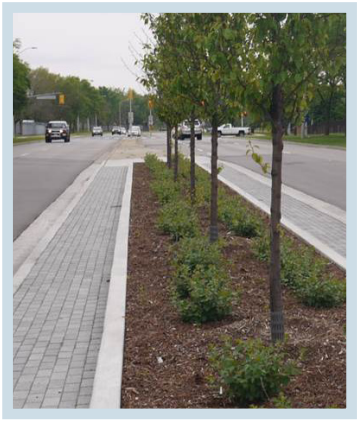
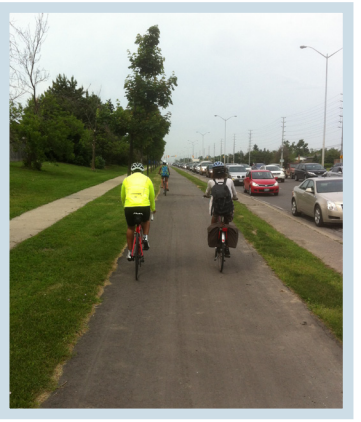
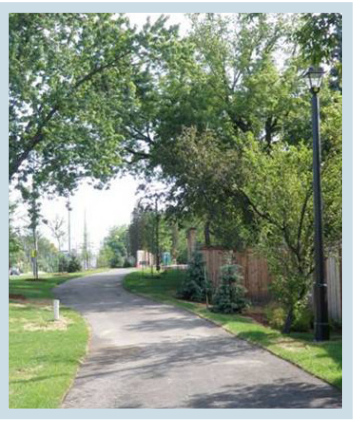
Region of Peel
Working for you

CVC | CREDIT VALLEY CONSERVATION

Streetscaping Toolbox Update

September 2017

This Page Intentionally Left Blank

Acknowledgements

The Region of Peel Transportation and Public Health departments and Credit Valley Conservation have partnered to update the Streetscaping Toolbox. Discussion, review and suggested improvements to the document were provided by internal staff at the Region and CVC and externally by our local municipal partners and the Toronto Region Conservation Authority. This document was updated through the collaborative efforts of Natalie Lapos, Public Health; Samantha Paquette, Credit Valley Conservation; and Liz Brock,Transportation. We would like to acknowledge and thank the following for their contribution:

Region of Peel

Public Works

Transportation - Infrastructure Programming and Studies, Road Design and Construction, Traffic Engineering, Road Operations and Maintenance,
Transportation Planning, Sustainable Transportation
Engineering - Development Services
Water/Wastewater - Program Planning
Operations Support - Environmental Education
TransHelp - Accessible Transportation

Health

Public Health - Chronic Disease and Injury Prevention

Corporate Services

Research and Analysis, Real Property Asset Management
Clerks - Accessibility Planning Program

Credit Valley Conservation

Office of the CAO, Corporate Services, Watershed Knowledge, Watershed Management, Watershed Transformation, Planning and Development Services

Toronto Region Conservation Authority

Planning & Development - Environmental Assessment Planning

City of Brampton

Public Works & Engineering, Street Lighting, Traffic Services
Heritage, Planning and Development Services
Capital Parks Construction, Parks Maintenance & Forestry Division
Brampton Transit
Long Range Transportation Planning

Town of Caledon

Community Services - Open Space Design, Parks Management, Planning and Development

This Page Intentionally Left Blank

Table of Contents

List of Tables

Cross Ride in Caledon East (Source: Region of Peel)

Section 1: Introduction

Introduction

Streetscaping Toolbox Update 2017

The updated Streetscaping Toolbox takes direction from the 2015-2018 Strategic Plan vision "Community for Life". Thriving, integrated, safe and complete communities are realized in part through the Council priorities to:

- Adapt to and Mitigate the Effects of Climate Change;
- Improve Goods Movement; and
- Promote Health and Age-friendly Built Environments.

Since 2011 when the original Streetscaping Toolbox was completed, new transportation infrastructure has been built or is planned such as roundabouts, bicycle lanes, cycle tracks and green infrastructure. Green infrastructure refers to natural and humanmade elements that provide ecological and hydrological functions and processes. Green infrastructure can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs. The Toolbox Update addresses how to design for or incorporate streetscaping for these new types of infrastructure.

This update is an opportunity to align the Toolbox with the Council-approved Road Characterization Study[2] (RCS) while providing a user-friendly and practical document that provides greater detail about how to design the streetscape in Regional right-of-ways.

Population growth in Peel and the resulting congestion continue to present major challenges for planners and engineers to maintain traffic functionality while addressing the needs of road users (pedestrians, cyclists, transit, cars and goods movement).

It is important that Regional roads meet the needs of all users including those:

- who use transit, walk and cycle;
- with disabilities; and,
- transporting goods.

Current issues, such as addressing climate change and improving health outcomes have driven the review of how transportation infrastructure can support health and the environment. Recent extreme weather events have impacted both Regional infrastructure and personal property with resulting damage and losses.

The provincial government is currently conducting a policy review of municipal stormwater management. In April 2016, the Ministry of the Environment and Climate Change

(MOECC) report "Policy Review of Municipal Stormwater Management in Light of Climate Change" recommended that municipalities identify measures that encourage source control best practices for municipal stormwater management[3].

The MOECC also released an interpretation bulletin in February 2015 that states "the natural hydrologic cycle should be maintained to the greatest extent possible". The Ministry's existing acts, regulations, policies and guidelines emphasize the need for this approach to stormwater management"[4]. The MOECC bulletin will be followed by requirements to provide volumetric control on all development and major redevelopment projects including linear projects.

To ensure that the Toolbox Update addresses the current issues of climate change, improving health outcomes and incorporating streetscaping for new types of transportation infrastructure, a partnership was created between Transportation, Public Health and Credit Valley Conservation. The team conducted an extensive scan of current transportation planning policies, updates to applicable Region of Peel policies, best practices, guidelines to identify gaps within the 2011 Streetscaping Toolbox and the opportunities for improvement. Information on policy changes since 2011 is provided in Appendix G.

The Toolbox Update will be used as a reference tool by Region of Peel staff including Public Works, Public Health, Integrated Planning, Development Services, local municipalities, consulting engineers and planners, and the development community.

The Toolbox Update will provide streetscaping guidance for:

- master plan studies;
- environmental assessments;
- land use plans and development applications;
- road construction projects;
- health initiatives;
- green infrastructure; and,
- roads maintenance activities such as tree replacements and rehabilitation of existing landscaping.

This Toolbox does not override local municipal streetscaping policies but aims to work with the municipal vision for specific land uses, by enhancing the streetscape appearance and character while improving active transportation infrastructure and incorporating green infrastructure.

Consultation with regulatory agencies must be carried out for each project using the most current

policies and guidelines so that restoration/ compensation for losses can be determined.

The Toolbox works with Region of Peel design criteria, design standards and specifications, standard operating procedures and guidance documents.

The objectives of the Toolbox Update are to:

- identify opportunities to optimize the streetscape to support active transportation, place-making, the built environment and environmental sustainability;
- provide guidance on the selection and placement of streetscaping elements with consideration for operations and maintenance and the various activities found within the Region of Peel road right-of-way in a balanced and sustainable manner; and,
- provide guidance on appropriate maintenance activities and best practices to support the health of its streetscape plantings and green infrastructure.

The Region of Peel Transportation System

The Regional road right-of way is a public place that is used for a variety of activities including walking and cycling (active transportation), the transportation of goods (goods movement) and motorized travel (including transit and individual vehicles). The road right-of-way connects people to their destinations.

It is also the location for public services such as hydro, watermains, sanitary and storm sewers, and telecommunication services, which are conveyed above and below ground to the greater community. The road right-of-way also acts as a conveyance system for stormwater during major storm events.

Peel's transportation system consists of expressways, highways, major arterial roads, collectors, local roads, active transportation facilities, and public transit systems that link communities within the Region to the Greater Toronto Area and destinations beyond. The expressways and highways are under Provincial jurisdiction except for Highway 407, which is privately operated. Local municipalities and the Region of Peel operate the remaining roads within the network and cooperate on a Region-wide basis to plan the transportation system.

The Region of Peel's primary jurisdiction is over high-capacity major arterial roads that historically connect traffic from collector roads to expressways or highways and between urban centres or act as inter-regional commuter routes and goods movement corridors. The major arterial roads often represent the first impression of the municipality and provide a key

role in defining the character of its communities.

The Regional road lanes are a combination of two, four, and six lane facilities within a 20 metre to 50 metre right-of-way at the mid-block; with transit facilities in urban areas and multi-use trails and/or sidewalks or a combination of both on either side of the road. In addition to supporting the use of active modes of travel and transit, the roads have high design standards to facilitate large volumes of traffic at varying speeds with limited parking and controlled access.

The Region of Peel also encourages Transportation Demand Management (TDM), which is a strategy to reduce travel demand as an alternative to increasing road capacity. Reduction in travel demand can be supported through changing the mode share from single vehicle trips to carpooling, increased use of transit, active transportation and through alternative working arrangements. Effective TDM can help manage congestion and improve health outcomes.

The Regional transportation system has an important role as a multimodal goods movement hub. The Region works with the private sector and other government agencies to implement actions to make better use of roads and infrastructure so goods move efficiently through the Region of Peel. Supporting goods movement enhances competitiveness and economic well-being.

Transportation programs are directed by policies established in the Region of Peel Official Plan[5] with a goal to foster a more sustainable transportation system that:

- meets the needs and protects the safety of all users;
- considers all modes of transportation: vehicular, transit and active transportation;
- minimizes health and environmental impacts;
- improves accessibility;
- integrates land use and transportation; and,
- manages travel demand and congestion due to growth.

The Streetscape

Improving and enhancing the design quality of the streetscape is known as streetscaping. The streetscape is a combination of the natural and built elements within the road right-of-way that can define the appearance, character, and function of the street. Streetscapes can define a community's identity, enhance economic activity, improve health, safety and environmental sustainability and provide social cohesion and social opportunity. The streetscape also provides an opportunity for incorporating

green infrastructure that improves stormwater management by facilitating infiltration and reducing risk of flooding and damage to property.

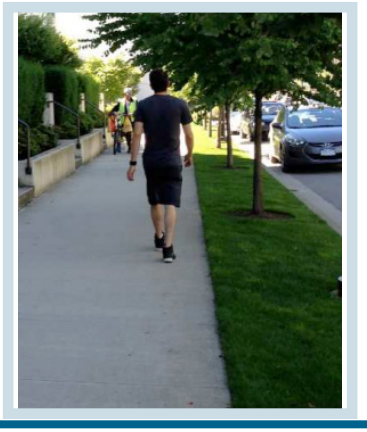
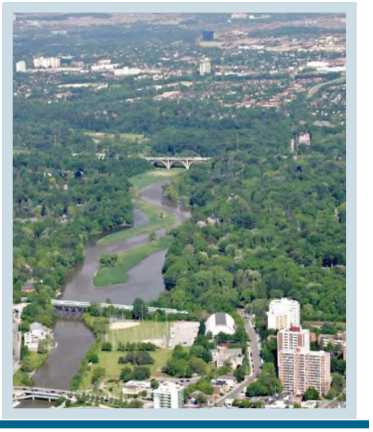
Streetscaping adds to active transportation infrastructure by creating an appealing, comfortable environment for all road users. Active transportation infrastructure can facilitate increased physical activity and improved health for residents within the Region of Peel and increasing active modes of travel has the co-benefits of reducing congestion and aiding in traffic flow.

Caledon East Gateway Feature (Source: Google Street View)

Double Rows of Trees Enhance the Streetscape (Source: Region of Peel)

Section 2: Planning and Design



Design Principles

Road Engineering

The Region's road right-of-way is made up of many elements, each of which provides a function in aiding in the safe movement of pedestrians, cyclists and vehicles. In addition to the specific design elements, there are three fundamental engineering design principles: design speed, clear zone and right-of-way width, that when applied to road designs, ensure that a reasonable level of safety is maintained.

Guidance on road engineering design is found in the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads[6] and the Ministry of Transportation Geometric Design Manual[7]. The Road Characterization Study (RCS)[2] provides direction on design speeds and lane widths for different road typologies. These documents assist road designers in applying engineering principles to the selection of appropriate combinations of features, dimensions and materials for a design.

Design Speed

Design speed is the basis for which the geometric design criteria is established. This includes horizontal and vertical alignments as well as clear zone. Vehicular safety is also determined by the roadway design speed. Regional road design speeds range from 60 km/h to 90 km/h.

The horizontal and vertical alignment criteria are based on sight and safe stopping distance as determined through research and as applied in the TAC and the MTO design manual[7]. These criteria are accepted as the standard for road design in Ontario and are not discussed further in this Toolbox.

Clear Zone

The clear zone is the unobstructed, relatively flat area beyond the edge of the traveled roadway that allows a driver to stop safely or regain control of a vehicle that leaves the road. The clear zone requirement is determined based on the design speed and the annual average daily traffic (AADT). The clear zone is important when developing typical cross sections because this will influence the location of potential hazards within the right-of-way.

Potential hazards include hydro poles, light poles and trees. In urban areas where the design speed is 60 km/h or less and the clear zone width, shown in the following table, is not practical, a barrier curb may be used to shield hazards for areas where utility poles and other immovable objects cannot be relocated.

The Optimum Clear Zone table indicates the desirable clear zone requirement for the range of speeds under which Regional roads are designed. The clear zone is measured from the edge of pavement of the through lanes. When

considering the clear zone, designers attempt to balance between the safety benefits and the economic and social implications of providing a clear zone adjacent to the road.

Table 1: Optimum Clear Zone (metres) - Annual Average Daily Traffic (AADT). Recommendations as per the MTO Roadside Safety Manual.

Design Speed km/h	AADT ≥ 6000	AADT ≥ 1500	AADT ≥ 750	AADT < 750
90	6	5	4	4
80	5	4	4	4
70	4	3	3	3
60 or less	3	3	3	3
60 or less with barrier curb	0.5	0.5	0.5	0.5

Right-of-Way Widths

The policies in the Regional Official Plan, Schedule F, outline the general right-of-way requirements for Regional roads based on Region of Peel's Long Range Transportation Plan.[5,8] The right-of-way size varies at the mid-block between 20-50 metres. The policies also support the accommodation of alternative modes of transportation such as transit, cycling, walking and other infrastructure appropriate for the planned adjacent land uses.

This Toolbox provides a methodology to determine streetscaping elements within Regional road allowances. For each Regional road right-of-way, the cross section elements can be selected that meet the requirements of the users (vehicles, cyclists, transit, pedestrians), while recognizing the potential constraint associated with the right-of-way width. The Regional road right-of-ways are summarized in Appendix A of the Region of Peel Official Plan.[5] Note that additional property requirements may be identified in an environmental assessment study. Once the right-of-way width and function of the road are known, the designer needs to determine the elements to be included in the right-of-way.

Health and Accessibility

Creating safe, accessible and inviting built environments that support active modes of travel is an important opportunity to promote health and enhance quality of life for Peel residents. The characteristics of the streetscape can significantly influence how residents use and experience the various elements in the right-of-way. For example, evidence has shown that people are more likely to walk or cycle in environments that are safe, inviting, physically and visually pleasing.[9] There are several design principles that, when applied to Regional projects, can promote the health of all road users. The design principles fall under the categories of active transportation, aesthetics

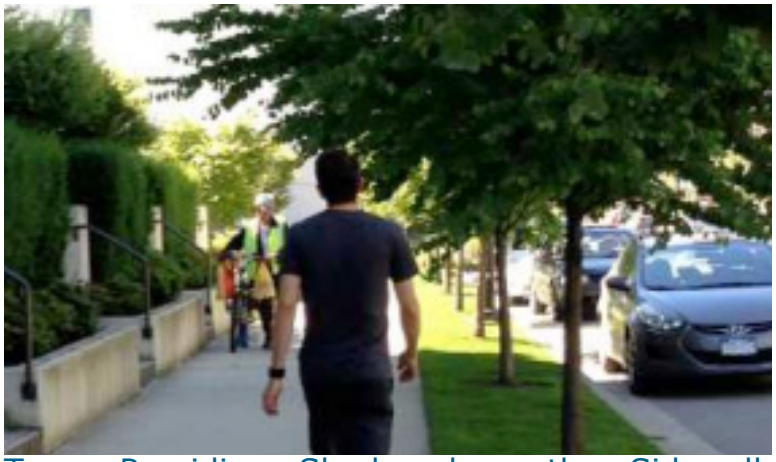
and pedestrian experience, accessible and age-friendly environments and transit.

Active Transportation

Those who travel using active means such as walking or cycling, can routinely incorporate moderate to vigorous physical activity into their daily lives. Each hour per week of moderate or vigorous physical activity is associated with a 4-9% reduction in the overall risk of death from all causes.[10] Physical activity has also been demonstrated to have a positive effect on a range of mental illnesses and can lead to improved mental health outcomes.[11] Additionally, utilitarian cycling (cycling as a means of transport to a destination rather than for recreation and leisure) for one hour or more per week is associated with greater cardiovascular fitness and reduced cardiovascular disease risk factors. Safe and comfortable active transportation infrastructure allows residents to choose healthier, more active modes of travel.

To design for active transportation, ensure that:

- Active transportation infrastructure is planned for **both sides** of the roadway.
- Intersections enhance pedestrian and cycling **visibility and crossing** as appropriate for the context (e.g. reducing crossing distance, cross-ride treatments, providing a pedestrian crossing island, removing right turn channels or moving to smart channels).
- New and existing infrastructure is **well connected** and that all infrastructure is in **good** condition.



Trees Providing Shade along the Sidewalk (Source: Region of Peel)

Aesthetics and the Pedestrian Experience

Aesthetically appealing and safe environments attract pedestrians and cyclists. Research has shown that poor aesthetics result in lower rates of cycling, whereas, higher measures of green cover have significant, positive associations with general walking trips, walking to school and lower Body Mass Index.[10] An aesthetically pleasing public realm has also been associated with increased physical activity among older adults.[10,12]

Design elements within the right-of-way can create a more pleasant experience and increase perceptions of safety for pedestrians. These elements include trees that provide shade; adequate lighting that is pedestrian-scaled (no higher than 4.6 metres); curb cuts in transitions from sidewalks to crosswalks; and the separation of all travel modes with a physical barrier, including separated cycling and walking infrastructure. To design for aesthetics and the pedestrian experience, ensure that:

- tree cover is planned over active transportation infrastructure (including sidewalks) to provide shade (trees that will grow greater than or equal to 15m tall at maturity);
- separate walking and cycling facilities from traffic using a physical separation and, where possible, separate walking and cycling infrastructure; and,
- identify opportunities to beautify the streetscape by using pedestrian scaled features, plantings and design elements including adequate pedestrian-scaled lighting.

Cycling Within the Regional Right-of-Way (Source: Region of Peel)

Accessible and Age-Friendly Environments

While provincial legislation sets design standards to ensure that public spaces including exterior paths of travel are accessible for those with disabilities[13], many of these same design considerations have been shown to increase physical activity, particularly among older adults[12].

Opportunities exist within the Regional right-of-way to further enhance accessibility. For example, including pedestrian crossing islands designed to AODA standards on roadways with wide cross sections is an enhancement to the Act requirements. Pedestrian crossing islands may also serve to calm traffic as pedestrians may appear more prominent and travel lanes visually narrowed.

To design accessible and age-friendly built environments ensure that:

- all standards and technical requirements are followed set by AODA[13];
- roadways are designed with shorter crossing distances or consider the use of pedestrian crossing islands/staged crossing in areas located close to areas such as schools, senior homes and community centres;
- the use of pedestrian crossing islands on roads of four lanes or wider are considered;
- steep slopes are avoided where possible (greater than 1:20); and,
- AODA improvements are provided at intersections such as countdown signals/ curb cuts/truncated domes.

