclists when compared to on-road cycling with traffic. Statistics show that these facilities reduce injury or crash rates by about half when compared to unmodified roadways.\(^9\)

Studies in Denmark indicate that providing segregated bicycle tracks or lanes alongside urban roads reduced deaths among cyclists by 35%.\(^2\)

Protected bicycle lanes adjacent to the curb and separated from traffic lanes by a buffer strip and parking lane yield the lowest number of conflicts between commercial vehicles and bicycles and yield the lowest number of conflicts when trucks need to park for delivery or pick-up of goods. (See Illustration above.) In New York City, when commercial vehicles are allowed to double-park, it is against regulations to block a bicycle lane when doing so. If a bike lane is blocked, a fine may be issued.\(^9\)

Alternatively, the design with the greatest conflict was the bicycle lane on the traffic side of the parking lane with a buffer strip between the bicycle lane and the traffic lane.\(^9\)

**Barriers / Considerations**

*A study evaluated truck parking behavior in and adjacent to three curb use street configurations (see illustration above) along high volume truck and bicycle routes in New York City; it documented thirty-five conflicts. Twenty-six of these conflicts were caused by trucks parking in the bicycle lanes and two were a result of “trucks crossing the bike lane to park.” The remainder of the conflicts occurred when the trucks were located outside of the bicycle lane, which included bicycles that moved to avoid close proximity to the trucks or near “dooring” events.\(^9\)*

Barriers to implementation include constrained street widths, limited budgets, and perceived impact on businesses due to reduced parking space. However, studies indicate that cycle tracks can potentially reinvigorate a business area.\(^9\)

In 71% of deaths (91 of 129) in Ontario, some modifiable action on the part of the cyclist was identified as contributing to the fatal collision.\(^2\)

Crossings between cycle tracks and streets do not always seem well understood by drivers, particularly when environmental features do not clearly reflect the right-of-way, thus creating confusion among drivers and cyclists alike.\(^29\)

One implementation delivery model is to give priority to intersections being rebuilt or to new intersections.
COUNTERMEASURES

4.5 Rules of the Road

Ignoring or breaking of the “rules of the road” is the major cause of collisions.
Part I: Specific to VRUs and Heavy Vehicles

Restrict Movement of Heavy Vehicles

Category: Policy/Legislation/Regulation; Vehicle Technology/Equipment; Enforcement

Description

Road safety measures that support Vision Zero suggest the restriction of heavy vehicle movement in urban areas, based on their size, use, and level of blind spots, will promote the safety of vulnerable road users. A recommendation is to place restrictions on certain truck configurations / types or travel times in specific urban zones and encourage the use of smaller trucks for local deliveries in residential areas. (30)

Issues / Evidence

Jurisdictions Studied
- Montreal, Canada
- London, U.K.
- Seattle, New Orleans, U.S.

Actions taken by cities such as London, Seattle and New Orleans are inspiring La Commission sur le transport in Montreal to develop an index measuring the visibility performance of heavy vehicles in North America. This exercise could result in gradually limiting the flow of vehicles with high blind spots in designated areas. (See Separate Truck and Bike Routes)

The documentation reviewed did not provide evidence supporting the successful implementation of this countermeasure.

Barriers / Considerations

Limiting the movement of trucks within urban areas could impact the delivery of merchandise to businesses.

Part II: Non-Specific to VRUs and Heavy Vehicles

Bicycle Helmets and Use

Category: Policy/Legislation/Regulation; Enforcement

Description

A bicycle helmet is designed to manage the energy of a single, hard blow but does not prevent the skull being crushed by a huge weight. Additionally, the shape of a bike helmet may help to convert a rollover to an “almost rollover” by allowing the wheel [of the vehicle] to be deflected. (https://www.helmets.org/truck.htm)

The wearing of bicycle helmets and attitudes towards their use vary around the world. In Canada, helmet legislation varies between provinces / territories. Compulsory use of helmets has often been proposed and is the subject of much dispute, based largely on considerations of overall public health. Bicycle Helmet Laws by Country
**Issues / Evidence**

In Ontario between 2006 and 2010, only 34 of 129 cyclists (26%) sustaining a fatal injury were wearing a helmet. In 71 of the 129 cases (55%), the cyclist sustained a head injury which caused or contributed to their death. In 43 of those 71 (60%) cases, a head injury alone (with no other significant injuries) caused the death. Those whose cause of death included a head injury were three times less likely to be wearing a helmet as those who died from other types of injuries. \(^{(2)}\)

In Ontario, helmet use is optional for cyclists aged 18 and older. Helmets are mandated under the Highway Traffic Act below the age of 18; parents are responsible for ensuring helmets are used by their children below the age of 16. \(^{(2)}\)

In the state of Victoria, Australia, a new law requiring helmets in 1990 increased the use of helmets from 31% to 75% within one year and was associated with a 51% reduction in head injuries to cyclists. \(^{(1)}\)

**Barriers / Considerations**

The outcome of a collision between a heavy vehicle and a cyclist who is wearing a bicycle helmet will depend on the location of the impact, the manoeuvre the heavy vehicle is undertaking, and the speed at which the vehicle is travelling. If the truck and the cyclist are both travelling straight (in the same direction) and the cyclist hits the side of the truck, the outcome would also depend on whether the cyclist falls beneath the truck, or is deflected into parked cars, onto a sidewalk or, conversely, into traffic.

A bike helmet is designed to manage the energy of a single, hard blow but not to prevent crushing of the skull by a huge weight. Also, the shape of a bike helmet ... may help to convert a rollover to an “almost rollover” event by allowing the wheel to be deflected. ([https://www.helmets.org/truck.htm](https://www.helmets.org/truck.htm))

Despite existing legislation, only 1 of 16 cyclists (6.25%) under the age of 18 who died were wearing a helmet, suggesting the need for cycling safety education in our schools. Cyclists do not undergo any formal evaluation of their knowledge of necessary rules and safe practices before they begin to use the road. \(^{(2)}\)

The Ontario Coroner’s review did not look at all cycling injuries (both fatal and non-fatal); consequently, it cannot be stated with certainty the degree to which wearing a helmet decreases the likelihood of a head injury. However, based on the review of cycling fatalities, those cyclists whose cause of death included a head injury were more than three times as likely to not be wearing a helmet as those who died of other types of injuries. \(^{(2)}\)

Some stakeholders felt the mandatory helmet legislation sent the message that the responsibility for safety rests with the cyclist alone, rather than a shared responsibility of all road users. \(^{(2)}\)

In Australia, the introduction of mandatory helmet legislation was associated with a drop in cycling activity. Some research exists suggesting that the health benefits of helmets may be outweighed by the detrimental effects on overall health of the population through the decrease in cycling activity. \(^{(2)}\)
Enforce Traffic Laws for all Road Users

**Description**

Penalties are a key enforcement factor. Enforcing traffic laws involves imposing sanctions that can range from a warning to a fine of varying amounts, jail, suspension or loss of driver’s license, and/or an impounded vehicle.

**Issues / Evidence**

Studies indicate that issuing warnings for minor offences rather than monetary penalties may have a larger impact. Conversely, some experts suggest that if the level of risk associated with **unsafe behaviour** is not correlated with penalties, these pedestrian behaviours will continue. More study is required to determine if this is indeed the case. (10)

In San Francisco, the most common cause of collisions is cyclists disobeying traffic laws. (9) Since 2008, there has been a decrease in illegal sidewalk bicycle riding, with 94% of cyclists now riding legally. This could be due in part, to the city’s willingness to cite cyclists for riding behaviour. They have been issuing “fix-it” tickets requiring traffic school for infractions. The city’s plan has a stated goal to increase citations for the violations related to behaviours that pose the greatest safety threat. (9)

**Barriers / Considerations**

*Safety concerns expressed by cyclists regarding sharing the road with large trucks seem to be greater than the data shows, suggesting that large trucks have an image problem that might not be entirely warranted. The fact that incident rates are relatively low for large trucks, and for trucks in general, is an important piece of information for the non-motorized community to know, and can inform future discussions.* (9) (See countermeasures under **Communications, Awareness and Education**)

The concept of citing cyclists for disrespecting the rules of the road warrants further research. Determination of how this practice affects the overall dialogue between the user groups (truck drivers, pedestrians and cyclists) may be useful (San Francisco). (9) Issuing citations for cycling behaviors that pose the greatest safety risk may soften the rough edges of the discussion (between cyclists and trucks). (9)

Combining awareness, education and enforcement with clear legislation would increase the confidence of police officers in their ability to enforce the laws. (10)

Success of enforcement initiatives depend on supporting programs including awareness, education and officer training programs that notify the community (of the laws). (11)

Pedestrian needs and limitations vary – children, older adults, and disabled persons each have behavioural and psychological drivers that affect road crossing, decision-making and judgment. (10)
Model Vulnerable Road User Law

**Description**

Vulnerable road user (VRU) laws provide important legal protection to cyclists and other persons who are not protected by their vehicles. VRU laws operate on the principal of general deterrence and reflect a Vision Zero approach to road safety. By providing an increased penalty for identified road behaviors that lead to the serious injury or death of certain road users, people will be deterred from exercising those behaviors. The model law includes very strong punishments for people who seriously injure or kill cyclists and other VRUs. Nine U.S. states have laws defining a vulnerable road user and provide particular penalties when such laws are broken – Connecticut, Delaware, Florida, Hawaii, Maine, Oregon, Utah, Vermont, and Washington.\(^{(31)}\)

**Issues / Evidence**

Some American jurisdictions have indicated that there is lenient treatment of punishing careless drivers who receive merely a fine and are not even required to make a court appearance after a horrific collision.\(^{(31)}\)

Legislation in Oregon changed in 2008 to include a non-criminal alternative of a $12,500 fine (up from $750.00) and a one-year license suspension (no license suspension previously included in Careless Driving conviction). To induce careless drivers to improve their driving skill and pay the community back for their actions, a requirement to attend a traffic safety course and complete 100-200 hours of community service were included as an alternative to the fine and suspension. In situations where the program was successfully completed, the suspension and fine would be lifted.\(^{(31)}\)

A 2013 report by the Center for Investigative Reporting showed that in 238 pedestrian fatalities in the Bay Area, California, 60% of motorists found to be at fault or suspected of a crime, faced no criminal charges.\(^{(31)}\)

**Barriers / Considerations**

*Heavy vehicle drivers perceive themselves as being held to very high and rigid safety standards. While their compliance is also based on ensuring the safety of vulnerable road users, they (along with other motorists) view bicyclists exhibiting unpredictable behaviour and not being held to operations / safety standards as part of the issue.*\(^{(9)}\)

(See countermeasures under Communications, Awareness and Education)

Perceptions exist that vulnerable road users can expect bad things to happen because the roadways are so dangerous. This attitude can adversely affect motorists taking proper safety precautions.\(^{(31)}\)

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No Right Turn-on-Red (RTOR)

**Description**

One of the conditions leading to motor vehicles hitting pedestrians is created when vehicles turn right at an intersection, especially when their traffic light is red and
pedestrians have the right of way. The right turn on a red manoeuvre is a major source of concern for pedestrian safety. Drivers are supposed to stop and yield to crossing pedestrians in this situation but often fail to do so.\textsuperscript{(10)} (See Protected Left-Turn Phasing, Warning Signs / Pavement Markings at Intersections and Increased Conspicuity and Visibility of Pedestrians / Cyclists)

**Issues / Evidence**

A Canadian study found a significant increase in pedestrian and cyclist trauma after the introduction of the RTOR at signalized intersections. These increases of pedestrian collisions in four jurisdictions ranged from 43 to 107\%. Analysis of police reports suggested that drivers stop for a red light, look left for a gap in the traffic and fail to see pedestrians and cyclists coming from their right as they turn.\textsuperscript{(10)}

Prohibiting right turns on red effectively removes a potential for conflict between drivers and pedestrians, as long as drivers comply with the rule.\textsuperscript{(10)} Turning right on a red light is already prohibited on the island of Montreal.\textsuperscript{(30)}

**Barriers / Considerations**

*A prohibition of right-on-red may mitigate the risks to pedestrians in intersections when heavy vehicles are turning and fail to see vulnerable road users in their blind spots.*

Collisions continue to exist when trucks turn on a green light and pedestrians do not observe the “DO NOT WALK” indicator or when the pedestrian is in the truck’s blind spot zone. (See Warning Signs / Pavement Markings at Intersections and Increased Conspicuity and Visibility of Pedestrians / Cyclists)

### Selective Traffic Enforcement Programs (STEP)

**Description**

Selective Traffic Enforcement Programs (STEP) combine intensive enforcement of a specific traffic safety law with extensive communication, education, and outreach to inform the public about a targeted enforcement activity. Examples of targeted enforcement campaigns include seatbelts, distracted or impaired driving, speeding, or other identified safety risks.\textsuperscript{(10)}

Effective enforcement measures require skillful planning and resource allocation to maximize the effect of a particular strategy. The objective of using a targeted approach is to address certain behavioural issues related to road safety and to increase compliance for all target groups through various channels.\textsuperscript{(10)} As communications and education programs have been shown to have limited effectiveness on their own, such programs have the greatest potential for success when combined with targeted enforcement programs.\textsuperscript{(10)}

**Issues / Evidence**

Failing to yield the right of way to pedestrians is the driver error most associated with pedestrian safety.\textsuperscript{(10)}
Targeted enforcement has been used to deter failure to yield right-of-way to pedestrians and cyclists. In coordination with the Department of Transportation’s education and marketing efforts, the New York Police Department (NYPD) targets failure-to-yield to pedestrians at intersections identified through previous crash data as being prone to collisions.\(^{10}\)

The documentation reviewed did not provide any further evidence supporting the successful implementation of this countermeasure.

**Barriers / Considerations**

*Since this type of enforcement program targets the behaviour of drivers and pedestrians (and, by extension, that of cyclists, as well), it may also address the concerns of both heavy vehicle drivers and vulnerable road users when it comes to safety and the need for all groups to respect the rules of the road.*

Targeted enforcement strategies require data on collision factors and frequencies to enable agencies to prioritize behaviours. Knowledge of the behaviour and traffic patterns of a community also helps police to develop countermeasures to address specific behaviours.\(^{10}\) (See *Monitoring Strategy – Forensic Review of Collision Data*)

Work is required to identify dangerous intersections. Further resources will need to be devoted to ensuring enforcement.
Side guards are designed to prevent exposed vulnerable road users from being caught under the sides of trucks and getting crushed by the back wheels.
Part I: Specific to VRUs and Heavy Vehicles

Truck Side Guards

**Description**

Groups Affected
- Vehicles
- Drivers

Truck side guards (also called “lateral protection” or “side underrun protection devices”) are designed to aid in the prevention of vulnerable road users, or VRUs (pedestrians and cyclists, and in some instances motorcyclists) against the risk of being hooked under the sides of the vehicle and being caught under the wheels.\(^\text{25}\)

Currently, designs include rail or smooth (flush mount) side guards. The types of devices used vary among jurisdictions. Typically, side guards are designed, built and installed by vehicle manufacturers or third party parts suppliers.

Issues / Evidence

Jurisdictions Studied
- United Kingdom
- Australia
- Japan
- North America
- Boston, New York, U.S.

The most recent collision data from the 2015 Canadian National Collision Data Base (NCDB) research revealed that three quarters of fatal collisions between heavy trucks, and pedestrians and cyclists happen in front of the vehicle, while only 22% of the fatal collisions happened on the side. A U.S. Department of Transportation study found approximately half of all bicyclists killed in crashes involving large trucks first hit the side of the truck, and 37% specifically hit the right side of the truck before they were killed. (Variances may be due to a number of factors related to population differences, classification of collisions, etc.). Other studies have also examined collisions between VRUs and heavy vehicles.\(^\text{2, 25, 32}\)

Based on a 2005 U.K. report using collision data, side guards were effective for collisions involving cyclists and pedestrians moving in the same direction as the heavy vehicle where the initial point of impact occurs on the “nearside of the HGV”. For such “going ahead” collisions, the introduction of side guards resulted in a 61% reduction of fatally injured bicyclists and a 20% reduction of fatally injured pedestrians.\(^\text{29}\)