Cultural Heritage Resources

Cultural Heritage Resources are part of the aesthetics of the streetscape and contribute to human scale architecture, thereby fostering alternative modes of transportation. Cultural Heritage Resources can provide inspiration for the design elements of a streetscape such as lighting and street furniture (e.g. benches, receptacles, art). Designers should consult with local municipalities when determining the placement of street furniture and the use of streetscaping that complements the use and access to cultural heritage resources.

Derry West Cemetery - Corner of Derry Rd and Hurontario Street (Source: City of Misissauga)

The Gore Rd at Ebenezer Rd - Heritage Community Hall (Source: Google Street View)

Pedestrian Crossing Island. (Source: Region of Peel)

Transit

The Region of Peel operates TransHelp, an accessible transit program and the local municipalities operate local transit programs. It is a Regional priority to ensure designated spaces for transit vehicles and passengers within all infrastructure projects. The Region of Peel works with its local municipal partners to construct transit facilities such as queue-jump lanes and transit stops along Regional roads in conjunction with road improvement projects. Typically, those who use transit walk more per day in order to access and disembark the transit network. In addition to the benefits of this added daily physical activity, transit use also decreases transportation related air pollution.[10]

To design for transit ensure that:

- Region of Peel projects are coordinated with local municipal transit providers to maximize opportunities to prioritize transit; and,
- active transportation infrastructure is wellmaintained and is connected to transit stops and stations.

TransHelp vehicle. (Source: Region of Peel)

Transit corridors are implemented by area municipalities as part of their transit plans. Transit corridors are often located along Regional roads as they help manage congestion and promote economic development.

Designers should consult with the local municipality on design requirements for transit

stops ensuring that bus pads are large enough to be accessible with a walkable surface and include shelter, benches, waste/recycling containers and a bus flag.

Specialized approaches to streetscaping may be required on transit corridors due to the high volume of pedestrian and cyclist traffic associated with surface rapid transit routes. Designing dedicated active transportation facilities and transit lanes limits conflict points between transit vehicles, other vehicles, pedestrians and cyclists.[14]

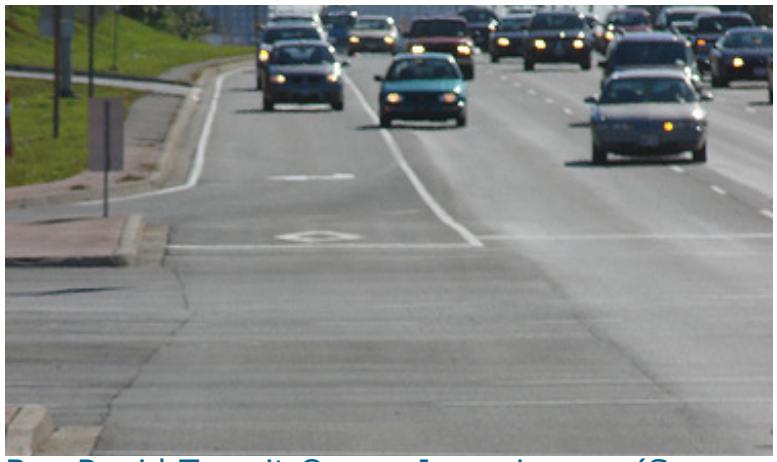
Proposed Light Rail Transit (LRT) along the Highway 10 Corridor will Intersect Regional Roads. (Source: Metrolinx LRT Concept)

High quality active transportation facilities (such as raised cycle tracks, two-way cycle tracks and pedestrian walkways) complement rapid transit in the corridor by allowing users to comfortably access and disembark the transit system using active means, thereby limiting the need for surface parking.

MiWay Bus with Bike Rack. (Source: City of Mississauga)

Signal timing and prioritization are important considerations on corridors where rapid transit vehicles operate in mixed traffic. These considerations will help ensure that transit vehicles move efficiently throughout the corridor[14].

In the Region of Peel, Bus Rapid Transit (BRT) is in place on some Regional roads and Light Rail Transit (LRT) is being implemented on roads where segments are part of the Regional road network.



Bus Rapid Transit Queue Jump Lanes. (Source: Region of Peel)

Green Infrastructure

Managing Stormwater Holistically

Green infrastructure technologies are practices that can be implemented using the integrated One Water approach. One Water is an integrated water management approach that incorporates and mimics the natural hydrologic cycle. It looks at drinking water, wastewater and stormwater holistically, at a watershed scale. Principles include harvesting stormwater as a resource, water conservation, climate change and carbon sequestration, and infrastructure resiliency.

Green infrastructure should be a priority in the design of innovative and creative stormwater management systems such as Low Impact Development (LID) in road right-of-ways. LID is a design approach that focuses on restoring and preserving water quality and maintaining pre-development hydrologic processes by implementing techniques to manage stormwater as close to its source as possible.

LID techniques can:

- reduce or even eliminate pollutants in stormwater runoff from impervious surfaces;
- regulate surface flow patterns and recharge rates; and,
- be connected to form a treatment train that can replicate a natural system.

For more information, refer to Region of Peel stormwater management guidelines and criteria.

Using green infrastructure for stormwater management can lessen future economic, social and environmental impacts of development while creating a safe, attractive, efficient and sustainable urban transportation network by managing polluted stormwater and achieving a cleaner, greener watershed. Each Regional road is unique with different opportunities and challenges for using green infrastructure.

Green Infrastructure Installation within Median (Source: Credit Valley Conservation)

To design green infrastructure for stormwater management in road right-of-ways:

- The overall stormwater management system must meet stormwater criteria established by the Region of Peel, and permitting agencies, such as water quality, erosion, peak flow, volume reduction and thermal mitigation.
- Consider a treatment train approach where multiple practices are connected together to provide enhanced treatment.
- Maximize landscaped areas and minimize hard surfaces (e.g. minimize lane widths where possible or hardscaped pedestrian areas).
- Minimize impermeable hardscaped areas by using permeable materials such as porous concrete and porous asphalt for the sidewalk or multi-use trail.
- Direct drainage from hardscaped areas such as sidewalks or multi-use trails to landscaped areas such as bioswales and bioretention cells or subsurface infiltration facilities.
- Consider designs that reduce the need for de-icing applications and implement a pollution prevention plan to reduce impacts to the watershed.
- Consider the use of pre-treatment practices before runoff enters green infrastructure facilities.
- Consider side inlet catch basins as a preferred design, from a cycling safety perspective.
- Consider pollution prevention techniques such as snow melting systems for platforms or sidewalks to reduce salt and using infrastructure at intersections to contain spills.

Street Trees and the Urban Forest

Street trees form green networks within the urban forest that provide social, economic and environmental benefits to the community. Street

trees represent a relatively small proportion of the urban forest; however, the resource is of elevated importance due to its proximity to impervious surfaces and the number of lanes that service high traffic volumes[15].The ecosystem services provided by street trees include mitigating and adapting to climate change and urban heat island effects, improving air quality, mitigating the timing and volume of stormwater runoff, erosion control, decreasing residential energy costs, increasing the lifespan of grey infrastructure and enhanced aesthetics and property values[16].

Planning for healthy trees, shrubs and perennials and the long term maintenance and sustainability of these components of the streetscape is a vital part of streetscape design. The most common causes of premature tree mortality are a lack of water, stress and physical restriction to root and canopy development. Poorly drained soils, highly compacted soils, alkaline soils, salt spray and salt laden runoff also negatively affect tree growth. These are typical growing conditions of the right-of-way in an urban environment.

Regional road right-of-ways typically constitute a harsh environment that makes it difficult to establish, grow and maintain the health of trees, shrubs and perennials. Often trees are considered as an afterthought in the design process without proper consideration being given to the appropriate tree species and ideal conditions needed for them to thrive. The Toolbox Update addresses this issue by providing planting standards and maintenance practices in Appendix A. Choosing the right trees and monitoring their health may reduce the amount of tree loss.

Newly planted trees failing to thrive along a Regional road. (Source: Region of Peel)

Region of Peel Urban Forest (Source: Peel Region Urban Forest Strategy)

Trees planted using updated Region of Peel standards (Source: Region of Peel)

Design Process

Project Planning and Scheduling

The Region of Peel's Long Range Transportation Plan (LRTP) provides direction to staff on projects that need to be accomplished to meet Regional goals including relieving traffic congestion and planning for growth.[8] The LRTP is a master planning process that:

- ensures Transportation planning decisions are made within the context of changes in provincial legislation and general transportation and land use trends;
- serves as input to studies including environmental assessments (EA); and,
- supports transportation policies in the Regional Official Plan.[5]

Improvements to the Regional road right-of-way are often precipitated through the environmental assessment process which helps to determine what changes need to take place, if any, based on identified problems and opportunities. The Long Range Transportation Plan sets the timing of the implementation of Regional road projects.

Environmental Assessments

The Environmental Assessment (EA) process is used to determine what priorities can reasonably be achieved within a defined right-of-way. The EA process includes consultation with stakeholders and establishes existing conditions, evaluates planning solutions, recommends a course of action, evaluates solutions to achieve the preferred recommendation, documents the process and communicates the findings to stakeholders. This Toolbox Update is useful as a reference tool in the EA process in conjunction with consultation with provincial agencies.

When the project moves to detailed design, the Toolbox Update is used to provide guidance on the type and location of elements within the road right-of-way. Streetscaping and landscaping plans are completed at this stage.

Low Impact Development (LID) Implementation Process for Regional Roads

The LID Implementation Process for Regional Roads report provides the generalized approach that Regional municipalities should follow for implementing LID in the Regional road right-of-ways (retrofit and/or new design).[17]

The report outlines ten (10) steps to be followed, information required to complete each step and provides specific details that relate to past projects. The ten steps can be refined by Region of Peel staff as subsequent LID projects are implemented and internal efficiencies are identified.

The ten step process has been developed for the Region of Peel with the intent to serve as a template process for future right-of-way projects that include LID with the goals of:

- overall improvements to the health of the watershed; and,
- compliance with the Peel Climate Change Strategy.[18]

Step 1: Building the Project Team

Identify core and support project team members and the project phases as their expertise will be required. Define the project goals and objectives, develop a Request for Proposal (RFP) to hire an experienced consultant, and determine the need and extent of any public consultation requirements.

Step 2: Site Evaluation and Field Reconnaissance

Review all relevant background documents from agencies, municipality, etc. Conduct field reconnaissance to verify site conditions and identify constraints and data gaps.

Step 3: Screening the Options

Screen the preliminary LID options based on the type of right-of-way construction, the type of Regional right-of-way cross section, project cost and site specific criteria.

Step 4: Pre- Design

Collect field measurements to build on information gathered during the field reconnaissance and background document review.

Step 5: Detailed Design

Develop a detailed design using a multi-step approach that utilizes the information gained through the previous steps.

Step 6: Approvals

Review municipal, government and agency policies to ensure compliance and identify the application process for obtaining approvals.

Step 7: Tender and contract

Develop tender packages that include review of detailed design drawings, the development of specifications, detailed cost estimates, schedule of items, and contractual documents.

Step 8: Construction Supervision and Administration

Provide supervision and guidance as necessary during construction. Document site activities while maintaining client relations.

Step 9: Certification and Verification

Verify accuracy of constructed elements and review any monitoring in order to evaluate

performance including the development of deficiencies lists to be rectified by the contractor prior to municipal assumption or issuance of final approval.

Step 10: Lifecycle Activities

Develop standard operating procedures to guide Operations and Maintenance staff on short and long term operation and maintenance strategies.

Designing within Regulated Areas

Where road works occur within or immediately adjacent to significant natural features (natural heritage systems, significant woodlands, and valleylands, watercourses, wetlands, flood plains, Peel Core Greenlands, etc.), impacts to these features should be avoided and/or minimized and planting plans should use commmon native species found within the relevant watershed. Restoration or compensation may be required for any impacts to natural heritage systems beyond the addition of streetscape trees.

Directional downcast lighting should be used in areas adjacent to natural features in order to minimize potential impacts to wildlife. Proper consultation is required with all applicable agencies.

Operations and Maintenance - Designing with the End in Mind

Streetscape assets that require maintenance include green infrastructure, street trees and plants, street furniture, lighting and active transportation infrastructure. Streetscape design should begin with the end in mind, which is the assumption of the asset by the municipality.

Good maintenance practices extend the life of the asset, until eventually all assets are replaced at the end of their lifecycle. Operation, maintenance and lifecycle costing of streetscape assets must be considered at the beginning of the design process. Standard operating procedures should be created for new infrastructure with input from maintenance staff as part of the design process. Involving maintenance staff in the design helps them evaluate if special training and equipment or additional resources are required. Information on maintenance procedures and estimates of operating costs of assets should be provided to staff for their budget preparation and forecasting.

Trees, plants and green infrastructure must be adequately inspected at the time of installation and maintained over the life of the asset; otherwise performance will decline until the

asset no longer functions as intended. Plant lists, planting specifications, and procedures are provided in the appendices.

Operations and maintenance practices for green infrastructure is not addressed in this document but a link is provided to a current guidance document from the Toronto Region Conservation Authority:

http://www.sustainabletechnologies.ca/wp/home/urban-runoff-green-infrastructure/low-impact-development/low-impact-development-stormwater-practice-inspection-and-maintenance-guide/

Road Construction

The choice of streetscaping approach will depend on many factors starting with the type of construction project. Opportunities to incorporate streetscaping into right-of-ways will likely come as a result of planned road works projects including road resurfacing and more extensive road reconstruction[14].

Successful and cost effective streetscapes are best incorporated into road construction projects and with other major utility replacements within the right-of-way. This allows for shared resources such as construction equipment, materials and project staff. It also ensures that the roadway is not closed to the public for additional periods of time[14].

Each project type presents different opportunities to incorporate streetscaping into the right-of-way. The four most common types of road construction are:

- Resurfacing;
- Reconstruction;
- Widening and New Construction; and,
- Intersection Improvements.

Resurfacing

Resurfacing projects involve removal and repaving of the road surface, to restore it to a state of good repair. Resurfacing projects are scheduled as part of lifecycle maintenance and provide limited opportunity to add improvements to the streetscaping, as most of the works focus on the road itself. Changes such as re-striping of roads to accommodate intersection improvements, the addition of street furniture or planters or the upgrade of active transportation facilities such as cycle crossings or bike boxes already planned may be combined with a resurfacing project.

Reconstruction

Reconstruction projects may involve improvements to the entire right-of-way, including road base and surface, curbs, storm inlets, lane reconfiguration, road alignment and

may increase or reduce the number of lanes or width of lanes.

Reductions in the number of lanes on arterial roads rarely happens, as arterial roads are meant to carry large volumes of traffic. However, reductions could be planned as part of a transportation demand strategy. Reducing the width of roadway lanes may be used as a means of slowing down traffic speed while keeping the same number of lanes.

Road reconstruction projects may be linked with complementary projects such as the replacement of utilities, including water and wastewater infrastructure and upgrades to active transportation and accessibility infrastructure. Road reconstruction projects provide opportunities to improve traffic, beautify streets, improve active transportation facilities and add green infrastructure.

Widening and New Construction

Widening is the addition of lane(s) identified through the environmental assessment process for a defined section of roadway in order to address capacity related issues. Widening projects provide the most suitable platform for implementation of new streetscaping infrastructure such as bike lanes/cycle tracks and multi-use trails as well as green infrastructure to address stormwater management. New construction is the construction of a new arterial road within a "Greenfield" (undeveloped) site. New greenfield arterial roads happen rarely but provide the greatest opportunity to provide a complete street, including streetscaping features.

Intersection Improvements

One of the challenges faced by road designers within high volume Regional corridors is the imposing width of the traveled roadway. Wide intersections created to accommodate up to 6 lanes of traffic, left and right turn lanes and transit priority lanes result in a substantially wider pavement width. These wider sections are also less hospitable to pedestrians and may require longer crossing times. The road intersection is a complex space with many actions happening at the same time.

Intersection projects may be a part of a road resurfacing, widening or rehabilitation project or a separate project identified for improvement from traffic planning studies. Intersection improvement projects follow the environmental assessment process. Intersection projects may require the addition of separate turning lanes, changes to crossing facilities, pavement improvements (for example a different pavement cross section for goods movement corridors), changes in location of active transportation lanes at intersections due to multiple movements and limits to the right-of-way size, transit facilities (such as far side bus bays), changes in pavement

markings and safety features (such as ladder crossings), bike boxes to accommodate cyclists turning left, countdown signals (both visual and auditory), AODA infrastructure (such as truncated domes at the edge of curb and curb cuts) and the use of a safety island for staged crossing.

Corners of intersections may function as public gathering places, serve as a gateway feature, or be used for wayfinding signage or public art. Intersection boulevards may contain waste receptacles, signage, bike racks and seating adjacent to high traffic areas and transit. Sufficient lighting must be be provided to ensure pedestrian safety.

Multiple priorities within the intersection pose a challenge to designers on how to accommodate all needs and improve streetscaping while ensuring pedestrian safety, working with utility placements and maintaining vehicle turning sight lines. This means that adding trees and green infrastructure may be limited at intersections. Substantial street plantings, such as gateway treatments, often occur outside of the Region's right-of-way and must meet safety guidelines.

Designers must consider the following infrastructure with intersections:

- transit stops and bus bays;
- gateway treatments;
- pedestrian crossing infrastructure, including for those with disabilities, and cycle crossings; and,
- green infrastructure such as permeable paving.

Utilities

The Regional road right-of-way is the location for public utilities such as hydro, water, sanitary sewage, storm water, and telecommunication services which are conveyed both above and below ground to the greater community. Establishing fixed locations within the road allowance for each utility is not always possible. However it is desirable for maintenance and to minimize expensive repair to roadways that utilities are placed within the boulevard. This practice also may present challenges to implementing green infrastructure and growing trees. For larger projects, site assessment using 3D utility modeling is useful to determine placement of green infrastructure and trees.

Hydro Lines

Overhead hydro lines require clearances which restrict the size of trees that can be grown under them so that branches do not interfere with the active hydro lines. Clearance zones were negotiated between the Region and its utility providers prior to the Road Characterization Study process. These negotiated clearance

zones significantly impact the Region's ability to plant large trees within its right-of-ways. Given the competing interests for space within right-of-ways and the importance of trees for supporting community identity, influencing walkability, creating habitat and reducing the urban heat island effect, designers should work with utility providers to ensure trees can be planted adjacent to sidewalks and multi-use trails while maintaining the use, functionality, and accessibility of overhead utilities. See Appendix E for a list of recommended plants within the hydro clearance zone.

When designing green infrastructure and adding streetscaping, it is advisable to:

- conduct a thorough investigation of all utilities during preliminary design;
- consult with each utility on layouts that allow room for future stormwater infrastructure and trees; and,
- seek compromises that maintain soil volume to help trees flourish.

Major Hydro Corridor Dixie and Matheson (Source: Google Street View)

Tree Planting Priority Tool

The TPPT is a Regional Geographic Information System (GIS) based mapping tool developed to identify and prioritize opportunity areas for tree planting within Peel's urban areas based on environmental, economic, and social benefits that trees in these areas could provide (Beacon Environmental, 2015). The tool was developed to help guide planting efforts throughout the whole Region (not just within Regional road right-of-ways) in order to ensure that plantings are implemented strategically to provide the greatest benefits, as well as to ensure cost-effectiveness.

The TPPT prioritizes plantings at three defined geographic scales, Ward level, Peel's Service

Delivery Areas (SDA), and Dissemination Areas (DA), however it does not replace the decision-making process required for site specific planting plans, such as tree species selection (Beacon Environmental, 2015). Dissemination Areas (DAs) have a population of about 500 people and are based on the area that one census enumerator can canvas.

The tool's framework is based on three main sustainability themes:

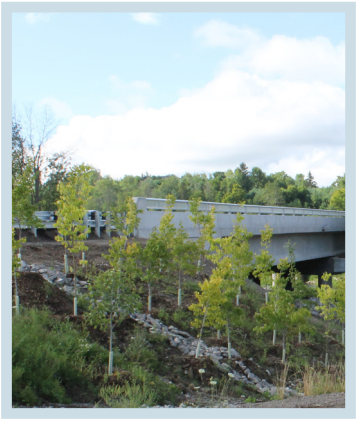
- environmental;
- economic; and,
- social.