A further report stated that in the U.K., with the introduction of side guards, fatalities and injuries among cyclists was reduced by 5.7% and 13.2% respectively.\(^\text{2}\) U.K.’s Transport Research Laboratory (TRL) computer simulation showed that although integrated side guards have the potential to offer substantial benefits to pedestrians, an analysis of fatal collisions estimated that fitting such integrated side guards could prevent up to 3% of pedestrian fatalities.\(^\text{33}\)
Other test results provided conflicting evidence regarding the effects of side guards when cyclists collide with heavy vehicles turning left (or turning right in North America). For example, previous collision data has shown that side guards have been effective at preventing the type of collision for which they were designed—where a heavy vehicle overtakes a cyclist or pedestrian and they fall sideways into the side of the vehicle between the front and rear axles (straight ahead manoeuvres). They were not designed to protect a cyclist that gets knocked to the ground by the heavy vehicle’s cab and then gets run over as the vehicle turns left (turns right in N.A.). They cannot stop a person who is already lying on the ground from passing underneath.\(^{(26)}\)

Evidence suggests there is little, if any, effect; however, an analysis of vehicles that are exempt from applying side guard technology, suggests that side guards have a significant effect both on reducing the frequency of such collisions and on reducing the severity of injuries sustained when these collisions do occur. Which analysis is correct cannot be proven with the data available in this study.\(^{(26)}\)

In the European Union, on research papers seems to indicate that deaths and serious injuries have been reduced with the introduction of side guards. However, it is not clear if this reduction is entirely related to side guards or if side guards are but one of the contributing factors.\(^{(25)}\)

A further study reports that when considering the influence and effectiveness of a single countermeasure with respect to heavy vehicles and cyclist fatalities, fitting current side guards is cited as a possible influence in a relatively large number of cases, but is usually considered to have a great deal of uncertainty, that is, most of the cases are coded only as “maybe” with none coded as “definite”.\(^{(26)}\)

In addition, when considering sole countermeasures most likely to reduce cyclist fatalities in collisions with heavy vehicles based on the vehicle’s manoeuvre, fitting current side guards (i.e. ending exemptions) was not among the top measures for either manoeuvre (Turning Left; Going Ahead; Overtaking). For turning left collisions it was considered to have a possible influence in a substantial number of collisions but there was never sufficient confidence to consider classifying it as “definite”. When “going ahead other”, (study terminology/criteria) the probability levels for the side guard measures were slightly more evenly distributed.\(^{(26)}\)

The U.K.’s Heavy Vehicle Crash Injury Study (HVCIS) database suggests alternative measures may be more effective in left turn (right turn in North America) collisions, in particular, “improve side vision.” In time, benefits may be achieved by a properly developed electronic warning system capable of alerting drivers to the presence of vulnerable road users. A 2010 study ranked such a VRU warning system as one of the top 5 commercial vehicle safety priorities, based on the assumption it would work all around the vehicle, not just at the side.\(^{(26)}\) (See Visibility Detection Technologies)

Currently, there is no way to accurately quantify the potential reduction in VRU deaths or serious injuries as a result of side guard installation.\(^{(25)}\)

**Barriers and Considerations**

It is not clear if side guards will reduce deaths and serious injury or if the guards will simply alter the mode of death and serious injury. For example, VRUs may strike the guards and be deflected into another lane of traffic to suffer a serious injury as part of secondary event with another vehicle or with the road/sidewalk surface.\(^{(25)}\)

City buses have built-in side skirting that are lower than side guards found on most trailers; yet, there are still incidences of pedestrians being killed as they slip and fall under the wheels of moving city buses.\(^{(25)}\)
What other jurisdictions are doing with respect to side guards:

As of 2016, all City of Montreal-owned trucks have side guards installed. The requirement to install side guards on other trucks or to include this requirement in tenders is being evaluated.

Federal U.S. law requires large trucks to have rear underride guards but not side underride guards. At least three U.S. cities – Boston, New York and Seattle – mandate side guards on city-owned and/or contracted trucks as part of Vision Zero initiatives to eliminate crash deaths and injuries, particularly among pedestrians and bicyclists. (34)

There are no U.S. federal regulations governing the use of side guards. So far, policy advancement on this proven life-saving device has been locally led. Boston, New York City, Portland, Ore., Washington D.C. and Cambridge, Mass. are some of the cities to create policies (all quite recently) requiring side guards on trucks in certain circumstances. (9)

### Truck Side Skirts

**Description**

Aerodynamic side skirts, or belly fairings, are devices fitted to the longitudinal edges of a trailer and are intended to allow the air flow to pass alongside the trailer rather than underneath it. (35) The skirts reduce vortices and prevent the air from contacting the underbelly, the spare tire, the rotating wheels and other running gears that are all relatively blunt. For example, side skirts help make the truck more aerodynamic by smoothing the air flow beneath the truck where gears and the spare tire is located. The addition of side skirts to highway trailers tends to smooth airflow and reduce cross-flow along and below the bottom edges of the trailer and entrain the air more efficiently around the trailer and keep crosswinds from causing turbulence under it. The secondary effects, such as brake cooling and the ability to prevent intrusion by a vulnerable road user are not as well documented.

Side skirt panels are primarily available in three materials: aluminum, thermoplastic olefin (TPO) and fiberglass reinforced plastic (FRP). TPO and FRP, are flexible, durable, lightweight, temperature resistant, ultraviolet (UV) stabilized and often recyclable. In comparison, aluminum, a metal known for its overall strength and relative lightweight, is less elastic than plastic, and tends to be heavier than TPO or FRP. (36)

### Issues / Evidence

Testing in Canada has been focused mainly on the strength of various types of aerodynamic side skirts in the event of a perpendicular impact on a stationary vehicle with a weighted bicycle. An anthropomorphic dummy, one that resembles a human form, was not used and so no testing was conducted on what effects an impact might have on a cyclist. (35)

Under specific test conditions, all three of the tested skirt types prevented the bicycles from entering under the trailer. Furthermore, the bicycles did not become wedged underneath the skirts. In all tests, the bicycles were ejected rearward along their original path and away from the trailer and became tangled in the test fixture, which would represent an adjacent lane, be it oncoming traffic or a lane travelling in the same direction. (35)
Safety benefits under realistic conditions have yet to be determined. Tests have primarily focused on bicycle collisions with heavy vehicles from a perpendicular impact only.\(^{(35)}\)

In the U.K., survey and strength testing work has shown that current examples of side skirts are stronger and typically have lower ground clearances than current rail-type side-guards. In general, they also fill far more of the space between the wheels. They have the added advantage that they present a smooth uninterrupted surface to the crash victim and are usually flush with the outer edge of the vehicle. All of these differences from rail side-guards are to enhance aerodynamic performance but test work has shown that they are all good features for improved safety.\(^{(26)}\)

In addition to the benefits of stronger and lower side-guards, where a cyclist or pedestrian has fallen against the side of a passing heavy vehicle fitted with side guards and not been run over, this has occurred because the smooth surface helps to prevent severe impacts between the cyclist’s head and projections such as load hooks, top edges of guards or supports. This helps to prevent heavy contact between the chest and the outer edge of the rear tire. An added benefit is that clothing and limbs are less likely to be caught in the structure of the side guard resulting in the cyclist being dragged along the vehicle. Tests also suggest the cyclist is typically thrown to the ground with less force. In theory, young, healthy adults wearing cycle helmets should not be killed when involved as a cyclist falling against the side of a passing HGV if this type of protection [side skirt] is fitted.\(^{(26)}\)

When considering the influence and effectiveness of a single countermeasure on heavy vehicles to cyclist fatalities, it can be seen that of the top 5 weighted countermeasures, “provide cycle lane” came out as the most effective countermeasure followed by “improve side vision” and “fit aerodynamic side skirt”.\(^{(26)}\)

When considering sole countermeasures most likely to reduce cyclist fatalities in collisions with heavy vehicles based on the vehicle’s manoeuvre, for turning left collisions, “improve side vision” was recorded as the most likely, followed by “provide cycle lane” and “fit aerodynamic side skirt”.\(^{(26)}\)

### Barriers / Considerations

N/A

### Part II: Non-Specific to VRUs and Heavy Vehicles

NIL
COUNTERMEASURES

4.7 Speed

Controlling vehicle speed can prevent crashes happening and can reduce the impact when they do occur, lessening the severity of injuries sustained by the victims.
Part I: Specific to VRUs and Heavy Vehicles

NIL

Part II: Non-Specific to VRUs and Heavy Vehicles

### Speed Limit Reductions

**Category:** Policy/Legislation/Regulation; Infrastructure; Enforcement; Education; Communications

#### Description

Maximum speed limits vary depending on the type of roadway and its intended use. These limits are determined by each jurisdiction. A number of jurisdictions are considering reducing speeds in urban areas from 50 km/h to 40 km/h, and from 40 km/hr to 30 km/hr in residential areas. (This measure has already been adopted by many municipalities.)