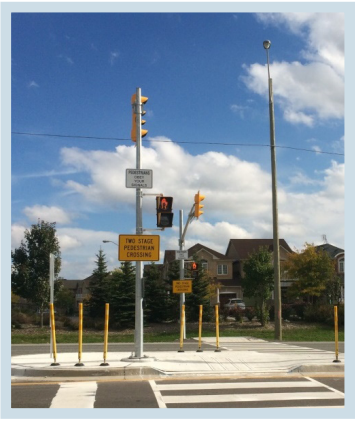
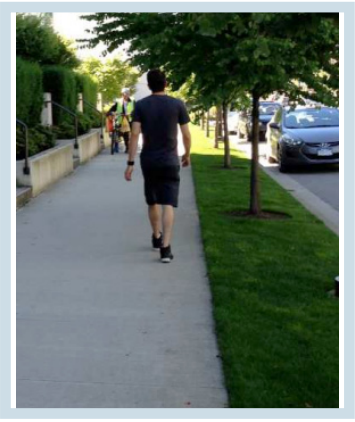
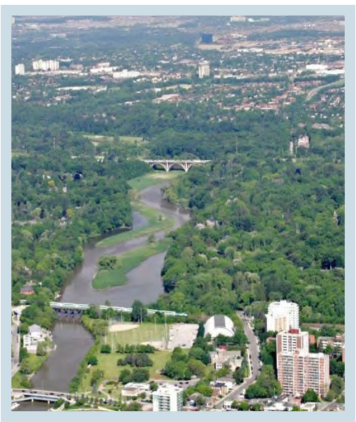
Eight overall benefits and twelve target benefits are nested within these themes. These benefits represent priority issues within the Region which can be addressed through tree planting, which means that this tool can be utilized at a variety of scales and also has the flexibility to allow decision-makers to prioritize tree plantings based on their jurisdiction's specific needs. Additionally, the Tool utilizes land cover data to categorize ground conditions based on whether they are permeable or impermeable surfaces, and if they have existing tree cover.

The TPPT then generates two types of indices, either a Benefits Score index, which identifies where plantings should be undertaken, based on the selected Target Benefit(s) of interest, for example social, or a Priority Planting Score which identifies where plantings could take place, based on the existing ground conditions.

The TPPT and the Streetscape Toolbox are complementary documents. The TPPT may be applied first to identify areas for new streetscape plantings, or to identify areas where streetscapes could benefit from green infrastructure retrofits. Then, the Streetscape Toolbox can be used at the road right-of-way level to determine which streetscape design treatments are suitable.

Section 3: Illustrative Cross Sections



Guide to Illustrative Cross Sections

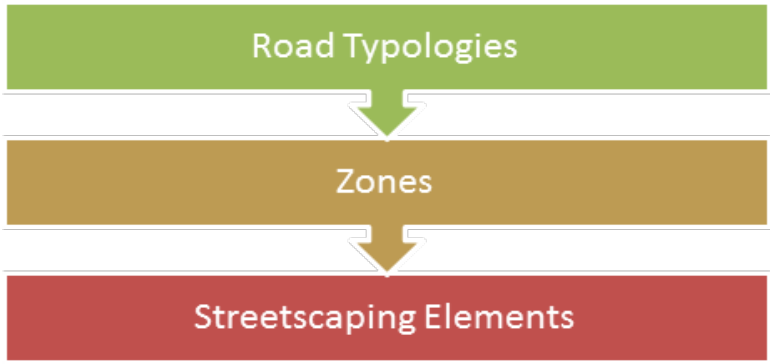
The role of this Toolbox Update is to build on the Road Characterization Study[2] (RCS) illustrative cross sections. The RCS used a context sensitive solutions lens to balance the local land use contexts and needs of stakeholders with roadway functionality and design. The illustrative cross sections found in the RCS are broad in scope and were developed as a starting point for designers when undertaking road projects.

This Streetscaping Toolbox Update provides further practical information and guidance on adding streetscaping elements including tree and shrub planting and green infrastructure.

There are nine cross sections, six for each road typology and three for intersections. Each cross section is divided into zones identified by the RCS. Within each zone are streetscaping elements related to the proposed use.

To use this Toolbox Update in design:

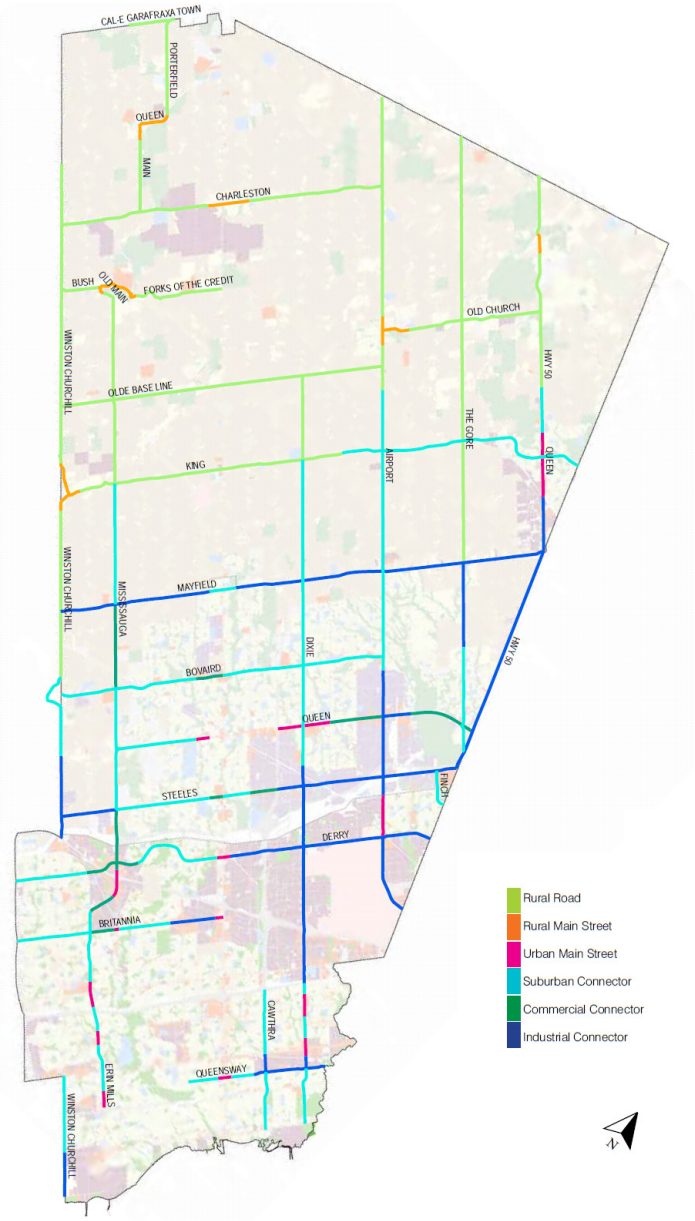
1. Identify the type of project and the applicable road typology from the RCS.
2. Refer to the charts for each road typology and the recommend streetscaping elements.
3. Refer to the respective cross sections as they illustrate examples of the placement of elements.



Relationship Between Road Typologies, Zones and Streetscaping Elements

Identifying Road Typologies

The RCS defines six road types along Regional Roads. Road typologies are based on adjacent land use as defined within the RCS. The RCS Road Character Map correlates land use character with associated right-of-way considerations. Descriptions of each road typology and the map are shown on the following page.



Road Typology Map (Source: Road Characterization Study)

Table 2 - Description of the Six Regional Road Typologies (Source: Road Characterization Study). See Appendix H for More Details.

Road Typology	Description
Rural Road	Agricultural/forest/ scenic with little or no built structures
Rural Main Street	A village centre with concentrated development
Urban Main Street	A mix of commercial, office, institutional and residential uses with complementary services provided
Suburban Connector	A link between strip commercial retail development hubs and suburban housing
Commercial Connector	Similar to suburban connector with higher density of commercial activity compared to residential development
Industrial Connector	Characterized by high amounts of warehousing and industrial development and high levels of truck traffic

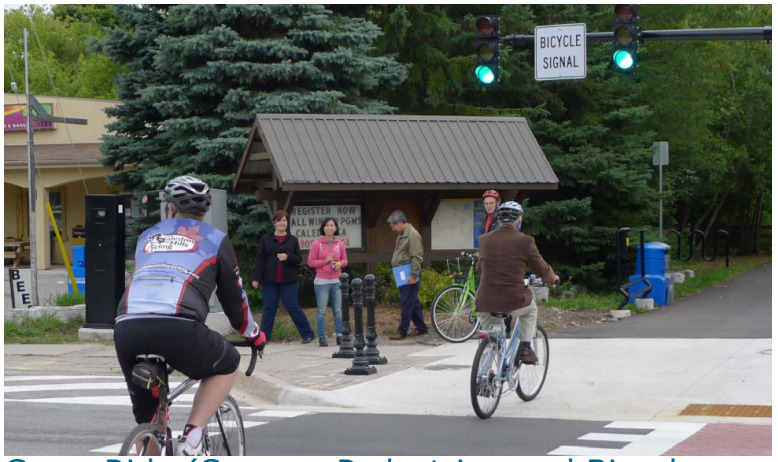
Streetscaping Elements

For each Regional Road right-of-way, streetscaping elements can be selected to meet the requirements of all users (vehicles, cyclists, transit, pedestrians), while recognizing the potential for context-specific constraints in the right-of-way width. A variety of streetscaping elements may be included in the streetscape and roadway design. Detailed cross sections illustrate potential placement of elements within the zone. These are intended to be used during discussions with Regional staff.

Active Transportation Infrastructure

Cross Rides

A cross ride is a part of the roadway intended as a crossing for pedestrians and cyclists and where cyclists are permitted to ride within the crossing.[19] This is indicated by signs, pavement markings and a traffic signal if the crossing is signalized.



Cross Ride (Source: Pedestrian and Bicycle Facility Design Guidance[19])

Paved Shoulders

Paved shoulders are typically located on rural roads that have ditches and are wide enough for bicycle use, to allow the transit of wide farm vehicles and for safe stopping in an emergency. Signage along paved shoulders often ask everyone to share the road alerting motorists that pedestrians/cyclists may be using the roadway too.

Paved Shoulder for Cycling on King St (Source: Region of Peel)

Bicycle Lanes

Bicycle Lanes are designated exclusively for bicycle travel and separated on the road through the use of pavement markings[19].

Cycle Tracks

Cycle tracks are physically separated from motor vehicle travel lanes and are located within the road right-of-way. Cycle tracks are a hybrid bicycle facility combining the experience of an off-street path with the on-street infrastructure of a conventional bicycle lane[19]. In many cases cycle tracks are separated by landscaping or curbs from the sidewalk, facilitating separation between cyclists and pedestrians[19].

On-street Bicycle Lane wth a 0.5m Buffer on Dixie Road (Source: Region of Peel)

The Region of Peel Environmental Assessment for The Gore Road, completed November 2016, recommends new in-boulevard cycle tracks to provide a safe cycling experience adjacent to a dedicated pedestrian sidewalk system. Cycle tracks are linked to cross rides at each intersection.

Cycle Track (Source: City of Ottawa)

Curb Extensions

Curb extensions are physical extensions of the curb into the parking lane at intersections to reduce speeds and increase the visibility of road users[19]. Curb extensions can serve to shorten the crossing distance and act as a traffic calming element.

Curb extensions can be used for traffic calming. They can create a safer pedestrian zone by increasing the buffer width between the sidewalk and roadway. Curb extensions can also incorporate green infrastructure. Their flexible design allows them to be installed during road resurfacing, road construction, or road reduction projects[20].

Curb Extension with Low Impact Development (Source: Credit Valley Conservation)

Lay-by Parking

Lay-by parking is designed to support street-related retail and land uses. It also serves to create a traffic calming effect. On Regional roads lay-by parking is most often found within rural main streets. Consider the use of permeable paving for lay-bys. Parking may be separated with bump-outs. Bump-outs may serve as areas to add green infrastructure. Street furniture should be located far enough away from parking to accommodate the opening of vehicle doors.

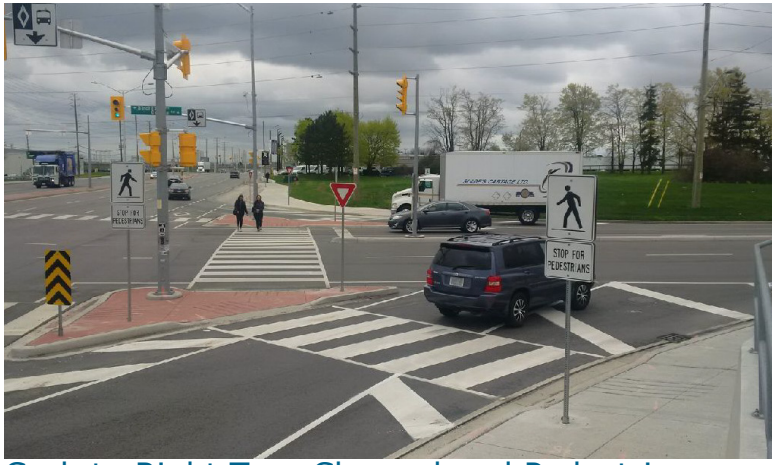
Lay-by Parking Old Church Rd, Caledon East (Source: Region of Peel)

Pedestrian Crossovers

Pedestrian crossovers provide a designated area that allows pedestrians to safely cross roads. Pedestrian crossovers are identified by specific signs, pavement markings and lights; and may have illuminated overhead lights/warning signs and pedestrian push buttons[21].

As of January 1, 2016, drivers, including cyclists, must stop and yield the whole roadway at pedestrian crossovers, school crossings and other locations where there is a crossing guard until pedestrians and or crossing guards have fully cleared the roadway.The new law is intended to make crossing safer for vulnerable road users, particularly children[21].

The Region of Peel is installing its first pedestrian crossover at the Caledon Trailway crossing on Highway 50 in Palgrave. Curb extensions also reduce crossing widths and may help to further slow traffic before the cross-over.



Curb to Right Turn Channel and Pedestrian Crossover Dixie Rd at Birchbank (Source: Region of Peel)

Pedestrian Crossing Islands

The preference is to fully cross pedestrians with the traffic signal. However, for a wide expanse of roadway or for roadways with challenging geometric conditions, signal timing/queuing concerns or the presence of Light Rail Transit (LRT), pedestrian crossing islands provide a safe refuge so that one direction of traffic can be crossed at a time. Pedestrian crossing islands can also be used as a traffic calming measure by making the crossing of pedestrians more prominent and to visually narrow the travel lanes.

Pedestrian crossing islands are not typically found within the Region of Peel right-of-way but have a specific use for pedestrian generators such as for nursing homes, schools, churches, hospitals, and malls. Where properly installed, pedestrian crossing islands encourage pedestrians to cross at more desirable crossing location rather than crossing mid-block.

In 2016, the Region of Peel installed a pedestrian crossing island at the intersection of Steeles Avenue and Polonia Avenue in Brampton to improve traffic flow and aid pedestrians crossing after leaving transit.

Pedestrian Crossing Island Steeles Avenue and Polonia Avenue(Source: Region of Peel)

Design requirements for pedestrian crossing islands should be established on the basis of the local conditions, experience, and engineering judgment. Pedestrian crossing islands may be enhanced using low growing plantings if there is sufficient space to accommodate them. Refer to Ontario Traffic Manual Book 15 for additional information[22].

Sidewalks

Sidewalks provide a defined location within the right-of-way for the movement of pedestrians. Sidewalks may be on both or either side of urban arterial roads. A key concern for pedestrians is the need to feel safe when using sidewalks.

Design considerations include:

- pedestrian signals at signalized intersections;
- barrier free access to meet the needs of all users;
- sufficient sidewalk illumination for safety; and,
- vegetation to create a pleasant space that encourages active transportation.

Desirable setback from the edge of pavement is 3 metres. The width of a standard sidewalk is 1.5 metres and optimally 1.8 metres to accommodate two wheelchairs being able to pass. At intersections, the sidewalk should widen to 2 metres and should connect to the curbs for pedestrian crossing.

Enhancements could include providing a wider sidewalk platform at intersection crossings and an enhanced visual appearance at key pedestrian crossings such as impressed or coloured concrete strips, grooved concrete, coloured asphalt strips, decorative and thermal plastic pavement markings. These enhancements improve tactile navigation and anti-slip surfaces.

Lockstone crosswalk treatments are not appropriate on high volume arterial roads due to heavy car and truck traffic. However, in downtown commercial business districts with high pedestrian volumes and lower traffic speed, the Region of Peel will consider, on an individual basis, the use of alternate crosswalk materials. For additional information refer to municipal design standards and Public Works Design, Standards Specification & Procedures Manual[23].

Enhanced Splash Strip Inglewood , Caledon (Source: Region of Peel)

Multi-Use Trails

Multi-use trails accommodate various modes of transportation such as walking, cycling and in-line skating. Multi-use trails are appropriate in the right-of-way where the boulevard width is 6.0 metres or greater and where a clear corridor can be achieved. The width of the multi-use trail is 3.0 metres or greater with asphalt as the standard surface material. For additional information refer to TAC Geometric Design Guide for Canadian Roads[6], Municipal Design Standards, and Region of Peel Active Transportation Guidelines[24].

Multi-Use Trail in the Region of Peel (Source: Region of Peel)

Green Infrastructure

Green infrastructure can be used to support climate change adaptation and maximize stormwater treatment and infiltration by mimicking the natural hydrologic cycle and should be a priority in the design of innovative and creative stormwater management systems in road right-of-ways.

Bioretention

Bioretention are vegetated practices that temporarily store, treat and infiltrate stormwater runoff. The most important component of these practices is the bioretention soil media, which is made up of a specific ratio of sand, fine soils and organic material[20]. Examples of bioretention forms include bioretention planters, bioretention curb extensions, and boulevard bioretention units.

Bioretention can be integrated into a diverse range of landscapes and land uses. For road ROWs, bioretention units are most commonly located along boulevards, but can also be constructed in medians, cul-de-sac islands and in curb extensions. Planting and landscaping treatments can be customized to provide aesthetic value and contribute positively to the character of the surrounding properties[20].

Depending on the native soil infiltration rate and site constraints, bioretention practices may be designed in three ways: without an underdrain for full infiltration, with an underdrain and gravel storage layer for partial infiltration, or, with an impermeable liner and underdrain for filtration only (i.e., a biofilter). Bioretention can be installed in both rural and urban cross sections[20].

Large Scale Bioretention Facility on Upper Middle Road to ProvideTreatment for 4 hectares of Roadway Drainage. (Source: Google Maps)

Bioretention Planter in Mississauga. (Source: Credit Valley Conservation

Swales

Simple grass channels, generally referred to as ditches, are commonly used for stormwater conveyance, particularly for roadway drainage in rural settings[20].

Swales incorporate a number of simple modifications to the standard ditch design to substantially improve pollutant removal and runoff reduction capability. Swale design features can include modified geometry such as a wider channel base with reduced side slopes, check dams, vegetation, and/or bioretention soil media[20].

Enhanced grass swales are vegetated open channels designed to convey, treat, and attenuate stormwater runoff. Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil, evapotranspiration, and infiltration into the underlying native soil[20].

Enhanced Grass Swale Built with Riprap Check Dams (Source: Delaware Department of Transportation)

Bioswales are similar to enhanced grass swales in terms of the design of their surface geometry, slope, and optional use of check dams. Bioswales also incorporate aspects of bioretention cells—they have bioretention soil media, a gravel storage layer, and optional underdrain components[20].

When designing, monitoring and maintaining swales and bioswales, it is important to ensure that water drains quickly and standing water does not take longer than seven days to infiltrate to reduce the risk of breeding mosquitos.

Infiltration Chambers

Underground stormwater exfiltration conveyance systems, also called infiltration chambers, infiltration trenches, or exfiltration systems, are designed for both conveyance and infiltration of stormwater runoff[25]. They are composed of perforated pipes or proprietary manufactured modular structures installed in gently sloping granular stone beds lined with geotextile fabric that allows infiltration of runoff into the gravel bed and underlying native soil[25].

Underground stormwater conveyance systems can be used in place of conventional storm sewer pipes where topography, water table depth, and runoff quality conditions are suitable. They are capable of handling runoff from roofs, walkways, parking lots, and low-to-medium traffic roads[20]. For areas of high pollutant loading, use pre-treatment such as a vegetated filter strip or an oil and grit separator. Pre-treatment helps to remove debris and coarse sediment and extend the life of the asset.

Typically, perforated pipe can be implemented with less dedicated staff time and resources than bioretention practices. Because these practices are buried and the streetscape remains largely the same as conventional curb and gutter, it requires less effort to secure buy-in from residents to construct practices in the boulevard or in the roadway[20].

Infiltration Chamber (Source: Region of Peel)

Prefabricated modules

Prefabricated modules provide designers with additional options for implementing low impact development (LID) retrofits. The main benefit of this option is that product specifications are readily available from manufacturers, along with design guidance, installation considerations, and expected performance[20].

This support can help provide confidence to designers not experienced with LID retrofits, as well as allowing an off-the-shelf retrofit process. Many prefabricated modules are designed primarily for stormwater treatment, so the use of these products may not address quantity and water balance[20].

These types of prefabricated modules are ideal as pre-treatment for other LID practices like perforated pipe. If quality control is not required, prefabricated modules can be used on their

own, or for units that manage both stormwater quantity and quality20. Types of prefabricated modules include precast tree planters, soil support systems, phosphorus removal media, and proprietary stormwater treatment devices[20].

Installation of proprietary treatment device. (Source: Credit Valley Conservation)

Soil support system being installed under a sidewalk in Toronto (Source: Deep Root Inc.)

Permeable Pavement

Permeable pavement is a type of pavement with open pores spaces that infiltrates rain water through the base into the ground. It falls under LID infrastructure and can be used in place of conventional asphalt or concrete pavement.

For best results in ROW applications, permeable pavement should be limited to areas subject to light vehicle traffic, including parking lay-bys, shoulders, cycle paths, multi-use trails and sidewalks[20].

Types of permeable pavement include porous asphalt, pervious concrete and permeable interlocking concrete pavers. The Region has installed pervious concrete on about 400 metres of the sidewalk along Dixie Road.

Enlarged View of Pervious Concrete (Source: Hunt and Collins)

Pervious Concrete Sidewalk Along Dixie Road (Source: Region of Peel)

Plantings

Plantings have a number of beneficial effects including improving air quality, modifying the microclimate and enhancing the character of a neighbourhood.

There are minimum requirements for street trees to achieve a mature canopy for effective reduction of both stormwater runoff and reflected heat from paved street and sidewalk surfaces. When the right conditions are provided, trees thrive and impart all their environmental benefits.

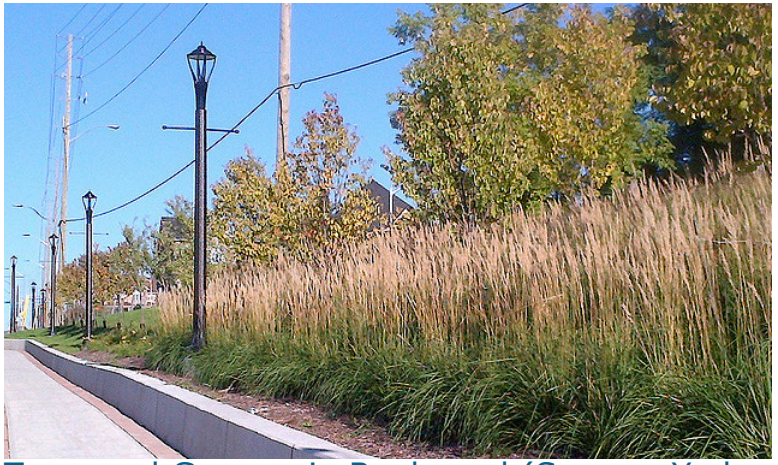
Tree and shrub plantings along Emil Kolb Parkway (Source: Region of Peel)

Design Guidelines for Streetscape Plantings:

- Provide the proper volume of high quality topsoil so trees can grow a healthy root system that supports their needs.
- Ensure species diversity. The Peel Urban Forest Strategy recommends no single

species represents more than 5 percent of the tree population, no genus represents more than 10 percent of the tree population, and no family represents more than 20 percent of the tree population[16].

- Select tree species that can tolerate salt, adverse weather and pests.
- Locate large trees outside of the clear zone as they can pose a safety hazard.
- Consider planting more shrubs and perennials for increased vegetation densities suited to the growing conditions and constraints.
- Consider the use of native seed mixes that can outcompete invasive species (see Appendix A).
- Consider the use of a soil-cell system or trench planting area to avoid below-ground conflicts between root systems and hardscaping or other utilities.
- Consider using drought and salt tolerant native seed mixes specifically suited to the growing condition and constraints along roadways instead of turf.
- Different types of plantings require differing levels of care. Once planted, provide sufficient water for at least 3 years so that they can establish their root system and endure periods of drought.
- Incorporate plantings including street trees into rights-of-way with boulevards greater than 8.0 metres in width.
- Consider the use of shrubs where clear zone is an issue. Consider sight lines of pedestrian and vehicular traffic in selecting planting heights.
- Set back trees a minimum of 6.0 metres from the edge of pavement and 1.5 metres from the property line.
- Use lower plantings immediately adjacent to noise attenuation walls.



Trees and Grasses in Boulevard (Source: York Region)

Tree and Shrub Plantings Along Dixie Road (Source: Region of Peel)

Table 3: Maintenance Levels of Care

Level of Care	Maintenance	Water Needs
Low	Annual	None
Medium	Quarterly	Some
High	Monthly	Potential Irrigation

Moving towards Water Efficient Landscapes

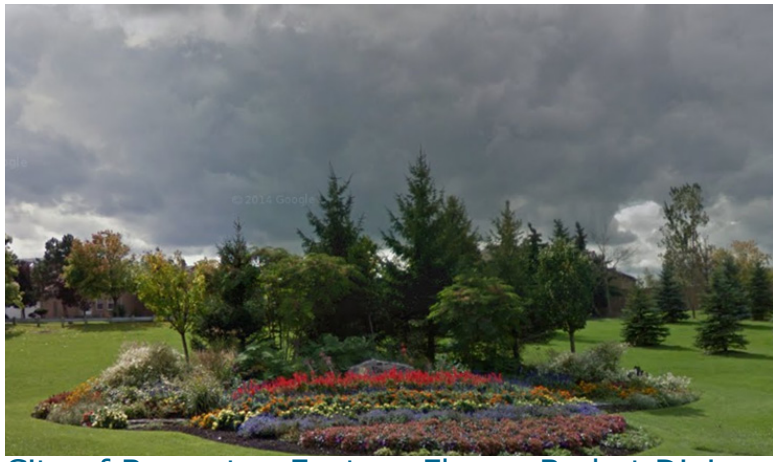
The Region of Peel is expected to grow to 1.6 million residents by 2031. Meeting the increasing water demands associated with population growth while ensuring the sustainable management of water resources are priorities of the Region's 2012 Water Efficiency Strategy.

Regional programming assists Peel residents with creating water efficient landscaping using a fusion landscape concept, that melds the traditional landscape aesthetic with a Best Management integrated practice. Fusion landscapes require little or no supplemental irrigation while still providing landscape aesthetics. Water efficiency and fusion landscape practices are principles that can be applied to road right-of-way design.

Site and Gateway Treatments

Site and gateway treatments provide a number of functions including:

- to signal when a traveller is entering a new region or a municipality;
- as a welcome element and community identifier; and,
- to highlight significant community areas such as city centres and areas of special character.



City of Brampton Feature Flower Bed at Dixie Rd and Bovaird Dr (Source: Google Street View)

Gateway features are typically located outside the right-of-way in buffer blocks at the entrance to communities, cities, towns or regions where design and adequate land is available. Typically, gateway treatments are developed near major intersections where additional land may be available in the buffer block or in the boulevard outside the daylighting triangle. For additional information refer to local municipal guidelines and standards

Gateway treatments can take numerous forms including change in road character; decorative lighting, signage, landscaping/planting bed, stone or masonry walls and gates, a unique art form, special median treatment, banners, floral features, and heritage signage.

Street Furniture

The street furniture zone is defined as the section of the sidewalk between the curb and the through zone in which street furniture and amenities, such as lighting, benches, newspaper kiosks, utility poles, tree pits, and bicycle parking are provided.[19]

Street Furniture Downtown Bolton (Source: Google Street View)

The street furniture zone may also consist of green infrastructure elements, such as rain gardens or flow-through planters.[19] Street furniture is a feature that can enhance the pedestrian environment by making it a more comfortable and inviting environment. Street furniture currently falls under the area municipal jurisdiction for implementation and maintenance.

Noise Attenuation Walls

Noise attenuation walls provide noise mitigation for the outdoor living space of residential properties with rear or side facing lots along Regional Roads in Noise Sensitive Areas that meet the Regional guidelines.

Size and type of wall is determined during detailed design for capital projects as a result of road widening or through the local improvement application process (both Region-owned walls). Noise attenuation walls may be constructed as part of a subdivision agreement as per local municipal requirements except they must use metal posts and are placed on the property line.

Currently noise attenuation walls on private property remain the sole responsibility of private owners until such time that the private noise attenuation walls are converted to Region ownership. The Region of Peel is responsible for the maintenance of noise attenuation walls located within its right-of-way and built as part of capital projects, local improvements or the private noise attenuation wall conversion program.

Wooden Noise Attenuation Wall (Source: Region of Peel)

City of Mississauga Living Noise Wall (Source: Region of Peel)

Buffer Blocks

A buffer is a piece of land between two differently zoned areas. Buffers may be located at intersections and used for gateway treatments on private land. More typically they are raised and located mid-block at the edge of the road right-of-way adjacent to noise walls and function to provide additional noise attenuation without increasing the height of the noise wall. Buffer blocks may be planted and maintained by the local municipality at their expense. Buffer blocks may be the location of utilities. Consider buffer blocks for incorporation of green infrastructure ensuring proper consultation with utilities and local municipalities.

City-maintained Buffer Block Airport Road. (Source: Google Street View)

Enhancements to Bridges, Culverts and Retaining Walls

Bridges, culverts and retaining walls act as crossings of water courses, railways and other roads and are present in all right-of-ways where a grade separation is required, or is existing.

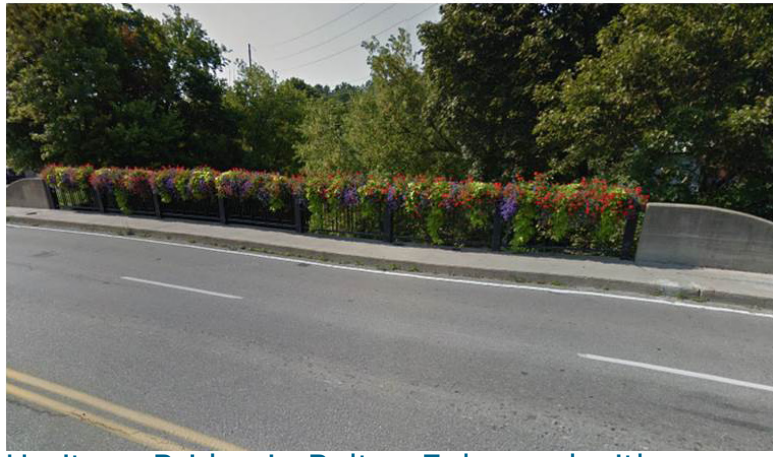
Belfountain Bridge Vegetated Retaining Wall. (Source: Region of Peel)

At significant river crossings, major arterial roads, gateway locations and environmentally significant areas, consider including:

- architectural treatments;
- separation of pedestrian/road traffic by traffic barriers;
- alternative railings that meet function and code requirements;
- special lighting which would reinforce the significance of these structures and settings (may be restrictions for regulated areas);
- road maintenance systems such as automated bridge anti-icing systems;
- connectivity with the Natural Heritage System;
- if pedestrian trails are required in the design of bridge/culvert crossings;
- green infrastructure such as bioswales, vegetated retaining walls, and underground stormwater exfiltration conveyance systems; and,
- features to enhance animal passage.

For additional Information refer to the Canadian Highway Bridge Design Code[26] and relevant regulatory agency standards for infrastructure elements.

Enhanced culvert (Source: Region of Peel)



Heritage Bridge in Bolton Enhanced with Hanging Baskets. (Source: Region of Peel)

Street and Pedestrian Lighting

Street lighting is provided on all urban and rural roads where street lighting is warranted. All roadway lighting should be designed to the Illuminating Engineering Society of North America (IESNA) standards. IESNA standards are in effect throughout all of North America and internationally, and the IESNA collaborates with the International Commission on Illumination to promote uniformity with the rest of the world.

Location of poles are to follow clear zone offsets as frangible base poles are not recommended where pedestrians are present. For boulevard locations the offset from edge of pavement for poles range from 2.0 metres to 3.5 metres according to design speed. During the detail design process it is the design engineer's responsibility to develop a design rationale, if necessary, for placing poles within the clear zone.

Pedestrian lighting is tied to roadway lighting and all roadway lighting should be designed to IESNA RP8-14 requirements. Normally, independent pedestrian street light poles are not utilized as they create pole pollution in the right-of-way. However to enhance the pedestrian experience decorative lighting that is pedestrian-scaled (no higher than 4.6 metres) may be incorporated with the poles illuminating the roadway[14].

Road and Pedestrian Lighting Downtown Brampton. (Source: Google Street View)

For additional information refer to:

- TAC Geometric Design Guide for Canadian Roads;

- MTO Geometric Design Manual[6]; and,
- MTO Lighting Manual.[27]; and,
- IESNA standards.

Road Ecology

Road ecology is an emerging area of study which focuses on the interactions between road networks and the natural environment. Some of the most widely used methods for reducing the impacts of roads to wildlife is the creation of, or improvement to, wildlife crossing structures or the removal of barriers to wildlife passage. These mitigation efforts may include the construction of new culverts, overpasses, and fencing, or the retrofit of existing infrastructure with passages and fencing to facilitate safe wildlife crossing based on best management practices. A best practice is to identify "hot spots" for road ecology enhancements early in an environmental assessment process.

To protect biodiversity, rural roadside vegetation management is important to ensure that the road doesn't become a deterrent to the passage of smaller animals such as birds and butterflies while making sure that motorists have proper visibility to see large animals such as deer, fox and coyote before they cross the road. Amphibians and reptiles can benefit from passages that direct and protect their crossing. Reptile and amphibian crossings are being added to The Gore Road north of Patterson Sideroad in Caledon.

Turtle Passage Structure, Guelph, ON (Source: Chris Parent, Cole Engineering)

Guidance on wildlife crossing structures can be obtained from the CVC Fish and Wldlife Crossing Guideline, the Ministry of Transportation Environmental Guide for Mitigating Road Impacts to Wildlife, the Ministry of Natural Resources and Forestry Best Management Practices for Mitigating the Effects of Roads on Amphibian and Reptile Species at Risk in Ontario, the TRCA Road Ecology and Mitigation Report and the Ontario Road Ecology Group. Although it may not always be a requirement, post-construction monitoring is the best way to determine if a crossing structure is functioning as intended.

Turtle Passage Structure, Guelph, ON
(Source:Chris Parent, Cole Engineering)

Invasive Species

Invasive species are non-native plants, insects, animals or aquatic species that compete for resources with natives species. They can dominate habitat and out-compete the native species affecting all aspects of an ecosystem. Plant invasive species often prefer disturbed land, are naturally aggressive, have high reproductive rates, and lack natural predators.

Non-native species are often introduced accidentally or by choice such as through plant purchase from a garden centre or as hitchhikers in the well of a boat. Invasive species are of a huge concern because they impact global biodiversity. Protecting biodiversity is important because healthy ecosystems can better withstand and recover from disasters and species diversity helps maintain sustainability of all life forms.

Invasive species can be found in many locations within the road right-of-way. Tree species that were originally planted because of their ability to survive in harsh growing conditions, such as Norway Maple, can become invasive if they are located adjacent to regulated areas.

Wthin the rural road right-of way, there are opportunities to remove the invasive European reed (Phragmites australis ssp. australis) and replant rural ditches with native species that support healthier habitats. Phragmites will reestablish unless Best Management Practices are used to eradicte or control it.

European Reed in a Roadside Ditch Location
Dixie Rd Caledon.(Source: Google Street View)

Best Management Practices (BMPs) for Invasive Species

BMPs have been created to assist in controlling or eradicating common invasive species. BMPs can be combined with proposed road works to help reduce or eliminate invasive species prior to the planting of native species. If not properly removed the long term sustainability of green infrastructure and plantings may be compromised and may increase the long term maintenance cost. For example, Japanese Knotweed can grow through concrete compromising its structural integrity.

Good maintenance practices such as keeping equipment clean and minimizing roadside disturbances help to control the spread of invasive species. Clean equipment greatly redues the transferability of invasive species during construction or maintenance work.

Cultivars

The planting of cultivars in or immediately adjacent to natural areas is not acceptable as they often do not provide the same ecological services as their counterpart. When given the option between a native species and a cultivar select the native species unless in special circumstances there is a large difference between the native and the cultivar for a specific application.

The use of native (not cultivars), habitat appropriate species is recommended in or adjacent to the natural heritage system. In areas away from the NHS, cultivars and other approved non-native species may be acceptable.

This Page Intentionally Left Blank

Illustrative Cross Sections

for Road Mid-block, Intersections and Roundabouts

The six cross sections relate to the six RCS road typologies. Each cross section is divided into zones identified by the RCS[2]. Within each zone are streetscaping elements that relate to the proposed use.

Intersections and roundabouts were not discussed in the RCS, however since many new road projects involve the re-design and improvement of intersections, there are opportunities to include streetscaping improvements within these types of projects. Two intersection types and a roundabout are shown in bird's eye view and zones identified for potential streetscaping elements.

- Identify the road typology of the project using the RCS map (as illustrated on page 29).
- Refer to the charts for each respective road typology. The charts provide direction on choosing streetscaping elements based on the type of construction project and have been adapted from the CVC Grey to Green Road Retrofits Guide[20].
- Review the type of construction project Definitions are provided under Design Process section.
- Determine the use of streetscaping elements, recommended and enhanced

Each cross section illustrates examples of the placement of streetscaping elements within each zone. The RCS identifies zone dimensions, however each project with be different based on opportunities and constraints and will be evaluated during the EA.

Highway 7 Streetscape (Source: York Region)

Zones

The RCS defines zones within the right-of-way based on the identified use. Each Toolbox cross section mirrors the zones from the RCS document. The general width of the zone is identified but not strictly defined as choices of elements to be placed within the zone remain dynamic.

The Streetscaping Toolbox provides direction on the placement of elements within the zones. The zones are described below and identified with colour blocks in the illustrative cross sections.

Vehicle Zone: The primary travel way for motor vehicles including buses, trucks and cyclists.

Pedestrian Zone: The area reserved for pedestrian traffic that is free of obstructions such as utilities, landscape elements, and lighting.

Multi-Use Trail Zone: A shared pathway that can be used by both pedestraians and cyclists.

Bicyle Zone: An area exclusively for bicyclists

Green Zone: The landscaped or green zone located between the travel-way and Pedestrian zone. It may serve as the median between lanes of oncoming traffic.

Median Zone: Centre divider between opposing traffic lanes, which may include landscaping treatments.

Splash Strip: Area reserved for utility placement, or paved area adjacent to travel lanes where vegetation will not grow due to salt spray. Splash strip is used for snow storage in winter.

Parking Zone: A dedicated area for parking within the right-of-way.