A little over 50% of Canadian roads are owned and operated by municipalities; a larger portion of the remainder fall under provincial/territorial jurisdictions. As a result, the variance in posted speed limits across the country are the norm rather than the exception.

#### Issues / Evidence

**Jurisdictions Studied**

- Montreal, Canada
- OECD, 35+ countries

**A New York City study found that collisions between heavy vehicles and vulnerable road users typically involved a low speed turning manoeuvre, in full daylight, in or near marked or unmarked pedestrian crossings in clear weather conditions.**

According to the Ministère des transports du Québec, speed limits lower than 50 km/h where there is a prevalence of pedestrians, cyclists and persons using motorized mobility aids, contribute to improved road safety, if they are coherent with the environment and respected by drivers.

A U.S. study found that the proportion of pedestrians who were severely injured or killed increased as impact speed increased across all categories of impact speed examined. The consensus of recent (global) studies indicates that reducing the impact speed from 50 km/h to 30 km/h reduces the pedestrian fatality risk by a factor of 80%.

In addition, risks vary significantly by age. For example, the average risk of severe injury or death for a 70-year-old pedestrian struck by a car travelling at 25 mph is similar to the risk for a 30-year-old pedestrian struck at 35 mph. While minor and severe injuries occur in similar speed environments, the age of the victims affects if the injury outcome is minor or severe.

The data also shows that even though fatal collisions (excluding run-over collisions) are rare in speed environments where the mean travel speed is below 40 km/h and severe injuries are rare below 25 km/h, over 30% of severe injury collisions occur in speed environments below 35 km/h. This indicates that 30 km/h speed limits might not be as safe as previously believed.
**Barriers / Considerations**

*Speed is not typically a factor in turning manoeuvres, per se. However, a Montreal, Canada, bus driver training and testing exercise revealed that by reducing a bus' turning speed from 24 km/h to 13 km/hr, a pedestrian would remain visible to the driver four times longer; thus giving the driver additional time to react.* (See [Bus Driver Training – Mitigating Blind Spots](#))

*A Swedish study acknowledges a slight under-representation of severe injuries with respect to heavy vehicles but an over-representation of heavy vehicles in fatal collisions. A comparison of the speed limits of those crashes reveals that the greater proportion of the heavy vehicle collisions is in zones with speed limits of 30 and 70/90/110 km/h; however, there was no statistically significant difference for the speed limit between heavy vehicles and passenger vehicles. However, risks were higher for pedestrians struck by light trucks than for pedestrians struck by cars.* [By extension, the risks would be even higher for pedestrians struck by heavy vehicles.](#) The data also reveals that those struck by heavy vehicles were slightly older compared to those struck by passenger vehicles. (36, 37)

Evidence pointing at the reduction and severity of crashes occurring at lower speeds should be shared with all parties to build and maintain support towards lowering maximum speeds. (3) (See [Monitoring Strategy – Forensic Review of Collision Data](#))

Changes (decreases) in the posted maximum speeds on roadways may not lead to tangible changes in the behavior of motorists (i.e. truly reducing operating speeds). This is in sync with what was noted in study findings: “The implementation of speed reduction initiatives should act simultaneously on the road infrastructure, the road user and the vehicle.” (3)

Due to the complexity of the issues regarding speeding, it is not always easy to identify the most appropriate measure. Some solutions, like redesigning a street’s geometry, often requires important investments. On the other hand, simple solutions are not always efficient. For example, the simple reduction of the speed limit without modifying the street infrastructure, or implementing the appropriate traffic controls, does not always have a significant effect on speeds; and yet, this measure is very often adopted. (6)

The regulation of speed is not a panacea to eradicating VRU casualties and injuries. Rather, it is one of many to be considered in a portfolio of measures designed to increase the safety of VRUs. In some collisions, speed may not be a factor; hence, there is a need to combine this countermeasure with others, as required in a [Complete Streets](#) and [Safe System Approach](#).

### Traffic Calming Strategies and Devices

**Description**

**Category:** Infrastructure

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<th>Groups Affected</th>
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Traffic calming can encompass a number of strategies, including reduced number and width of travel lanes; wide parking lanes and the introduction of cycling lanes; road diets (another name for reducing travel lanes), speed humps, raised intersections, bulb outs (also called curb extensions or blisters), chicanes (an artificial narrowing or turn of a road), cross walks; automated traffic enforcement systems (scientifically validated and strategically located); and reduced speed limits on residential streets from 40 to 30 km/hr. (1) (See countermeasures under [Intersection and Crosswalk Design](#) and [Traffic Control Devices](#).)
Issues / Evidence

New York City’s Department of Transport (DoT) installs about 75 speed reducers (speed humps) per year; the Department’s before and after studies found an average of 19% reduction in speeds where speed reducers were in place.\(^{(12)}\)

An ongoing DoT study has found that speed reducers reduce injury crashes by approximately 40%.\(^{(12)}\)

A World Health Organization (WHO) study found that the speed of buses was lowered after installing rumble strips (in December 2008). As a result, pedestrian incidents involving speeding buses have been reduced. It also found that, in general, lower speed streets experience low rates of vehicle-pedestrian crashes, while downtown areas with wide travel lanes and higher operating speeds experience higher rates.\(^{(19)}\)

Barriers / Considerations

While the studies have focused on reductions in overall fatalities and injuries, and confirm that any countermeasure that is effective in reducing vehicle speeds will improve pedestrian injury outcomes\(^{(10)}\), collisions between heavy vehicles and vulnerable road users generally take place at lower speeds, which may not be subject to speed violations.

Traffic-calming interventions alone may not improve conditions for pedestrians. Other issues need to be addressed, such as law enforcement, adequate street lighting, etc.\(^{(5)}\)
COUNTERMEASURES

4.8 Traffic Control Devices

Traffic control devices are typically placed adjacent to, above or along highways, roads, traffic facilities, and other public areas that require traffic control.
Part I: Specific to VRUs and Heavy Vehicles

NIL

Part II: Non-Specific to VRUs and Heavy Vehicles

Advanced Green for Pedestrians

**Category:** Infrastructure

**Description**

This low-cost countermeasure, referred to as a leading pedestrian interval (LPI), allows pedestrians to get a head start (3-6 seconds or more) before vehicles receive a green light. This puts pedestrians well into the crosswalk, increasing their visibility before drivers begin to turn. As pedestrians become accustomed to this advanced signal measure, many are able to move well into the crossing during this protected pedestrian period. The longer times are especially helpful in areas where there are multiple lanes to cross.\(^{(10)}\) (See **Separate Offside-Turn Phases for Cyclists**)

There are different types of pedestrian signals. For example, in Montreal, a green straight arrow light prompts pedestrians to cross before cars are permitted to move into the intersection.

**Issues / Evidence**

At a typical intersection in Canada, the pedestrian signal works simultaneously with the traffic signal and many pedestrians are struck just after leaving the curb with a WALK signal in their favour, typically by a right-turning vehicle and, at other times, by a left-turning one.\(^{(10)}\) A Transport Canada report noted that crossing the road at a signalized intersection when the “green signal for the pedestrian” is not showing, was the most frequent at-fault behaviour and accounted for about 13% of all pedestrian traffic deaths in Canada.\(^{(3)}\)

A study, which examined a three-second leading pedestrian interval (LPI) whereby the WALK signal comes on three seconds before vehicles can proceed, found that this treatment reduced conflicts by 95% for pedestrians starting across at the beginning of the walk interval. The introduction of this LPI reduced the odds of a pedestrian having to yield to a vehicle by approximately 60%.\(^{(10)}\)

**Barriers / Considerations**

Advanced Green for Pedestrians may mitigate the risks to pedestrians in intersections when heavy vehicles are turning and fail to see vulnerable road users that are in their blind spots. While this countermeasure could reduce the risks to pedestrians, consideration should be given to the reality that not all pedestrians (or cyclists) leave the intersection at the same time. For example, an incident in Montreal involved a truck driver who safely passed a group of pedestrians but then hit another late pedestrian who was running to cross the intersection as well. Further, especially in the case of heavy vehicles, this countermeasure does not address the main problem, that is, the driver’s blind spot.
There is a need for an absolute minimum of three seconds for this LPI. This is underscored by the fact that older pedestrians delay for about 2.5 seconds before starting to cross. This would not only make it safer for pedestrians, but may also give them an increased sense of comfort and safety. The distance traversed by pedestrians during the LPI would be sufficient for them to assert their right-of-way over vehicles.\(^{(10)}\)