Table 4: Streetscaping options to consider for a rural road (30 metre right-of-way)
R = Recommended; **E** = Enhanced; **N** = Not Applicable
Adapted from Grey to Green Road Retrofits Guide[20]

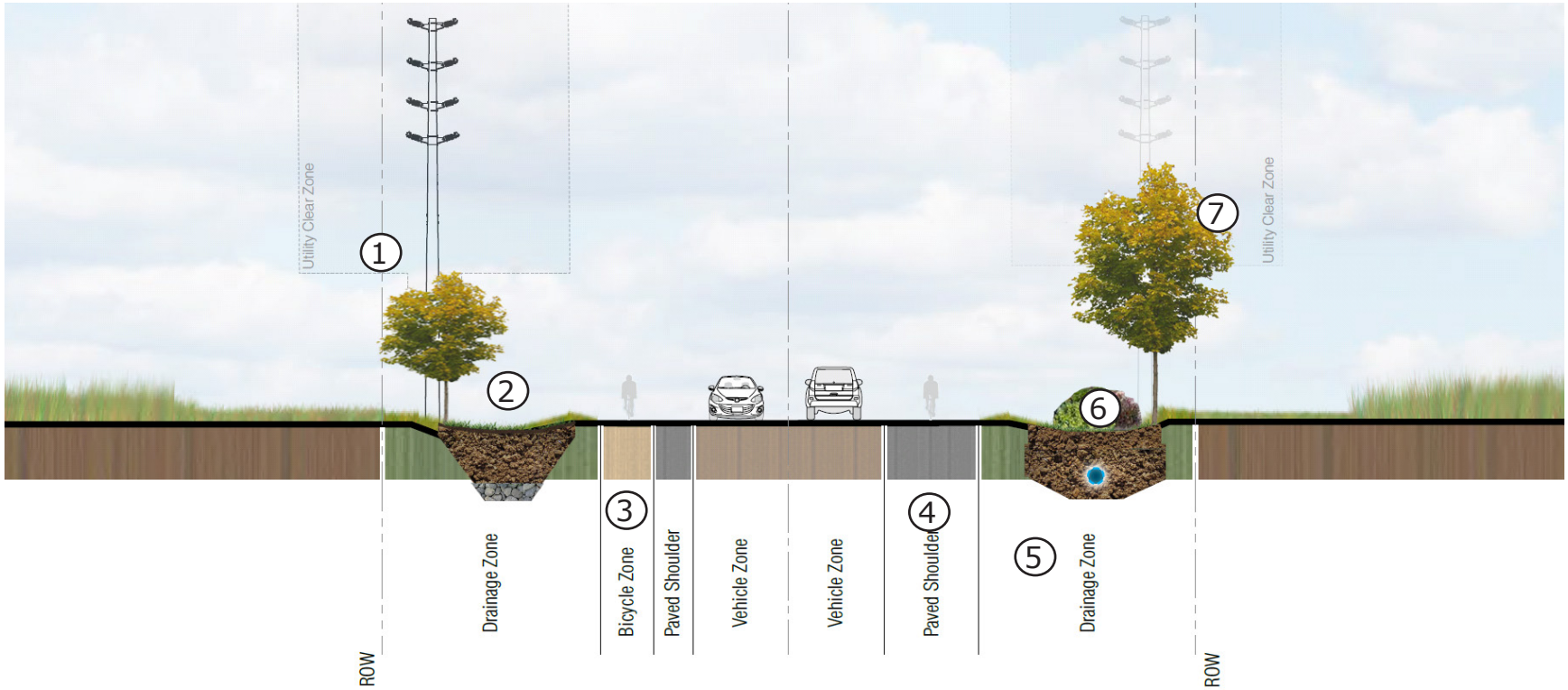
Right-of-Way Construction Type	Sidewalk	Multi-Use Trail	Paved Shoulder	Bike Lane	Cycle Track	Curb Extensions	Bioretention	Swales	Infiltration Chambers	Prefabricated Modules	Permeable Pavement	Plantings (including ditch rehabilitation)	Gateway Features	Street Furniture	Noise Attenuation Walls	Enhancements (including wildlife crossing structures)	Pedestrian Lighting
Resurfacing	**N**	**N**	**R**	**E**	**N**	**N**	**E**	**R**	**E**	**N**	**N**	**R**	**N**	**N**	**N**	**N**	**N**
Reconstruction	**N**	**N**	**R**	**E**	**N**	**N**	**E**	**R**	**E**	**N**	**N**	**R**	**N**	**N**	**N**	**R**	**N**
New Construction/ Widening	**N**	**N**	**R**	**E**	**N**	**N**	**E**	**R**	**E**	**N**	**N**	**R**	**N**	**N**	**N**	**R**	**N**

Enhanced Grass Swale (Source: Centre for Watershed Protection)

Bicycle Lane Dixie Road (Source: Region of Peel)

Paved Shoulder Olde Base Line Road (Source: Google Street View)

Illustrative Cross Sections
Rural Road



1. Small tree under utility clear zone (Refer to Ontario Hydro Approved Tree List Appendix E)
2. Enhanced Grass Swale infiltrates water and stores and infiltrates snow
3. Bike Lane
4. Paved Shoulder
5. Perforated Pipe System also serves for snow storage
6. Native seed mix to control invasive species (e.g. Phragmites)
7. Native Shade Trees

Cross Sections Adapted from Region of Peel Road Characterization Study (2013)[2] Note: Actual layouts will vary and be dependent on specific site conditions, TAC, MTO clear zone requirements, utilities and private/public partnerships for enhanced streetscaping.

Table 5: Streetscaping options to consider for a rural main street (20 metre right-of-way)
R = Recommended; **E** = Enhanced; **N** = Not Applicable
Adapted from Grey to Green Road Retrofits Guide[20]

Right-of-Way Construction Type	Sidewalk	Multi-Use Trail	Paved Shoulder	Bike Lane	Cycle Track	Curb Extensions	Bioretention	Swales	Infiltration Chambers	Prefabricated Modules	Permeable Pavement	Plantings	Gateway Features	Street Furniture	Noise Attenuation Walls	Enhancements (including Lay-By Parking)	Pedestrian Lighting
Resurfacing	**E**	**N**	**N**	**R**	**N**	**E**	**E**	**N**	**N**	**E**	**E**	**E**	**E**	**E**	**N**	**N**	**E**
Reconstruction	**R**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**R**	**R**	**R**	**R**	**R**	**N**	**R**	**R**

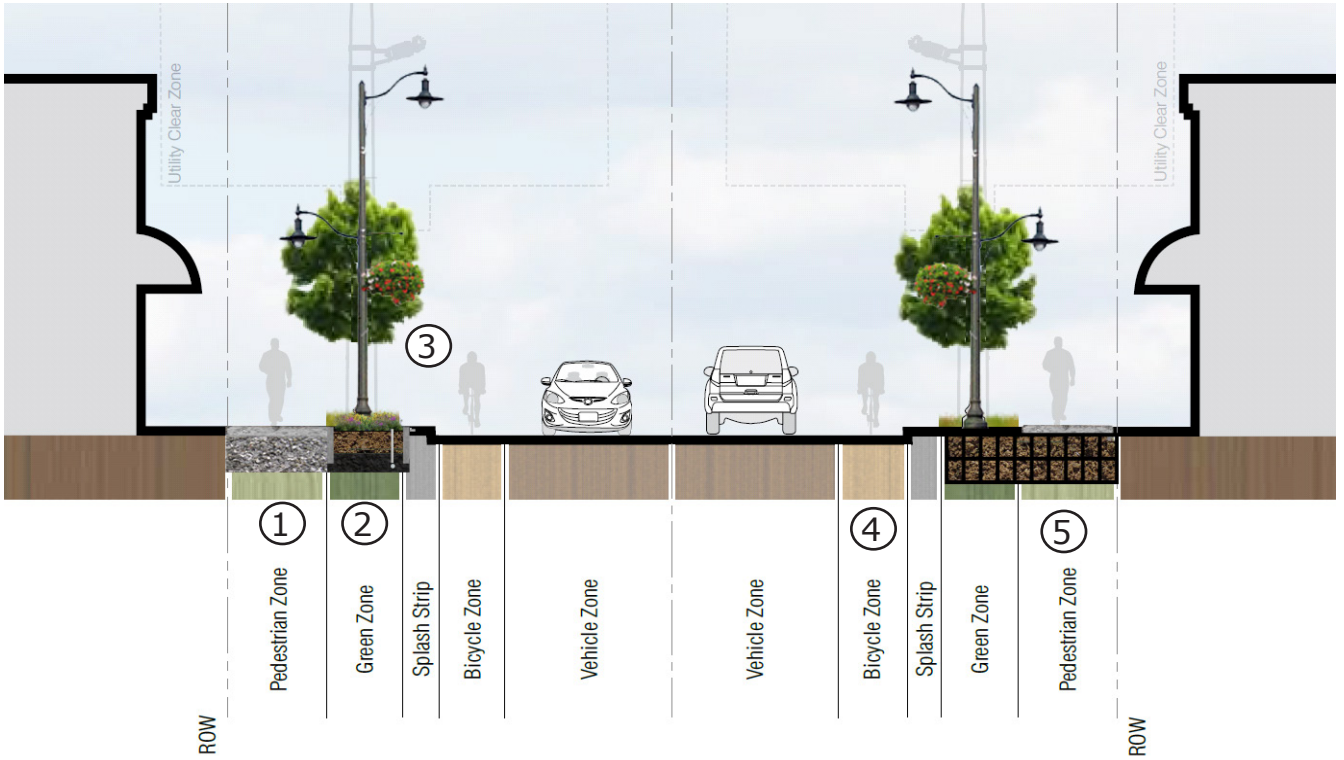
Bioretention planter (Source: CVC)

Trees in soil support system (Source: CVC)

Pervious concrete lay-by parking in Streetsville. (Source: CVC)

Illustrative Cross Sections

Rural Main Street



① Pervious Concrete Sidewalk

② Bioretention Planters with Trees and Perennials

③ Decorative Pedestrian Lighting with Hanging Baskets

④ Bike Lane

⑤ Soil Support System for Trees with Pervious Concrete Sidewalk

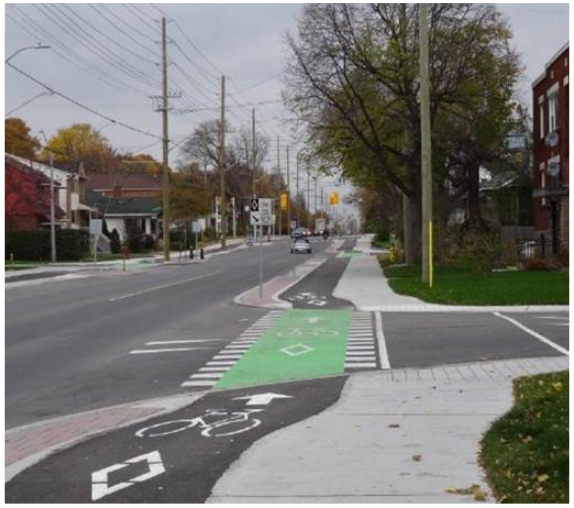
Cross Sections Adapted from Region of Peel Road Characterization Study (2013)[2]
Note: Actual layouts will vary and be dependent on specific site conditions, TAC, MTO clear zone requirements, utilities and private/public partnerships for enhanced streetscaping.

Table 6: Streetscaping options to consider for an urban main street (45 metre right-of-way - with on-street parking)

R = Recommended; **E** = Enhanced; **N** = Not Applicable

Adapted from Grey to Green Road Retrofits Guide[20]

Right-of-Way Construction Type	Sidewalk	Multi-Use Trail	Paved Shoulder	Bike Lane	Cycle Track	Curb Extensions	Bioretention	Swales	Infiltration Chambers	Prefabricated Modules	Permeable Pavement	Plantings	Gateway Features	Street Furniture	Noise Attenuation Walls	Enhancements	Pedestrian Lighting
Resurfacing	**E**	**N**	**N**	**R**	**N**	**E**	**E**	**N**	**N**	**E**	**E**	**E**	**E**	**E**	**N**	**E**	**E**
Reconstruction	**R**	**N**	**N**	**R**	**R**	**R**	**R**	**N**	**R**	**R**	**R**	**R**	**R**	**R**	**N**	**R**	**R**



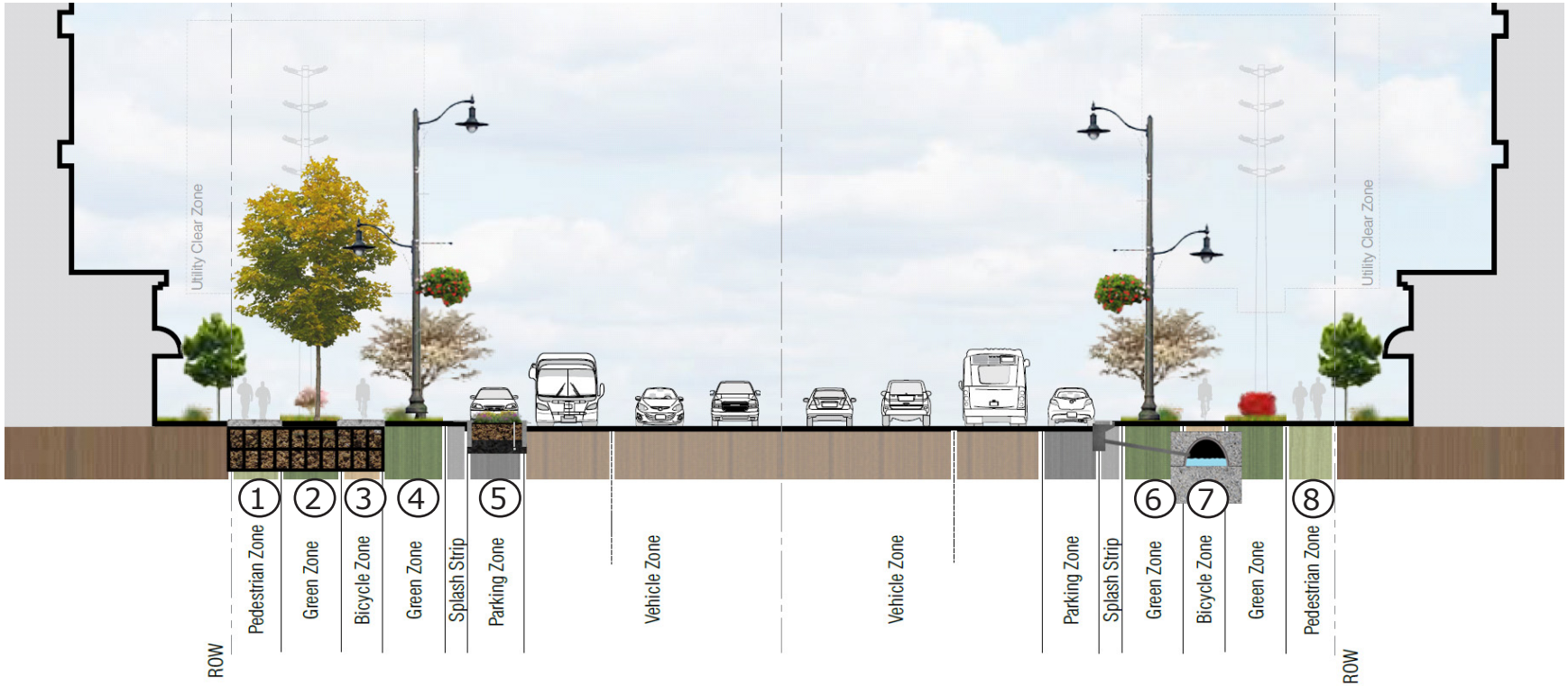
Cycle Track (Source: City of Ottawa)

Bioretention Curb Extension (Source: Credit Valley Conservation)

Soil Support System (Source: Google Street View)

Illustrative Cross Sections

Urban Main Street



1. Pervious Concrete Sidewalk
2. Soil Support System with Large Shade Tree
3. Pervious Concrete Cycle Track
4. Decorative Pedestrian Lighting with Hanging Baskets
5. Bioretention Curb Extension with Perennials
6. Infiltration Chambers
7. Cycle Track
8. Sidewalk

Cross Sections Adapted from Region of Peel Road Characterization Study (2013)[2]

Note: Actual layouts will vary and be dependent on specific site conditions, TAC, MTO clear zone requirements, utilities and private/public partnerships for enhanced streetscaping.

Table 7: Streetscaping options to consider for a suburban connector (45 metre right-of-way)

R = Recommended; **E** = Enhanced; **N** = Not Applicable

Adapted from Grey to Green Road Retrofits Guide[20]

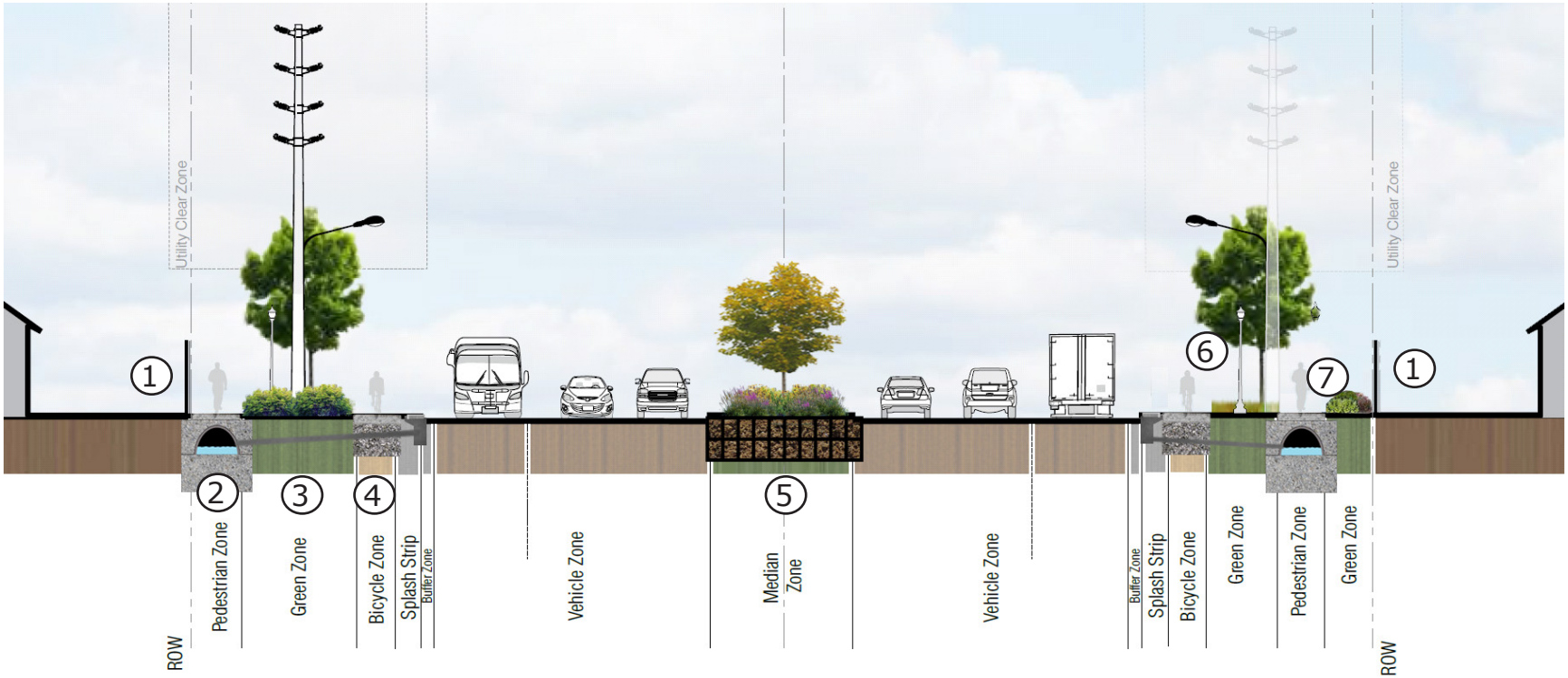
Right-of-Way Construction Type	Sidewalk	Multi-Use Trail	Paved Shoulder	Bike Lane	Cycle Track	Curb Extensions	Bioretention	Swales	Infiltration Chambers	Prefabricated Modules	Permeable Pavement	Plantings	Gateway Features	Street Furniture	Noise Attenuation Walls	Enhancements	Pedestrian Lighting
Resurfacing	**E**	**E**	**N**	**R**	**E**	**N**	**N**	**N**	**N**	**N**	**E**	**E**	**N**	**N**	**N**	**N**	**N**
Reconstruction	**R**	**R**	**N**	**R**	**R**	**N**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**N**	**E**	**E**
New Construction/ Widening	**R**	**R**	**N**	**R**	**R**	**E**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**R**	**E**	**E**

Concrete Noise Attenuation Wall, Dixie Road, Brampton (Source: Region of Peel)

Tree and Shrub Plantings along The Gore Road (Source: Google Street View)

Trees Growing in Soil Support System Hwy 7 York Region (Source: Google Street View)

Illustrative Cross Sections
Suburban Connector



1. Noise Attenuation Wall
2. Infiltration Chamber
3. Tree and Shrub Plantings
4. Pervious Concrete Cycle Track
5. Soil Support System with Trees and Shrubs
6. Pedestrian Lighting
7. Pervious Concrete Sidewalk

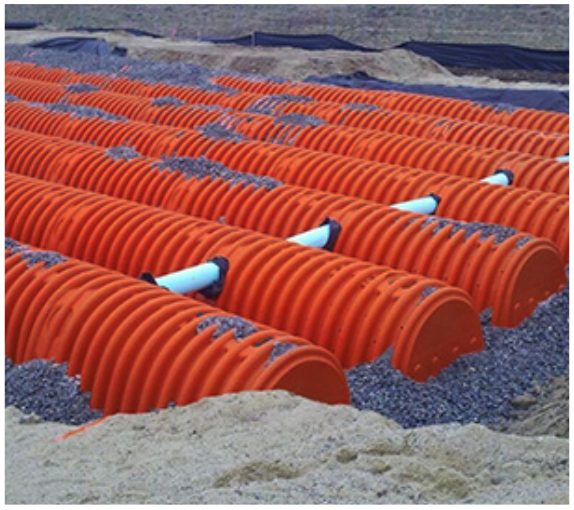
Cross Sections Adapted from Region of Peel Road Characterization Study (2013)[2]
Note: Actual layouts will vary and be dependent on specific site conditions, TAC, MTO clear zone requirements, utilities and private/public partnerships for enhanced streetscaping.