There is limited time for pedestrians to assert their right of way (ROW). In this scenario, vehicles can still proceed to turn into the intersection once the advance green (3 seconds) time has expired. (See No Right Turn-on-Red (RTOR))

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### Auditory Messages at Intersections

#### Description

Audio messages, such as WAIT FOR THE WALK SIGNAL or WATCH FOR TURNING VEHICLES, provide particular instructions to pedestrians at signalised intersections. To indicate when it is safe for visually impaired pedestrians to cross, two audible tones are used to indicate the direction in which the pedestrian has the right of way; a cuckoo sound indicates the pedestrian has the right-of-way in the north/south direction or a chirp sound indicates the pedestrian has the right-of-way in the east/west direction.\(^{(10)}\)

In addition to the “cuckoo” and “chirp” sounds, some signals are equipped with a continuous tone called a “locator tone”. This tone is emitted from the pushbuttons to assist pedestrians, who are blind or visually impaired, in locating the pushbuttons. Some pushbuttons are equipped with a raised arrow that points in the direction of travel. This arrow vibrates when the Accessible Pedestrian Signals (APS) sounds are activated. These sounds and locator tones automatically adjust to ambient sound levels. Therefore, during peak traffic conditions, they may sound louder; overnight they drop to their lowest volume level.

#### Issues / Evidence

*Pedestrians* [or other vulnerable road users] *often fail to scan the traffic environment and are, therefore, vulnerable to being struck by turning vehicles.*\(^{(10)}\)

A U.S. study examined the influence of verbal messages, spoken by either a woman or child just before the walk signal was illuminated, to determine if such an approach would reduce pedestrian / vehicle conflicts at intersections. During the baseline condition, 16.3% of pedestrians did not look for threats (vehicles) resulting in an average of one conflict per session. The auditory signal reduced the number of those not looking to 4.2% and the conflicts to 0.25 per session. The use of a child’s voice was more effective than an adult’s in promoting the search for threats.\(^{(10)}\)

#### Barriers / Considerations

*As many of the collisions between pedestrians and heavy vehicles occur at intersections, specific sounds that draw pedestrians’ attention to WATCH FOR TURNING VEHICLES can help to increase their safety in these scenarios.*

It is not always possible to hear these messages properly at a busy intersection due to ambient noise.\(^{(10)}\)
The cuckoo-chirp signals are no longer the recommended standard in the U.S. This is based on research completed since 1988. The cuckoo-chirp signals resulted in incorrect decision about which street has the walk signal and people had difficulty remembering which tone was for which direction and often, they didn’t know what direction they were travelling. In addition, birds sometimes mimicked the chirp sound. With this new system, the visual WALK sign is accompanied by a rapid ticking or beeping sound. However, it also might be a speech message saying the street name such as “Peachtree, Walk sign is on to cross Peachtree.” This auditory message usually will repeat for the entire time the visual WALK or “walking man” symbol is displayed. To use the speech message effectively, the name of the street being crossed must be known. Accessible Pedestrian Signals (APS)

### Flashing “EYES” Traffic Signal

**Description**

The flashing “EYES” pedestrian crossing signal is designed to remind pedestrians to be aware while waiting or crossing at an intersection. In one configuration (Florida), it consists of blue LEDs – two blue “eyeballs” that scan left and right at a rate of one cycle/second. The position of the eyes are as follows: one set of eyes above the standard symbol of a hand (for wait), and one set of eyes above the walking person (for walk), which are also LED configurations.

**Issues / Evidence**

*Pedestrians [or other vulnerable road users] often fail to scan the traffic environment and are, therefore, vulnerable to being struck by turning vehicles.*

A Florida study showed that in the baseline condition, standard pedestrian signals were used. The experimental conditions included the “EYES” display either immediately before the “WALK” signal for 2.5 seconds, concurrent with the beginning of the “WALK” signal for 2.5 seconds or concurrent, then repeated every 9.5 seconds during the “WALK” signal. The percentage of pedestrians not looking for turning vehicles reduced dramatically under all conditions. Conflicts between pedestrians and turning vehicles were also greatly reduced by using the “EYES” display.

There is little additional evidence with respect to the successful implementation of this countermeasure.

**Barriers / Considerations**

As many of the collisions between pedestrians and heavy vehicles occur at intersections, these pedestrian signals may help to increase their safety.

N/A
Pedestrian Countdown Signals

**Description**

This signal is a timer that provides a numeric countdown displaying the number of seconds remaining for a pedestrian to complete the crossing. The timer starts counting at the beginning of the pedestrian flashing DON'T WALK display and finishes counting (i.e. a "zero" display is shown) until the end of the pedestrian flashing DON'T WALK display. There is no countdown display during the pedestrian WALK or solid DON'T WALK displays. The practice of starting the countdown at the beginning of the FDW (Flashing Don’t Walk) is recommended by the Transportation Association of Canada (TAC).

The initial countdown display value is dependent on the length of the crosswalk. Consequently, the display value can vary depending on the crossing and intersection type.

**Issues / Evidence**

*Jurisdictions Studied*

- Ontario, Canada
- New York, NY

**Crossing-against-the-signal, pedestrian KSI (killed or severely injured) crashes are 56% more deadly than crossing--with-the-signal crashes. The most common reason listed for a crash was driver inattention; a factor in 36% of pedestrian KSI crashes. Children involved in a KSI crash while crossing against the signal were more likely to be killed than an adult struck while crossing against the signal.**

Countdown signals have been shown to reduce pedestrian injury crashes and are strongly preferred by pedestrians, who find them easier to understand than other signal types.

**Barriers / Considerations**

*As many of the collisions between pedestrians and heavy vehicles occur at intersections, these pedestrian signals may help to increase their safety. However, increased education on their proper use may be warranted as they are often ‘misused’ by both pedestrians and drivers.*

Nearly half (47%) of pedestrian fatalities and severe injuries occurred at signalized intersections; surprisingly, most (57%) of these crashes occurred while the pedestrian was crossing with the signal. This suggests that both driver failure to yield to pedestrians in the crosswalk as well as pedestrian failure to follow traffic signals are both significant factors leading to KSI crashes at intersections.

Road users can usually be guided towards making safe decisions by informative street design and traffic engineering. However, some problems can only be addressed with the deterrence that comes from strong enforcement of traffic law.
**Protected Left-Turn Phasing**

**Description**

Protected left-turn phasing is a traffic signal sequence that holds the pedestrian at the curb by a “DO NOT WALK” phase while through traffic is held by a red light. The driver is able to make a left turn without conflicting with pedestrians. (10) (See No Right Turn-on-Red (RTOR) and Advanced Green for Pedestrians)

**Issues / Evidence**

*Most intersections make it difficult for drivers to make safe turning choices.* (10)

Some jurisdictions have increased the number of intersections with protected left-turn phasing where drivers are prohibited from turning right on a red light. (See No Right Turn-on-Red (RTOR))

The documentation reviewed did not provide evidence supporting the successful implementation of this countermeasure.

**Barriers / Considerations**

*This countermeasure separates the movement of vulnerable road users and heavy vehicles (and other motor vehicles) at intersections.*

No further information discovered.

---

**Separate Offside-Turn Phases for Cyclists**

**Description**

This involves introducing a phase at signalized intersections providing cyclists advanced time to turn left.* There are other measures commonly used in some countries to reduce the number of nearside turn crashes at signalized intersections, such as pre-green stages for cyclists and separate phases for nearside turning cars against bicycles, but no specific evaluation of safety effects have been found (for these).

*In the U.K. and Ireland, “offside” refers to right turns; in Canada and the U.S. this would refer to left turns.

**Issues / Evidence**

*In the U.S. (between 2005 and 2010), 36% of all fatal bicycle crashes occurred at junctions (intersections). Sixty-four percent (64%) of all junction-related fatal crashes between 2010 and 2011, took place at 4-way crossroads.* (38)

Traffic signals and different ways of upgrading existing signalized intersections have been subject to a fairly high number of evaluations and research studies. Only very few studies have presented quantified results for reductions of bicycle crashes.