Table 8: Streetscaping options to consider for a commercial connector (45 metre right-of-way)

R = Recommended; **E** = Enhanced; **N** = Not Applicable

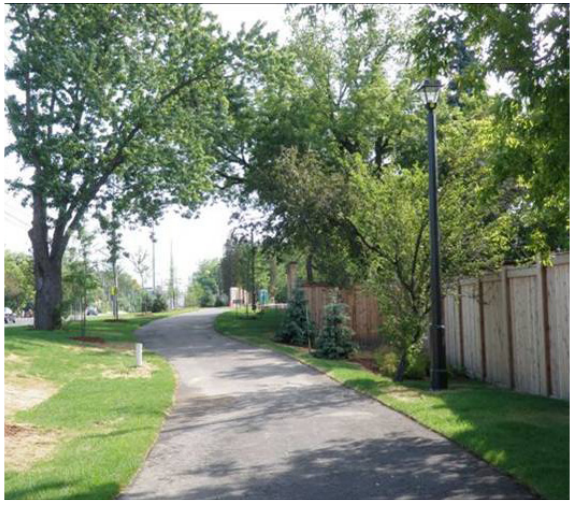
Adapted from Grey to Green Road Retrofits Guide[20]

Right-of-Way Construction Type	Sidewalk	Multi-Use Trail	Paved Shoulder	Bike Lane	Cycle Track	Curb Extensions	Bioretention	Swales	Infiltration Chambers	Prefabricated Modules	Permeable Pavement	Plantings	Gateway Features	Street Furniture	Noise Attenuation Walls	Enhancements	Pedestrian Lighting
Resurfacing	**E**	**N**	**N**	**N**	**E**	**N**	**N**	**N**	**N**	**N**	**E**	**E**	**N**	**N**	**N**	**N**	**N**
Reconstruction	**R**	**R**	**N**	**N**	**E**	**N**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**E**	**E**	**E**
New Construction/ Widening	**R**	**R**	**N**	**N**	**E**	**N**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**R**	**E**	**E**



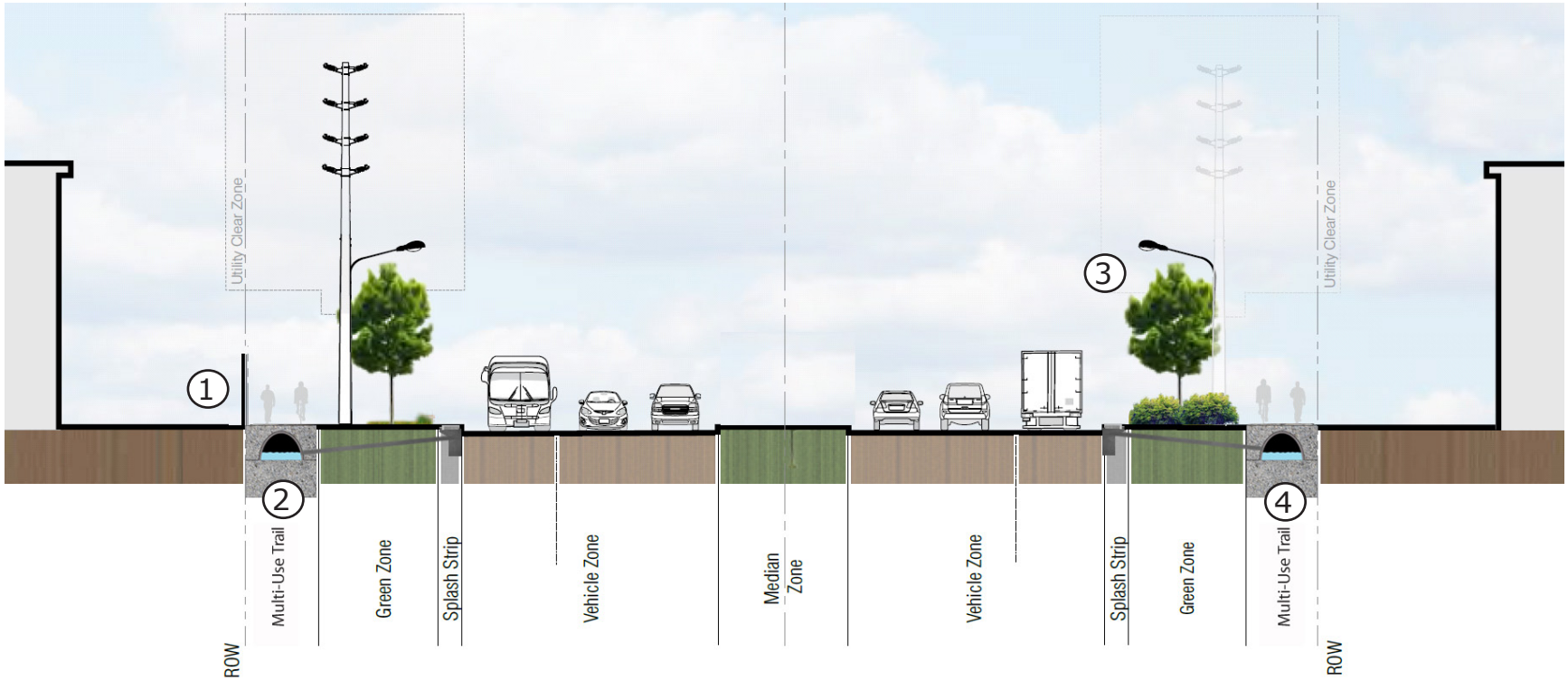
Infiltration chamber (Source: Stormchamber)

Multi-use trail in the Region of Peel (Source: Region of Peel)



Wooden noise attenuation wall (Source: Region of Peel)

Illustrative Cross Sections
Commercial Connector



① Noise Attenuation Wall

② Infiltration Chambers

③ Tree and Shrub Plantings

④ Porous Asphalt Multi-Use Trail

Cross Sections Adapted from Region of Peel Road Characterization Study (2013)[2]
Note: Actual layouts will vary and be dependent on specific site conditions, TAC, MTO clear zone requirements, utilities and private/public partnerships for enhanced streetscaping.

Illustrative Cross Sections

Industrial Connector

Table 9: Streetscaping options to consider for an industrial connector (45 metre right-of-way)

R = Recommended; **E** = Enhanced; **N** = Not Applicable

Adapted from Grey to Green Road Retrofits Guide[20]

Right-of-Way Construction Type	Sidewalk	Multi-Use Trail	Paved Shoulder	Bike Lane	Cycle Track	Curb Extensions	Bioretention	Swales	Infiltration Chambers	Prefabricated Modules	Permeable Pavement	Plantings	Gateway Features	Street Furniture	Noise Attenuation Walls	Enhancements	Pedestrian Lighting
Resurfacing	**E**	**E**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**E**	**E**	**N**	**N**	**N**	**N**	**N**
Reconstruction	**E**	**R**	**N**	**N**	**N**	**N**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**N**	**N**	**N**
New Construction/ Widening	**E**	**R**	**N**	**N**	**N**	**N**	**E**	**N**	**R**	**N**	**R**	**R**	**N**	**N**	**N**	**N**	**N**

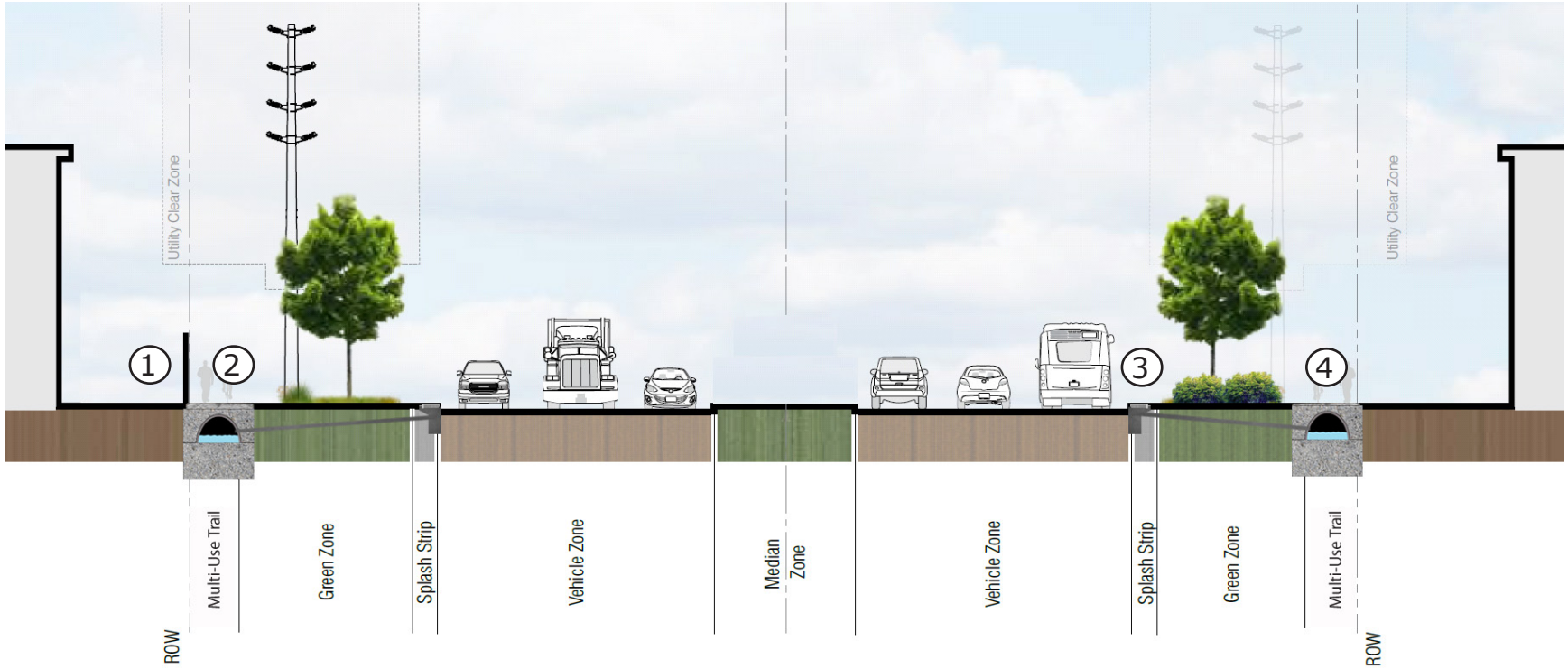
Streetsville GO Station Living Noise Attenuation Wall (Source: CVC)

Plantings along Airport Road (Source: Google Street View)

Pervious Concrete Sidewalk (Source: Region of Peel)

Illustrative Cross Sections

Industrial Connector



① Noise Attenuation Wall

② Infiltration Chambers

③ Tree and Shrub Plantings

④ Pervious Concrete Multi-Use Trail

Industrial connectors are often situated within goods movement corridors. On-street bike lanes and cycle tracks are generally not recommended with multi-use trails the preferred alternative. Residential areas are generally not located within an industrial connector so noise walls are not required. Green infrastructure improvements recommended include permeable pavements and infiltration chambers.

Cross Sections Adapted from Region of Peel Road Characterization Study (2013)[2]

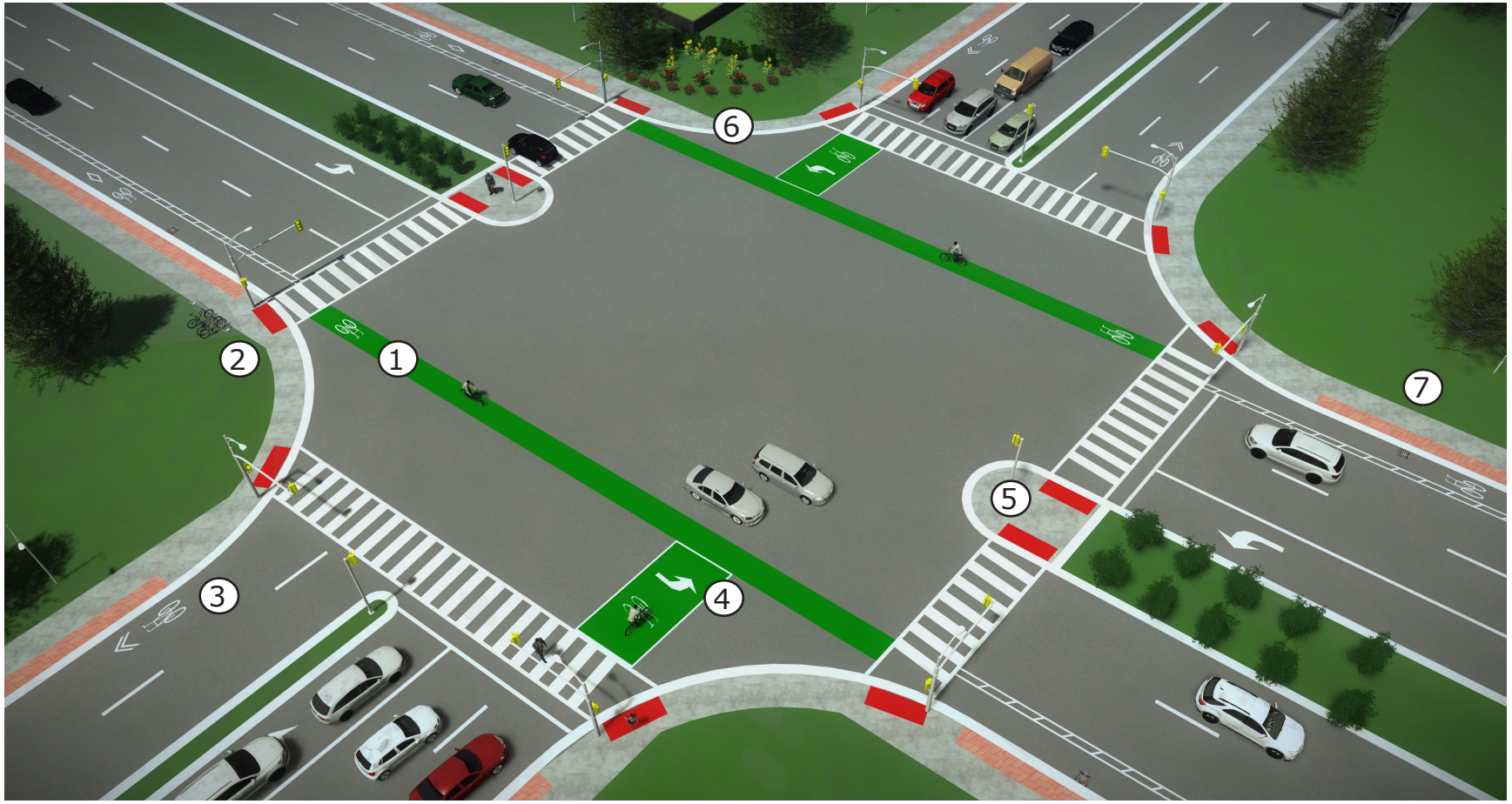
Note: Actual layouts will vary and be dependent on specific site conditions, TAC, MTO clear zone requirements, utilities and private/public partnerships for enhanced streetscaping.