An international study found that separate offside-turn phases reduces the number of offside-turn crashes in signalised junctions (intersections) by 58%. This effect is also likely to apply to crashes with bicycles (especially collisions where bicycles are hit by offside-turning cars from the opposite direction). (38)
Barriers / Considerations

This measure is equivalent to Advanced Green for Pedestrians and may mitigate the risks to cyclists in intersections when heavy vehicles are turning and fail to see vulnerable road users that are in their blind spots.

It should be mentioned that separate offside-turn phases are likely to cause a minor increase in other types of crashes - including crashes involving bicycles. If separate offside-turn phases are introduced in an intersection where offside turn crashes only account for a minor share of overall crashes, there is a risk that the decrease in offside-turn crashes will be outnumbered by an increase in the number of other types of crashes. [38]
4.9 Visibility and Conspicuity

To be noticed is to be safe.
Part I: Specific to VRUs and Heavy Vehicles

Audible Sensors on Vehicles

**Description**

Groups Affected

- Vehicles

A variety of technologies exist that audibly alert vulnerable road users that they need to move further away from a heavy vehicle’s blind spot. These might include Turn Warning Systems, Directional LED Headlight Systems and BUS Blank-Out Signs, among others. Some of these systems may simply be activated when the vehicle turns; other, more intelligent systems rely on vision, radar, ultrasonic and lidar* sensors.

Similar equipment works for reversing beepers on various trucks that alert of an approaching ‘danger area’.

* Lidar stands for Light Detection and Ranging; it is a detection system that works on the principle of radar, but uses light from a laser.

**Issues / Evidence**

Jurisdictions Studied

- Montreal, Quebec
- Toronto / other Ont. municipalities

Audible sensor devices are in the process of testing and review in Montreal, Quebec, and York region in Ontario. There are also field tests that have been conducted in the U.S. Results are pending.

**Barriers / Considerations**

Although this technology is becoming available, it is yet unproven.

Emerging intelligent systems can be expensive. Also, the noise that they generate may impact the reaction with the community. Additionally, exterior cameras and sensors can be damaged in environments such as construction sites.

An important consideration for vulnerable road users is that ongoing noise tends to be ignored and becomes less effective as time goes on.

The type of equipment and the manner in which it functions must comply with jurisdictional regulations. This could be supported by educational pamphlets for cyclists / pedestrians, and commercial drivers.

Auxiliary Turn Signals

**Description**

Groups Affected

- Vehicles

Auxiliary turn signals on heavy vehicles provide notice to cyclists positioned along the vehicle’s passenger side providing another cue of the driver’s intention to turn. This allows the cyclist to re-position themselves away from the vehicle and avoid danger.

**Issues / Evidence**

Jurisdictions Studied

- Canada

* Due to the length of most commercial vehicles, when a cyclist is positioned along the passenger side of the vehicle on the road, ahead of the bumper, the cyclist is often unable to see the activated turn signal of the truck.*
Many fatalities occur when cyclists are positioned at the mid-point of the truck’s passenger side, while stopped at an intersection. Since the cyclist is unable to see the truck’s turn signal, coupled with the driver’s difficulty detecting the cyclist, the driver enters into a right turn without knowledge that a cyclist is located in a danger zone.\(^\text{[39]}\)

The documentation reviewed did not provide evidence supporting the successful implementation of this countermeasure.

**Barriers / Considerations**

Auxiliary turn signals could also be used in conjunction with Audible Sensors on Vehicles.

Lafarge Canada has committed to installing auxiliary turn signals on all their owned commercial vehicles operating across Eastern Canada by the end of 2017.\(^\text{[39]}\)

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**External Mirrors to Reduce Blind Spots**

**Category:** Vehicle Technology/Equipment

### Description

**Groups Affected**

- Vehicles

Heavy vehicles can be equipped with multiple exterior mirrors to improve the driver’s field of view. In Canada, these include rear view planar mirrors on each side of the vehicle, as specified in the Canada Motor Vehicle Safety Standard (CMVSS)*. They could also include additional mirrors (nearly always installed by drivers) such as circular convex mirrors near the planar mirrors, fender or hood-mounted circular convex mirrors, a look-down rectangular convex mirror over the passenger door window, and cross-over mirrors installed in front of the cab to eliminate a truck driver’s front “blind spot”.

![External Mirrors](image)

* The Canada Motor Vehicle Safety Standards (CMVSS) outline minimum requirements for heavy vehicles, such as rear and side view mirrors.

### Issues / Evidence

**Jurisdictions Studied**

- New York City
- E.U.
- U.K.

*Based on a preliminary analysis of a sample of large trucks involved in crashes resulting in injuries or deaths, a 2007 U.S. study reported that large trucks lacking right fender mirrors were over-involved in crashes resulting in deaths and injuries compared with large trucks with right fender mirrors designed to mitigate the large blind spot on the right side.*\(^\text{[41]}\)
Crossover convex mirrors are currently required by state law on large trucks operating in New York City and the European Union also has requirements for enhanced mirrors on large trucks to reduce the size of blind spots. In the Netherlands, blind spot mirrors had been mandatory on all Dutch trucks since the end of 2003. No studies evaluating the safety effect of blind spot mirrors have been found. Crash statistics from Netherlands show that for a short period of time (2002-2003), the number of related fatal collisions decreased, but from 2004 the numbers were back up to the same level as before.

In the E.U., the number of vulnerable road users killed in collisions with a heavy goods vehicle (HGV) has fallen substantially; in 2009 the number was less than expected based on the predicted effects of Directive 2007/38/EC. This would suggest that retro-fitting side view blind spot mirrors had been successful. However, the overall number of fatalities also fell more sharply in the same time period and the specific data available are limited. It is not, therefore, possible to quantify the extent to which the overall fall in HGV-VRU fatalities was the result of the mirrors being installed.

**Barriers / Considerations**

Vehicle size and design can affect direct and indirect vision, either reducing or increasing a truck’s blind spots. Design issues include the height of the cab above the ground, window apertures (openings), position of the A and B pillars, as well as the position and height of the driver’s seat. Even vehicles with the same cab height may have other design differences and, therefore, have different blind spots. Trucks will have greater blind spots than passenger vehicles. (See Field of View Standards for Heavy Vehicles)

External mirrors are only useful if they are properly adjusted and used by heavy vehicle drivers. However, there is some indication that multiple mirrors may, in fact, be a distraction to drivers and thus limit their effectiveness (U.K.).

While external mirrors help drivers see pedestrians and cyclists that are beside the vehicle (outside of blind spots), external blind spot mirrors may not be a sufficient countermeasure for reducing fatalities when trucks or buses are making turns into intersections. The mirrors themselves can create blind spots for the driver, along with the vehicle’s hood, and the A and B pillars.

The City of Montreal is testing a tool that helps to evaluate blind spots on heavy vehicles. Based on the assigned blind spot rating, these vehicles would have limited access to [specific areas] in cities.

---

### Field of View Standards for Heavy Vehicles

**Category:** Policy/Legislation/Regulation; Enforcement

**Groups Affected**
- Vehicles

**Description**

Field of view standards (also referred to as direct vision standards) define the ability of a driver to see someone directly through their windows. Direct vision standards for trucks, which reflect a Vision Zero approach to road safety, mandate at least best-in-class performance for different heavy vehicle categories. In the U.K., Direct Vision Standards use a star rating system (from 0 to 5).
For heavy vehicles, better field of view usually means lowering the position of the driver. This increases what the driver can see, and puts the driver closer to the level of other road users in (urban) traffic.\(^{(40)}\) (See \textit{External Mirrors to Reduce Blind Spots} and \textit{Visibility Detection Technologies})

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{field_of_view.png}
\caption{Field of View – Blind Spot Areas from a Heavy Vehicle}
\end{figure}

\section*{Evidence}

\textit{Truck design is a major contributor to fatalities involving trucks and VRU’s. Blind spot mitigation using mirrors has been attempted but is proving ineffective. The European Union (EU) is exploring solutions for direct vision between truck drivers and VRUs. Implementation models are to be considered.}\(^{(40)}\)

With direct vision, problems of distorted images or poorly adjusted mirrors are eliminated. Secondly, seeing something directly also reduces the time needed to “scan” a traffic situation. Thirdly, it is likely direct vision also has a number of ‘cognitive’ benefits over indirect vision. This means people react differently to something they see directly.\(^{(40)}\)

The U.K.’s Transport Research Laboratory (TRL) 2015 estimated the lifesaving potential of better direct vision to be up to 553 lives saved per year in the EU.\(^{(40)}\)

\section*{Barriers / Considerations}

There is a major difference between North American trucks (conventional cabs that experience many blind spots that make it difficult to improve line-of-sight) and European trucks (almost exclusively advanced cab design with good visibility). An adequate standard of line-of-sight would require a change in vehicle type and would further require a profound change in the North American trucking culture.

The E.U. study recommended that differentiated direct vision standards be introduced for different truck categories. Construction vehicles, long haul and urban vehicles have different characteristics and potentials for improvement. Urban trucks clearly have the biggest potential whereas construction vehicles with off-road capability are more challenging. The exact classification needs to be further researched but it is clear that one-size-fits-all approach would deliver suboptimal results … and would end up having little impact as it would likely be tailored to the lowest common denominator.\(^{(40)}\)

This study also indicated that implementation of the Direct Vision Standard could be a lengthy process.\(^{(40)}\) Vehicles cannot be retrofitted; implementation would be applied to the design of new vehicles moving forward.
Direct Vision Standards reflects a Vision Zero approach to road safety and the protection of vulnerable road users sharing the road with heavy vehicles. As Vision Zero has, as its goal, the elimination of traffic deaths and serious injuries, prioritizing large vehicle safety measures within jurisdictional plans will enable increased safety on their streets.

### Parking Restrictions / Bus Stop Placement near Intersections

**Category:** Policy/Legislation/Regulation; Enforcement

**Description**

Parking restrictions near intersections, also referred to as “daylighting”, involves the prohibition of parking any vehicle within a specified distance of an intersection. Vehicles stopped too near to a crosswalk can obscure the visibility of a crossing pedestrian or cyclist.

**Issues / Evidence**

Unsafe parking by trucks or the placement of bus stops near intersections can affect the safety of pedestrians. When a bus is stopped and passengers are disembarking, some drivers may attempt to overtake the bus. The bus obstructs the vision of other drivers to see pedestrians crossing in front of the bus; likewise, pedestrians cannot see the passing vehicle. Parking of heavy trucks at intersections can also hinder vulnerable road users’ ability to see oncoming traffic.

To reduce the potential for collisions, many jurisdictions have prohibited parking near intersections and crosswalks and moved bus stops from these locations.

For example, in line with Vision Zero principles, a law is being proposed in Quebec that will enforce the prohibition of parking a vehicle within 5 meters of an intersection. European Transport Ministers have passed resolutions banning parking near crosswalks in school zones. It was noted in the U.S. Department of Transportation’s Toolbox of Countermeasures that moving a bus stop location away from crosswalks deterred pedestrians from crossing in front of the bus.

The documentation reviewed did not provide detailed evidence supporting the successful implementation of this countermeasure.

**Barriers / Considerations**

N/A

### Visibility Detection Technologies

**Category:** Vehicle Technology/Equipment

**Description**

Specific technologies to alert tractor-trailer drivers of other vehicles traveling in their blind spots are already on the market. The side view assistance system has sensors to monitor the blind spot in the adjacent lane and provides an audio warning if there is a vehicle in the blind spot after the driver signals an intention to change lanes. In addition, rear vision assistance systems, consisting of cameras and monitors, allow drivers to see pedestrians (and passenger vehicles) present in the rear blind spot while drivers are backing their vehicles.
European regulations refer to more encompassing “Devices for indirect vision”, which allows for technology other than enhanced mirrors. The rule states that these are “devices to observe the traffic area adjacent to the vehicle which cannot be observed by direct vision. These can be conventional mirror, camera monitors or other devices able to present information about the indirect field of vision to the driver.”

**Issues / Evidence**

The National Transportation Safety Board (NTSB) concludes that onboard systems and equipment can allow tractor-trailer drivers to better detect passenger vehicles, motorcyclists, pedestrians and cyclists. Such systems are available and their use could prevent fatalities and injuries that occur in collisions involving tractor-trailers. The NTSB recommends that the National Highway Traffic Safety Administration (NHTSA) require newly manufactured truck-tractors with Gross Vehicle Weight Ratings (GVWRs) over 26,000 lbs (approx. 11,793 kg) to be equipped with visibility enhancement systems to improve the ability of drivers to detect passenger vehicles and vulnerable road users.

An NTSB multidisciplinary case review team reviewed 11 single-unit truck cases involving impacts to the front, side, rear of the single-unit truck and identified whether there were countermeasures that could have mitigated the effects of the crashes.

In the case of an incapacitating injury involving pedestrian impact at the front of the truck, when the truck was travelling straight:

- Pedestrian detection technology may have limited effectiveness if there was traffic on the two adjacent travel lanes.

In the case of a fatality involving pedestrian impact at the front of the truck when the truck was turning left:

- Pedestrian detection technology should focus on a crash scenario where the truck is turning left across traffic and the pedestrian is legally crossing the adjacent crosswalk.

In the case of a fatality involving pedestrian impact at the back of the truck when the truck backing up:

- This is a classic example of the benefits of a backup camera system.

NTSB concludes that onboard systems and equipment that compensate for blind spots and allow drivers of single-unit trucks to detect VRUs could prevent fatalities and injuries.

**Barriers / Considerations**

There is significant evidence highlighting the issues of blind spots. There have already been developments of vehicle technologies to mitigate these issues. Evidence presented strongly supports the use of visibility enhancement systems.

However, there are risks associated with multiple systems designed to increase visibility. Acceptance and driver behaviour are important considerations, especially with drivers who are unfamiliar with new or advanced systems. In addition, there is a risk of increasing distractions, overloading the drivers’ tasks, and dealing with false alarms which, ultimately, may undermine confidence in the detection system.

At this time, the reliability and effectiveness of such systems are unknown; in particular, those designed to detect vulnerable road users in all manoeuvres (front, side and at the back of heavy vehicles).

Pedestrian technology may be limited based on location of collision (with truck) and where there is existing traffic in adjacent lanes.
The study also recommends the development of performance standards for visibility enhancement systems to compensate for blind spots. Once developed, newly manufactured single-unit trucks over 10,000 lbs should be equipped with such systems.\(^{30}\)

The City of Montreal is testing a tool that helps to evaluate blind spots on heavy vehicles. Based on the blind spot rating assigned, these vehicles would have limited access to [specific areas] in cities.

### Ongoing Studies of Visibility Detection Technologies by Transport Canada

Transport Canada (TC) has been testing advanced technologies for improving the safety of vulnerable road users around heavy vehicles. These advanced technologies warn the operator with visual and audio warnings when pedestrians and cyclists are at risk. This research is aimed at preventing cyclist and pedestrian collision with heavy vehicles in many collision scenarios.

Testing has been conducted at TC’s Motor Vehicle Test Centre in a controlled environment exploring various technologies such as radar, ultrasound, camera, as well as a combination of these tools. With the collaboration of several cities across Canada, the performance of these systems will be further evaluated in real world settings. The intent is to evaluate their operation for a full year and gather data on their performance across different conditions, e.g. Canadian weather, driving conditions and driver acceptance.

### Warning Signs / Decals at Rear of Heavy Vehicles

#### Description

**Groups Affected**
- Vehicles

Warning signs (decals) at the rear of vehicles could advise cyclists and other vulnerable road users to avoid riding and/or passing trucks along the passenger side. As most designated bike lanes / tracks are installed along the right curb of the roadway, this design invariably funnels cyclists along the passenger side of vehicles, where they are at greater risk of becoming involved in a collision, especially with a right-turning vehicle.\(^{39}\)

(See [Segregated Bicycle Lanes](#))

**Issues / Evidence**

The documentation reviewed did not provide evidence supporting the successful implementation of this countermeasure.

**Barriers / Considerations**

Lafarge Canada Inc. had committed to installing cyclist warning signs on all its owned commercial vehicles across Eastern Canada by the end of 2015.\(^{39}\)
Part II: Non-Specific to VRUs and Heavy Vehicles

Daytime Running Lights on Bicycles

**Category:** Vehicle Technology/Equipment

**Description**

**Groups Affected**

- Vehicles (Bicycles)

These are new types of bicycle lights that are permanently affixed to the bike and powered by magnetic induction from magnets fixed to the spokes. (38)

A daytime running light is an automotive lighting and bicycle lighting device on the front of a road-going motor vehicle or bicycle, that automatically switches on when the vehicle is moving forward. The lights emit white, yellow, or amber light to increase the visibility of the vehicle during daylight conditions. (Definition taken from Wikipedia)

**Issues / Evidence**

**Jurisdictions Studied**

- OECD (35+ countries)
- E.U.