Table 10: Streetscaping options to consider for each road typology at intersections
R = Recommended; **E** = Enhanced; **N** = Not Applicable
Adapted from Grey to Green Road Retrofits Guide[20]

Road Typology	ROW Construction Type	Median Refuges	Pedestrian Cross-Overs	Cross Rides	Gateway Features	Infiltration Chambers
Rural Road	Resurfacing	**N**	**N**	**E**	**N**	**N**
	Reconstruction	**N**	**N**	**E**	**N**	**N**
Rural Main Street	Resurfacing	**N**	**E**	**E**	**E**	**N**
	Reconstruction	**R**	**R**	**R**	**E**	**N**
Urban Main Street	Resurfacing	**E**	**E**	**E**	**E**	**E**
	Reconstruction	**E**	**R**	**R**	**R**	**R**
	New Construction/Widening	**R**	**R**	**R**	**R**	**R**
Suburban Connector	Resurfacing	**N**	**E**	**E**	**N**	**E**
	Reconstruction	**R**	**E**	**E**	**N**	**R**
	New Construction/Widening	**R**	**E**	**E**	**N**	**R**
Commercial Connector	Resurfacing	**N**	**E**	**E**	**N**	**E**
	Reconstruction	**E**	**E**	**E**	**N**	**R**
	New Construction/Widening	**E**	**E**	**E**	**N**	**R**
Industrial Connector	Resurfacing	**N**	**N**	**E**	**N**	**E**
	Reconstruction	**E**	**N**	**E**	**N**	**R**
	New Construction/Widening	**E**	**N**	**E**	**N**	**R**

Illustrative Cross Sections

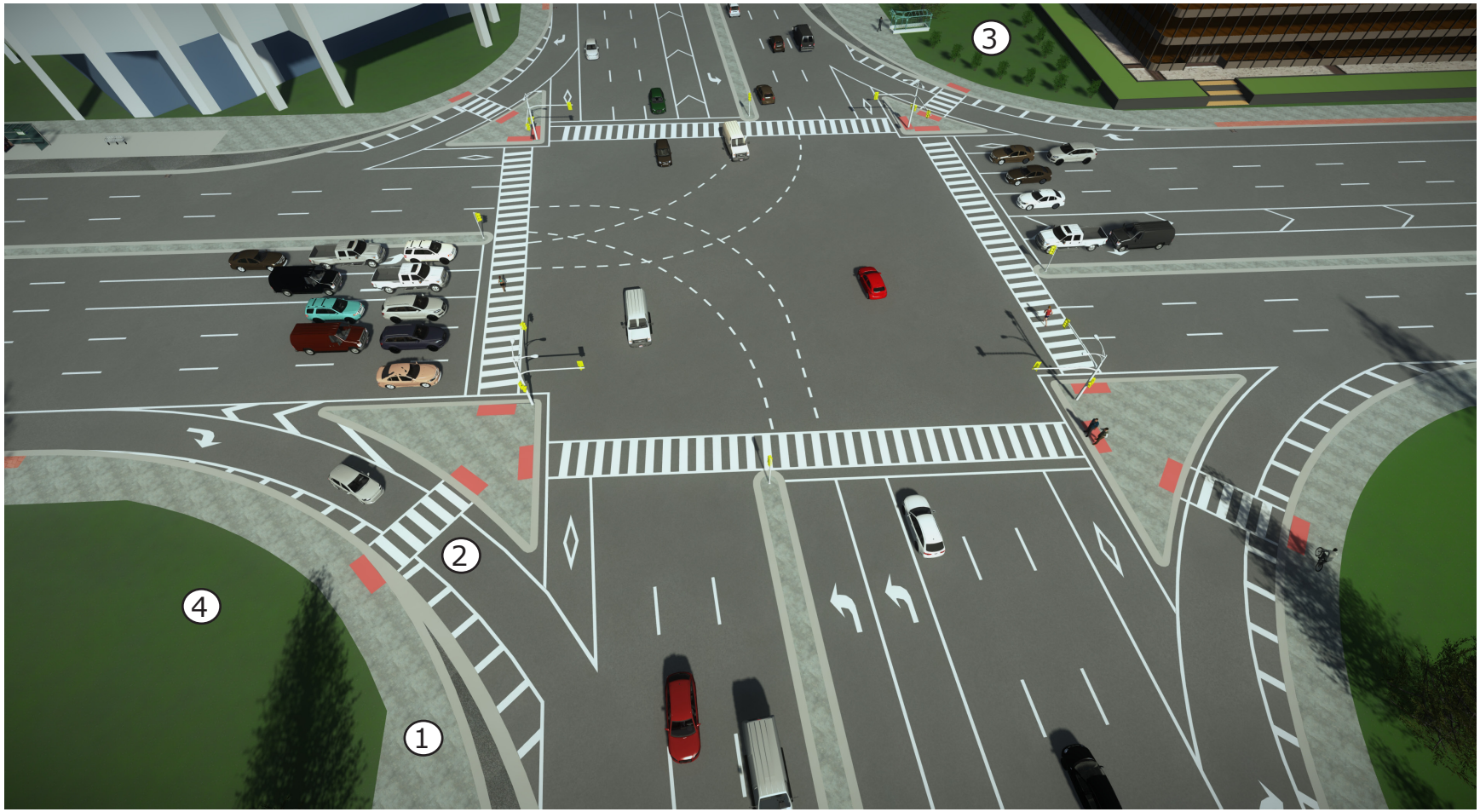
4 Lane Intersection



1. Bike Lane
2. Bike Parking
3. Shared-lane marking or sharrow
4. Bike Turning Box
5. Refuge Island
6. Tree and Shrub Plantings
7. Infiltration Chambers

Illustrative Cross Sections

6 Lane Intersection



1. Multi-Use Trail
2. Right Turn Channel
3. Tree and Shrub Plantings
4. Infiltration Chambers

Bicycle crossing at Steeles and Hurontario (Source: Region of Peel)

Roundabouts

A review of streetscaping opportunities for roundabouts was not included in the original Toolbox as no roundabouts were planned on Regional roads at the time. Since 2011, multiple roundabouts have been built and roundabouts are considered in the planning stage of environmental assessment projects at all intersections.

Roundabouts improve:

- traffic safety through the elimination of T-type collisions;
- traffic flow as vehicles slow down but may not have to stop before entering the roundabout; and,
- air quality by eliminating unnecessary stopping and idling at intersections.

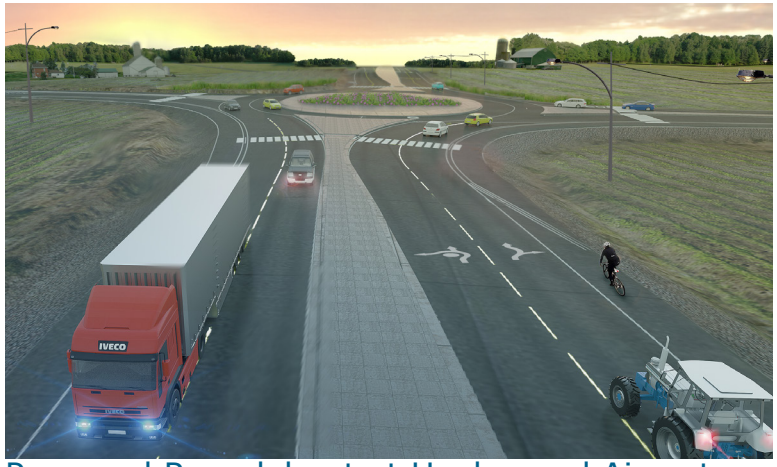
Landscaping in the centre of the roundabout blocks oncoming vehicle headlights and works with road geometrics and signage to safely guide drivers through the intersection. Potential plantings should include coniferous trees that help block oncoming traffic headlights year round.

The centre of the roundabout can be used for low impact development (LID) practices that can minimize and treat runoff to help achieve stormwater management objectives. The road cross section is designed to slope towards the center island. A curb-less edge or curb cuts can be used to direct stormwater.

Roundabouts also provide opportunities to improve aesthetics along a road corridor through the use of landscaping for beautification or to serve as a gateway feature.

Roundabout at Dixie Road and Olde Baseline Road (Source: Region of Peel)

Planted Roundabout at Dixie and Olde Baseline (Source: Region of Peel)

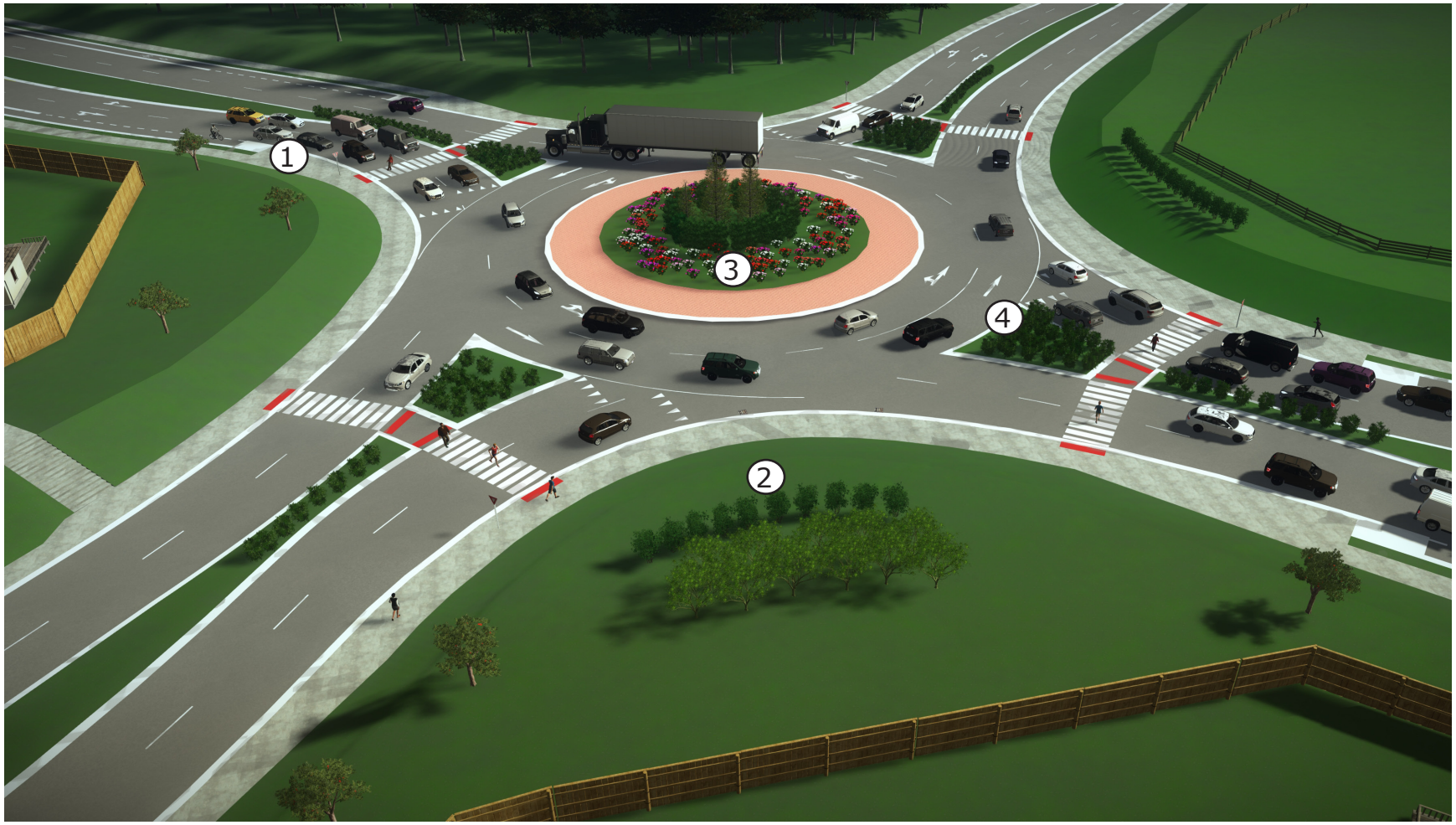


Proposed Roundabout at Healey and Airport Road (Source: Region of Peel)

Emil Kolb Parkway Roundabout (Source: Region of Peel)

Illustrative Cross Sections

Roundabout



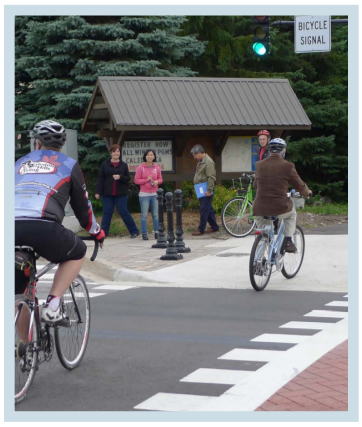
① Multi-Use Trail
② Tree and Shrub Plantings
③ Infiltration Chambers
④ Median Plantings

Table 11: Streetscaping options to consider for each road typology at roundabouts

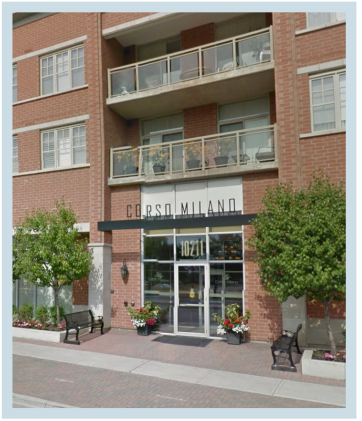
Road Typology	ROW Construction Type	Median Refuges	Pedestrian Cross-Overs	Cross Rides	Gateway Features	Infiltration Chambers
Rural Road	Resurfacing	**N**	**N**	**E**	**N**	**N**
	Reconstruction	**N**	**N**	**E**	**N**	**N**
Rural Main Street	Resurfacing	**N**	**E**	**E**	**E**	**E**
	Reconstruction	**R**	**R**	**R**	**E**	**R**
Urban Main Street	Resurfacing	**E**	**E**	**E**	**E**	**E**
	Reconstruction	**E**	**R**	**R**	**R**	**R**
	New Construction/Widening	**R**	**R**	**R**	**R**	**R**
Suburban Connector	Resurfacing	**N**	**E**	**E**	**N**	**E**
	Reconstruction	**R**	**E**	**E**	**N**	**R**
	New Construction/Widening	**R**	**E**	**E**	**N**	**R**
Commercial Connector	Resurfacing	**N**	**E**	**E**	**N**	**E**
	Reconstruction	**E**	**E**	**E**	**N**	**R**
	New Construction/Widening	**E**	**E**	**E**	**N**	**R**
Industrial Connector	Resurfacing	**N**	**N**	**E**	**N**	**E**
	Reconstruction	**E**	**N**	**E**	**N**	**R**
	New Construction/Widening	**E**	**N**	**E**	**N**	**R**

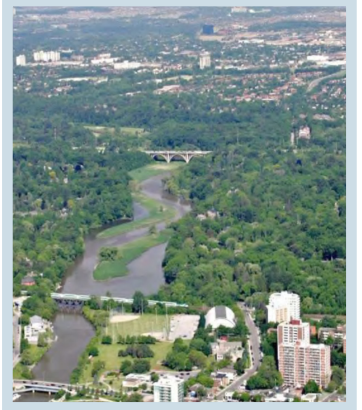
R = Recommended; **E** = Enhanced; **N** = Not Applicable

Section 4: Summary









Summary

The Streetscaping Toolbox Update supports the 2015 - 2018 Term of Council Priorities:

- Adapt to and Mitigate the Effects of Climate Change;
- Improve Goods Movement; and,
- Promote Healthy and Age-Friendly Built Environments;

This update aligns with the Council-approved Road Characterization Study (RCS) while providing a user-friendly and practical document that provides detail about how to design the streetscape in Regional right-of-ways.

Emerging issues such as climate change and health have been included in the Update to address how Transportation infrastructure can support healthy outcomes and the environment. Climate change is causing devastating impacts and the Region of Peel has experienced flooding, damage to infrastructure and personal property losses from recent extreme weather events. The update reflects Provincial policies such as the MOECC report "Policy Review of Municipal Stormwater Management in Light of Climate Change" and the interpretation bulletin that states that "the natural hydrologic cycle should be maintained to the greatest extent possible".

A partnership between Transportation, Public Health and the Credit Valley Conservation Authority was created in order to incorporate these council priorities, policies and objectives into this Toolbox.

In order to carry out these council priorities, the Streetscaping Toolbox Update will be used as a streetscaping reference tool by Region of Peel staff including staff members from Public Works, Health, Integrated Planning, and Development Services, and area municipalities, consulting engineers and planners and the development community for:

- master plan studies;
- environmental assessments;
- land use plans and development applications;
- road construction projects;
- health initiatives;
- green infrastructure; and,
- roads maintenance activities such as tree replacements and rehabilitation of existing landscaping.

Streetscaping Regional right-of-ways supports and enhances Regional, local municipal and Conservation Authority strategies, policies and programs. It complements active transportation infrastructure by creating an appealing and comfortable environment for all users; it helps to infiltrate and manage stormwater within the right-of-way; it provides a place that encourages healthy walking and cycling; it helps to mitigate the urban heat island effect and manage air quality; and provides social benefits including placemaking and positive social interaction.

References

1. Region of Peel. Term of Council Priorities. Available from: https://www.peelregion.ca/strategicplan/term-of-council-priorities.htm. Accessed February 3, 2017.

2. Region of Peel. Road Characterization Study. 2013. Available from: http://www.peelregion.ca/pw/transportation/business/pdfs/rcs-full-report.pdf. Accessed: February 3, 2017.

3. Ontario Ministry of the Environment and Climate Change. Policy Review of Municipal Stormwater Management in the Light of Climate Change. Available from: https://www.ontario.ca/page/policy-review-municipal-stormwater-management-light-climate-change. Accessed on February 3, 2017.

4. Ontario Ministry of the Environment and Climate Change. Interpretation Bulletin Expectations Re: Stormwater Management. February 2015. Available from: http://www.sustainabletechnologies.ca/wp/wp-content/uploads/2015/02/MOECC-Interpretation-Bulletin-Stormwater-Management.pdf. Accessed February 3, 2017.

5. Region of Peel. Official Plan. 2014. Available from: https://www.peelregion.ca/planning/officialplan/pdfs/rop-consolidation-oct2014.pdf. Accessed: February 3, 2017.

6. Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads. Available from: http://www.tac-atc.ca/en/projects/production/geometric-design-guide-canadian-roads-new-edition. Accessed: February 3, 2017.

7. Geometric design standards for Ontario highways. Ontario Ministry of Transportation. Surveys & Design Office. Imprint Downsview, Ont.: Surveys and Design Office, c1985.

8. Region of Peel. Peel Long Range Transportation Plan. 2012. Available from: https://www.peelregion.ca/planning/residents/transportation/LRTP-Report.pdf. Accessed: February 3, 2017.

9. Peel Healthy Development Index. 2009. Available from: http://www.peelregion.ca/health/urban/pdf/HDI-report.pdf. Accessed: February 3, 2017.

10. Improving Health by Design in the Greater Toronto Hamilton Area: A report of the GTHA medical officers of health. 2014. Available from: http://www.peelregion.ca/health/resources/healthbydesign/pdf/moh-report.pdf. Accessed: February 3, 2017

11. City of Toronto. A Health Toronto By Design Report – Road to Health: Improving Walking and Cycling in Toronto. 2012. Available from: http://www.toronto.ca/legdocs/mmis/2012/hl/bgrd/backgroundfile-46520.pdf. Accessed: February 3, 2017.

12. Community design factors and their influence on physical activity in the aging population: A Rapid Review; November 2016. Available from: http://www.peelregion.ca/health/library/pdf/rapid-reviews/rapid-review-community-design.pdf. Accessed: February 3, 2017

13. Accessibility for Ontarians with Disabilities Act (2005) Available from: https://www.ontario.ca/page/accessibility-laws. Accessed: February 3, 2017.

14. National Association of City Transportation Officials. Available from: http://nacto.org/publication/urban-street-design-guide/. Accessed: February 3, 2017.

15. The Region of Peel Street Tree Inventory; October 2014. Unreleased internal report.

16. Peel Region Urban Forest Strategy (2011). Available from: https://www.peelregion.ca/planning/climatechange/reports/. Accessed: February 3, 2017.

17. LID Implementation Process for Regional Road Right-of-Ways. 2015. Unreleased internal report.

18. Peel Climate Change Strategy. 2011. Available from: https://www.peelregion.ca/planning/climatechange/reports/pdf/climate-chan-strat-rep.pdf. Accessed: February 3, 2017.

19. Pedestrian and Bicycle Facility Design Guidelines, 2014. Available from: https://www.peelregion.ca/pw/construction/pdf/pedestrian-bicycle-facility-design-guidance.pdf. Accessed: February 3, 2017.

20. Grey to Green Road Retrofits: Optimizing Your Infrastructure Assets through Low Impact Development. Available from: http://www.creditvalleyca.ca/wp-content/uploads/2015/01/Grey-to-Green-ROW-Road-Right-Of-Way.pdf. Accessed: February 3, 2017.

21. MTO Road Safety: Pedestrians. Available from: http://www.mto.gov.on.ca/english/safety/pedestrian-safety.shtml. Accessed: February 3, 2017.

22. Ontario Traffic Manual Book 15: Pedestrian Crossing Facilities. 2010. Available from: http://www.directtraffic.ca/wp-content/uploads/2014/02/Book-

151.pdf. Accessed: February 3, 2017.

23. Public Works Design, Standards Specification & Procedures Manual. Available from: https://www.peelregion.ca/pw/other/standards/. Accessed: February 3, 2017.

24. Region of Peel's Active Transportation Study; November 2011. Available from: http://www.walkandrollpeel.ca/projects/pdf/TTR-ATplan-part1-final-v2-2011-11-23v2.pdf. Accessed: February 3, 2017.

25. Low Impact Development Stormwater Management Planning and Design Guide. 2010. Available from: http://sustainabletechnologies.ca/wp/wp-content/uploads/2013/01/LID-SWM-Guide-v1.0_2010_1_no-appendices.pdf. Accessed: February 3, 2017.