In a Danish study in 2005, nearly 2,000 cyclists in the town of Odense used the new induction (running) lights (flashing type) for one year, while 2,000 others continued with ordinary bike lights, which were only turned on during dark hours. The crash frequencies (based on self-reported collisions) were then compared and analyzed. The use of daytime running lights were associated with a reduction in the number of crashes by more than 30%. The number of related crashes (crashes in daylight and with a counterpart) decreased by approximately 50%. (38)

**Barriers / Considerations**

The Danish study may not have controlled for all factors and makes no findings on the safety effects of flashing versus steady lights. (38)

While most collisions occur during daylight (when there is likely to be more cycling), a significant share occur in unlit or low light conditions, especially in the U.S. where these crashes account for nearly half of all fatal crashes. (38)

Increased Conspicuity and Visibility of Pedestrians / Cyclists

**Category:** Policy/Legislation/Regulation; Enforcement; Education; Communications

**Description**

**Groups Affected**

- Pedestrians
- Cyclists
- Drivers

Driving on a typical major road is a complex activity, involving processing large amounts of visual information, which continuously changes, and making decisions at speed. The amount of visual information in road environments is increasing, resulting in a road environment that is increasingly prone to ‘visual clutter’, that is, visual information presented in road environments in the forms of advertisements, billboards, road signs, vehicle traffic, buildings and other infrastructure, etc. (6)

While crashes are usually complex events with a mix of causal factors, it is clear that crashes between vehicles and pedestrians are overrepresented at night and there is strong evidence that visibility issues are a key factor. (43)

Pedestrians and cyclists can take measures to increase their visibility to drivers and thus, in some cases, decrease their risk of being hit by a motor vehicle. Visibility aids
include reflective clothing and flashing lights for both pedestrians and cyclists\(^{(14)}\) and help to ensure visibility of pedestrians wanting to cross [the road].\(^{(3)}\)

In addition, there are conspicuity treatments for large vehicles, such as lamps, reflective devices, and associated equipment.

**Issues / Evidence**

Analyses of crash databases have determined that the increased incidence of crashes involving pedestrians at night is primarily a consequence of lower illumination rather than other factors that vary between day and night, such as driver fatigue and the use of alcohol.\(^{(43)}\) While driver age affects accuracy in identifying pedestrians, actual pedestrian motion significantly affected their recognition (or conspicuity). However, the main effect of clutter was not significant.

Research has repeatedly demonstrated that pedestrians are even more conspicuous to drivers at night when reflective material is attached to the pedestrian’s major moveable joints rather than to their torso. The conspicuity benefit associated with these limb markings has been attributed to our perceptual sensitivity to the distinctive patterns of “biological motion” that are associated with normal human gait.\(^{(43)}\)

In contrast to the widely reported conspicuity benefits that biological motion configurations provide, one previous study failed to find a conspicuity advantage associated with biological motion. Those authors suggested that biological motion configurations may not be effective when the pedestrian is surrounded by visual clutter. The present study addressed this issue explicitly. Three patterns in the present data confirm that clothing configurations that include reflective markings on the limbs offer conspicuity advantages that are both significant and substantial, even in the presence of visual clutter.\(^{(43)}\)

**Barriers / Considerations**

Almost half of cyclists and pedestrians killed in motor vehicle crashes are under the influence of alcohol or drugs. It is unlikely that efforts to encourage these people to use lights or reflective clothing will be particularly effective.

Caution should be taken when promoting the use of reflective clothing with respect to increasing the visibility of pedestrians around heavy vehicles. Studies on the impact of retro-reflective clothing have typically been performed with automobiles. The effectiveness of reflective materials will be less with heavy vehicles due to the greater distance between the driver’s eyes and the headlights. There is also evidence that people overestimate the effectiveness of safety equipment such as reflective clothing, resulting in them potentially taking more risk.

It is important to undertake a critical review of the existing traffic codes, to add, edit or rewrite rules that do not consider the safety of pedestrians or that cause too many constraints on them (or other vulnerable users). The traffic rules and standards applied by authorities should ensure visibility, predictability and the moderation of vehicle speed wherever pedestrians and vehicles use the same road, and especially where drivers approach a pedestrian crossing.\(^{(3)}\) (See countermeasures under Rules of the Road, Speed and Communications, Awareness and Education)

Education campaigns sufficient to reach and change the behavior of a significant portion of the population are costly. Before undertaking a campaign to encourage people to improve their visibility, the costs and benefits of other measures including infrastructure improvements should be considered.
ANNEXES
ANNEX I: NEW COUNTERMEASURES

The following new countermeasures were identified as a result of an ongoing literature review. At this time only the titles are included:

- Collision Avoidance Warning System
- Fleet Safety Accreditation Program
- Fleet Safety Forum
- Improved Side Vision
- Integrated Camera-Mirror System for Buses
- Safe Fleet Transition Plan
- Safer Vehicles Policy
- Turn Assist System for Heavy Vehicles
- Visibility Modelling for Trucks
ANNEX II: CANADIAN REFERENCES—BEST PRACTICES AND GUIDELINES


# Annex III: Assessment Tool

## Vulnerable Road Users (VRU) and Heavy Vehicles Countermeasures Project

### VRU Countermeasures Assessment Tool

#### Anchor Question

What countermeasures can be implemented to encourage/foster an increasingly safer environment for Vulnerable Road Users (VRUs) – that is, pedestrians and cyclists – as they manoeuver city streets and share space with heavy vehicles?

#### Section One: Countermeasure

<table>
<thead>
<tr>
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#### Countermeasure Category (check all that apply):

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<th>Vehicle Technology/Equipment</th>
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<td>Education/Training*</td>
<td>Communications/Awareness*</td>
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<tr>
<td>Other</td>
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* Communications/awareness countermeasures will apply to a broader audience; education/training countermeasures will be more effective if they are targeted at a particular audience.

#### Considerations *(check all that apply):*

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<td>Legal</td>
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<tr>
<td>Demographic</td>
<td>Jurisdictional</td>
<td>Future Consideration</td>
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</table>

#### Comments:

* Education/Training countermeasures may have demographic considerations. For example, attention will need to be given to the differing delivery channels and needs that could be targeted to adults/parents, young drivers, seniors, etc.

#### Countermeasure intended to affect: (check all that apply)

<table>
<thead>
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<th>Pedestrians</th>
<th>Cyclists</th>
<th>Vehicles</th>
<th>Drivers</th>
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<td>Children</td>
<td>Youth</td>
<td>Adults</td>
<td>Seniors</td>
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#### Jurisdictions where work (study) completed:


#### Number of jurisdictions, if applicable:


---

*As of 01/01/2023.*
### SECTION TWO: Performance Measures

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<th>Question</th>
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<td>1. Were any evaluations, cost/benefit analyses, or cost effectiveness analyses conducted?</td>
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<tr>
<td>2. If no, what evidence supports the inclusion of the countermeasure?</td>
<td></td>
<td></td>
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<tr>
<td>3. If yes, please indicate the author, title, source, and/or web-link where the cost-benefit, statistical, or other evidence-based analyses can be located. (Include evidence such as real-life experience, field or lab tests, etc.)</td>
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### SECTION THREE: Evidence and Evaluation

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<td>4. Barriers and considerations for implementation. Please identify any barriers or concerns that may hinder the implementation of this countermeasure.</td>
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<td>5. How would you rate this countermeasure, based on the research? Provide comments and your rating (using the rating guide below).</td>
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**Rating:

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<td>★★★★★</td>
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<tr>
<td>Demonstrated to be effective in certain situations</td>
<td>★★★★</td>
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<tr>
<td>Likely to be effective based on balance of evidence from high-quality evaluations or other sources</td>
<td>★★★</td>
</tr>
<tr>
<td>Effectiveness still undetermined; different methods of implementing this countermeasure produce different results</td>
<td>★★</td>
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<tr>
<td>Limited or poor-quality evaluation evidence (descriptive studies, case studies, expert opinion, studies of poor methodological quality)</td>
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# ACRONYMS

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<td>APS</td>
<td>Accessible Pedestrian Signals</td>
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<td>ASL</td>
<td>Advanced Stop Lines</td>
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<td>CAA</td>
<td>Canadian Automobile Association</td>
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<tr>
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<td>Canadian Council of Motor Transportation Administrators</td>
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<td>Ontario Traffic Manual</td>
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<td>Pedestrian Scramble Operations</td>
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