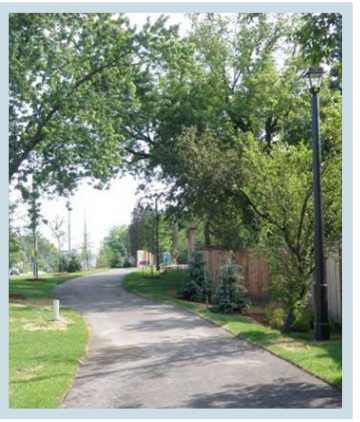
26. Canadian Centre for Occupational Health and Safety: Canadian Highway Bridge Design Code. Available from: http://www.ccohs.ca/products/csa/27012322014. Accessed: February 3, 2017.

27. Ontario Provincial Standards for Roads and Public Works. Available from: http://www.raqsa.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage. Accessed: February 3, 2017.

Appendices







This Page Intentionally Left Blank

Appendix A - Planting Standards and Maintenance Practices

Planting Standards

Trees provide a number of benefits to both the natural and social environment. As trees grow, their leaves absorb carbon dioxide during photosynthesis and it is stored in their branches, trunk, and roots while oxygen is released. In addition to this, trees also absorb other air pollutants such as ozone, carbon monoxide, and sulfur dioxide. The planting of trees, shrubs, and herbaceous plant materials also contributes to an increase in air quality as their leaves filter out dust and other particulates.

Tree planting can also alter the microclimate of a site by moderating extreme sun, wind, and precipitation. The leaves on a tree are constantly absorbing or deflecting radiant solar energy, creating a cooling effect under the canopy and moderating the urban heat-island effect caused by asphalt and other built surfaces. Also, the correct tree species planted in an appropriate location can create an effective windbreak by altering wind speed and direction, as well as influencing snow deposition in the winter.

At a larger scale, trees and landscaping also help to moderate the effects of climate change and support existing stormwater infrastructure by retaining a portion of the water after a storm event.

The character of a city, neighbourhood, or region is changed by the abundance of trees. By screening out unattractive views, reducing noise pollution, and enhancing the aesthetic appeal of architecture and built forms, trees provide benefits at the streetscape level, while also contributing to canopy cover at the Regional level. Thoughtful streetscape design also encourages the use of the road right-of-way for healthy activities, such as walking and cycling.

The most common causes of premature tree decline and mortality are a lack of water, environmental stress, and physical restriction to root system and canopy development. Soils which are poorly drained, heavily compacted, or highly alkaline may also impact tree health. Salt spray and runoff from roadways containing salt may also negatively impact tree growth. However, since these conditions are typical of the road right-of-way in an urban environment, mitigation through choice of plant material and optimization of growing conditions to support tree health is essential.

General Planting Considerations

1. Confirm the location of all existing or proposed above and below ground utilities

early in the design process, to facilitate the preparation of a feasible planting plan.

2. Provide the largest possible growing space for the root system and canopy of each planted tree. As more soil yields a larger root system and a healthier tree, it is important that every tree is planted in an adequate soil bed. A rough guideline for determining the required soil volume for a planting is that each cubic metre of soil volume will support approximately 2.2m2 of tree canopy area. When designing the planting area, it is also important to note that approximately 95% of a tree's root system is found in the upper 0.6 m of soil. For mass plantings, provide a continuous root zone to maximize soil volume, water, and oxygen infiltration.

3. All trees should be planted in the ground where possible, to avoid the increased initial cost and long-term maintenance commitment associated with planting in containers or planters.

4. Maintaining sight lines and taking into account safety considerations are important components of developing a tree planting plan. All planting designs must provide adequate sight lines for safe stopping and turning at intersections, as well as sufficient access for turning in and out of private accesses.

5. Trees should not be planted where they may potentially obstruct the visibility of regulatory or cautionary traffic control signs, crosswalks, or fire hydrants. Trees should also not be planted within the daylighting triangle of an intersection.

6. In the event of interim traffic improvement projects, landscaping should be installed taking into consideration the ultimate cross-section of the roadway. This is recommended to ensure that the existing and established landscaping is not affected by subsequent roadway improvements.

7. Fill embankments slopes and noise attenuating berms can be hostile environments for plants due to the increased sun and wind exposure, highly compacted soils, and reduced moisture availability. Special attention is required while selecting plant materials and determining soil treatments when streetscape improvements are proposed involving slope plantings.

Salt Tolerant Landscaping

1. Vegetation planted in close proximity to roads and sidewalks often faces adverse growing conditions in the winter due to de-icing salt spray and snow or salt loading. As such, plant materials planted within the ROW should be selected based on their tolerance to salt spray and saline soils. The

plant list in Appendix D-G identifies salt tolerant species.

2. Where possible, ensure that planting designs employ groupings of plants instead of individual specimens, in order to maximize the protection created by adjacent vegetation.

3. Where existing vegetation is to be retained within or adjacent to the ROW and it is not salt tolerant, consider implementing filtration strips or comparable green infrastructure, and intercept plantings between the road and sensitive vegetation, to block the majority of air-borne salt spray and to catch salt laden run-off. Filter strips should be composed of tightly knitted, suckering, and salt tolerant shrubs such as native dogwood (Cornus spp.), willow (Salix spp.), and sumac (Rhus spp.), as well as any additional species indicated as salt tolerant listed in Appendix D-G.

4. Excessive salt loading can also lead to the deterioration of soils. Where excessive salt loading is likely, the addition of gypsum (calcium sulphate) to soils can improve the structure and drainage of the soil and facilitate the leaching of salts. Rates of application should be determined on a site-specific basis through an analysis of existing and proposed conditions.

5. Excessive salinity can also deteriorate the biological activity of soils; therefore it is important to ensure that the planting media has been augmented with biologically active amendments, such as compost. Mycorrhizae are a symbiotic group of fungi that can enhance a plant's nutrient uptake, drought tolerance, and rate of growth. These beneficial organisms can be added as an amendment to increase biological activity of the soil and plant health. The Region generally recommends the mycorrhizal inoculant Myke Pro Landscape – G or approved equivalent with every tree planting; however amendments should be determined on a site-specific basis through an analysis of existing and proposed conditions. Additionally, when planting adjacent to natural areas, a locally-sourced inoculant can be made by creating a slurry of soil and water from an adjacent vegetation community with similar plant species. Consult with regulatory agencies where an intrusion is proposed into a natural feature or materials will be removed.

6. Air-borne salt spray and salt laden runoff also percolates into soil and can result in an accumulation of salt. To lessen this build-up, a spring flush of the soil around trees and planting beds is recommended to reduce salt loading. A heavy watering, either manually or through an irrigation

system, is recommended in the spring to leach salts through the soil and away from the root zones of plants. Additionally, it is recommended that the salt residue is washed from the branches and trunks of trees and shrubs.

Existing Tree Preservation

When road corridors are identified for improvement, they undergo an environmental assessment (EA) study that evaluates existing features, constraints, and opportunities, as well as any changes identified through the public consultation process. The environmental study for the EA provides an inventory and condition assessment of existing vegetation, including trees, and also identifies Species At Risk (SAR). High quality trees identified for retention should be determined at both the EA stage and reconfirmed in detailed design. The species, location and elevation of the trunk and drip line, size (measured as the diameter at breast height or 1.37 metres high,) and health of trees should be assessed to accurately determine the retention potential and recommended mitigation measures.

The retention potential of trees should be determined within the context of resulting changes to the water table and site drainage. Additionally, soil compaction and root zone disturbances as a result of construction activities such as grading and excavation should be considered, as well as changes in microclimate and exposure to salt and other airborne contaminants. The inventory process will identify existing trees tolerant of right-of-way conditions and should also influence proposed planting recommendations. The relocation of utilities to their ultimate location may also impact the retention potential of existing trees.

The installation of utilities in open trenches should be routed at the outer edge of the drip line, wherever trees are being retained. Trenchless construction is recommended where utilities must be installed within the drip line of mature or historically significant trees, when the trees are of good health and with such structural integrity that they warrant retention.

Pre-construction, construction, and post construction mitigation measures, such as temporary protective fencing, pre-stressing, branch or root pruning, fertilization, or additional post-construction planting, should be prescribed by a qualified professional and completed by a certified Arborist. Pre-stressing may only be appropriate in certain situations and requires consultation with the appropriate regulatory agency. Pre-stressing of an existing woodlot edge may involve the removal of trees which are declining, diseased, or in poor condition, one to two years in advance of construction. A pre-stressing treatment of the woodlot edge

should encourage the release of existing native saplings, as well as increase the tolerance of existing herbaceous plants to the new site conditions.

Protection of trees to be retained should be provided by the installation of a temporary tree protection fence consisting of 1.2 m 9 gauge wire farm fence wired to steel "T-Bar" posts on 3.0 m centres in conjunction with 15 cm diameter wooden posts (or double "T-Bar posts) on 21.0 m centres. Silt fencing or filter cloth should be attached to the front of the fence where drainage and potential siltation is a concern. Periodic inspection and maintenance of the temporary tree protection fence should be completed throughout construction.

Plant Species Selection

A plant list is provided in Appendix D-G to assist with the preparation of planting plans for landscape improvements. The plant list should not be considered a comprehensive list as additional plants may become available that are suitable for arterial road landscaping. The plant species selection for each site specific planting program will require consideration of the following plant characteristics:

Habitat

The natural distribution or range of a particular plant species. Species native to the Region of Peel are recommended where suitable habitat exists, or in other areas adjacent to natural areas, ravines, watercourses and stormwater management basins.

Size: Estimated typical height and spread of a species under normal landscape conditions.

Growth Rate: The vertical increase in growth under normal landscape conditions. A slow growth rate refers to less than 30 cm of growth per year, while a moderate growth rate is 30 cm to 60 cm of growth per year, and a fast growth rate is greater than 60 cm of growth per year.

Canadian Plant Hardiness Zone:

Hardiness is the term used to describe the ability of a plant to be grown successfully in the temperature and general climate of an area. The minimum temperature that a plant can tolerate is indicated by the hardiness zone assigned to it. The Region of Peel is within plant hardiness zones 5a, 5b, and 6a according to Plant Hardiness one Maps by Natural Resources Canada. Ensure that the hardiness of a selected species reflects the site-specific conditions. Plants with a hardiness rating of 6 or greater should be used with caution.

Attributes

Plants are often identified for having interesting ornamental qualities such as leaf or bark colour, overall form, and flowers.

Growth Habit
The ultimate form or outline of a plant; this characteristic should influence the planting design.

Diversity
Planting designs should include species from a variety of different taxonomic families, as monoculture plantings have the potential for mass failure in the event of a disease or pest infestation, as seen with the significant loss of boulevard trees due to Dutch Elm Disease, Asian Long-Horned Beetle, and Emerald Ash Borer. The Peel Urban Forest Strategy (2011) recommends no single species represents more than 5 percent of the tree population, no genus represents more than 10 percent of the tree population, and no family represents more than 20 percent of the tree population.

Urban Tolerance
Observe the species' tolerance to salt or urban pollution based on a review of the literature (Lumis et al., 1973, and Dirr, 1976).

Invasive plants are those species which can move into a habitat and reproduce so aggressively that they can replace some of the original components of the vegetative community (White and Haber, 1992). Potentially invasive species should not be considered for planting, especially where there is the opportunity for them to invade a natural area.

Where vegetation is desired within the clear zones of the right of way, along boulevards, and within the median, it is recommended that break-away vegetation be selected, where there are no planters, to reduce the risk of injury to vehicle occupants in the event of an accident. Designers are to follow the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads, and consider design speed and clear zone when choosing plant material. TAC provides guidance on the decision-making process to select appropriate combinations of features, dimensions, and materials for a design. Break-away or frangible vegetation are plants that will readily break, bend, or crush upon collision by a typical passenger vehicle. Typically, vegetation that is considered to be frangible is that which has a trunk or stem diameter 100mm or less, as measured between 150mm-300mm from the ground. In general this may exclude trees planted within the median and immediately adjacent to the curb, but tree locations should always be reviewed in conjunction with design speed and clear zone as the Region looks for more opportunities to increase its urban forest. The greatest opportunities to plant trees exist within the Region's boulevards.

Using vegetation for minor crash attenuation can also be explored where desired. Although definitive research regarding the use of vegetation for crash attenuation is limited, shrub borders which incorporate thicket-forming,

densely-growing vegetation within medians and along roadsides can assist in the gradual reduction of vehicle velocity when impacted in a crash.

Where vegetated crash cushions are desired, it is recommended that they are designed to a minimum width of 3m. While planting locations and clear zones shall conform with the guidelines herein, species suitable for these 'crash cushion' plantings include flexible trees and shrubs including, but not limited to, the following:

- *Cornus racemosa*, Gray Dogwood
- *Cornus rugosa*, Round-leaved Dogwood
- *Cornus stolonifera*, Red-osier Dogwood
- *Rosa blanda*, Smooth Rose
- *Salix discolor*, Pussy Willow

Consideration should also be given to the growing conditions of the site when selecting species for crash attenuation.

It should be noted that vegetated crash cushions are not a direct substitution for engineered crash attenuators, and that the above recommended planting list can be utilized in conjunction with other engineered measures where more robust barriers or guards are required.

Recommended Planting Standards

The following is based on a review of the Reference Guide for Developing Planting Details (1995) produced by Landscape Ontario in association with the Ontario Association of Landscape Architects and Landscape Ontario Horticultural Trades Association and input from Regional staff. For additional planting details, refer to the following Region of Peel Planting Design Details (2016): caliper coniferous and deciduous tree planting detail for landscaped beds; caliper coniferous and deciduous tree planting detail for softscape boulevards; caliper deciduous tree planting detail for tree grate planter; and container grown shrub detail.

Soils within the right-of way should be tested and analyzed to identify undesirable planting conditions, and amended as required to encourage plant survival.

Highly compacted soils should be ameliorated with improved drainage, aeration, and soil amendments. Soils that have been heavily compacted by construction activities may require use of a vibrating sub-soiler or a chisel plow to improve aeration and drainage.

All foreign material (i.e. miscellaneous matter, lumber, cement, mortar, large rocks, and asphalt,) shall be removed and disposed of off-site in an approved location.

Soils contaminated with hydrocarbons such as gas, oil, and residual herbicides or pesticides shall be removed and disposed of off-site in an approved location, as per Ministry of the Environment guidelines.

Quality topsoil which is evenly mixed, well aerated, and free of debris or contaminants shall be added to replace any soil or substrate that is discarded. The topsoil shall not be used if it is in a muddy or frozen condition.

To maximize tree health in urban configurations where trees are surrounded by paving, consider the use of a product such as 'Silva Cell' or similar product to decrease soil compaction and increase soil volume. Conflicts with utilities must be reviewed as part of the planting design.

Backfill the planting hole using the existing soil removed from the dug planting hole and tamp in place to eliminate air pockets. Where poor quality backfill material has been identified, the material should be removed and replaced so that it will not impact planting success. The replacement soil must be of a similar texture and structure to that of the surrounding area.

Soil samples should be collected and tests conducted to determine if fertilizer is required to enhance soil productivity.

Suitable compost material may be available at the Regional landfill and may be an attractive alternative to manufactured soil amendments. Prior to use, the compost material should be analyzed for macro-nutrient content and potential contaminants.

The width and depth of planting pits should be governed by the size of the root mass and soil drainage. The pit should be excavated so that the root collar of the plant is 5-10 cm above the finished grade. It is recommended that in well-drained soils the sides and bottom of the planting hole are scarified to reduce soil compaction in the root zone.

For poorly drained soils, the planting pit should be excavated to a depth so that the root collar will be positioned 5-10 cm above the finished grade as settling may occur. Glazing of soil pits may occur in poorly drained clay soils, therefore augured planting pits are not recommended. It is also recommended that in poorly-drained soils, the sides and bottom of the planting hole are scarified to reduce soil compaction in the root zone.

Staking or guying of trees is recommended to protect the trunk from breakages, maintain the trunk in a vertical position, and to provide anchorage for roots while they become established.

Stakes shall be wooden and placed into undisturbed soil aligned with prevailing winds where necessary, to provide adequate stability.

No stakes shall be driven through the root ball of container supplied stock or the root mass of bare root stock. Tree stakes must be removed one year after date of installation.

Tree ties should be used to hold the trunk in place and protect the trunk from damage. Many brands of biodegradable tree ties are available for this purpose, and are ideal in situations where long-term staking is required or where follow-up site visits are not possible.

Trunk protection is recommended to protect trees from mechanical damage during shipping, handling, planting, and landscape maintenance. Trunk protection is also recommended to protect trees from browsing and chewing damage caused by rodents and other mammals.

Recommended methods of protection are as follows:

- Animal injury: Arborguard + AG9-4 or approved equivalent tree guard.
- Lawn maintenance injury: Arborguard + AG9-4 or approved equivalent tree guard.
- Mechanical injury: Arborguard + AG9-4 or approved equivalent tree guard.
- Sunscald injury: White wash, burlap wrap, “Kraft Wrap,” or “Foylon” applied to the trunk.

All tree protection measures must be removed at the end of the maintenance and warranty period.

Vine plantings should be clearly delineated with arched concrete, plastic edging, or aluminum edging to protect new plantings from lawn maintenance injury. In addition, the base of the vine should be protected with an approved tree guard (trimmed to size) or wrapped with burlap.

Woodchip mulch is recommended to conserve soil moisture, reduce weed problems, minimize erosion and surface compaction, improve soil structure and planting bed aesthetics, and moderate soil temperature.

Woodchip mulch should be composed of disease and insect -free partially composted twigs, branches, and tree bark. Mulch shall be applied to a depth of 10 cm, with a mulch ring 30 cm deep created at the edge of the root ball. Mulch shall be kept clear of the trunk to a distance of 5 cm.

Suitable landscape mulch material may be available from the Regional landfill. Brush clippings collected from dead, dying, or diseased trees should not be used. Additionally, wood chips are not recommended in plantings directly adjacent to watercourses and wetlands.

Prune at the time of planting to carefully remove dead, broken, damaged, or interfering branches,

as well as double leaders and narrow branch unions.

Avoid "heading" or "tip pruning" cuts to main leaders. Avoiding tip pruning is essential for maintaining a tree's ideal shape, and using "thinning cuts" where cuts are made at a lateral branch union to remove unwanted branches will encourage structurally sound branch development.

Do not apply any tree wound dressings to cuts. They do not provide any measurable benefits, as trees will naturally seal wounds without the aid of additional chemicals.

The preferred planting period for trees and shrubs is during the spring, with fall planting also being acceptable for numerous species. Spring plantings are generally more successful than fall plantings because they have the benefit of typically high seasonal precipitation, and plant material has the opportunity to become established during the summer months prior to winter dormancy.

Trees should be watered at the time of installation as per the Region's planting specifications and a Gator Bag installed to provide continuous drip irrigation for the first 3 years of the trees' life.

Recommended Plant Layout Standards

A number of cross-sections and plan views have been prepared illustrating the implementation of the recommended plant layout standards.

1. Specify trees, shrubs, and groundcovers so that pedestrian and vehicular sight lines are not obstructed. Trees should not be planted within sight triangles.

2. Where caliper sized trees (>40 mm diameter) are specified in groups they should be spaced at a distance of approximately 5-8 m on centre. Exact tree spacing should be determined based on the planting site and species selection.

3. For naturalized plantings of 125 cm to 300 cm tall nursery stock, tree spacing may be reduced to 2.5-3.5 m on centre based on species selection. Where high mortality is anticipated and small seedling stock is planted, the spacing may be reduced to less than 2.5 m on centre.

4. Bare root plantings of suitable deciduous trees and shrubs are only recommended for naturalized plantings within ravine, valley, river and stream corridors; plantings adjacent to woodlot edges; or within stormwater management facilities. Bare root stock should only be used during

spring planting to reduce installation and maintenance costs.

5. All right-of-way plantings must be supplied as container grown or in appropriate containers (i.e. plastic or fibre pots, ball and burlap, or wire basket,) with soil surrounding the root mass. All wire, rope, burlap, and twine shall be removed from the top 1/3 of the rootball and all containers are to be removed prior to planting, including fibre pots.

6. The planting of mulched clusters of trees and shrubs is recommended to reduce competition for nutrients and moisture from herbaceous plants, and for mutual shade and wind reduction benefits.

7. Where long lengths of linear plantings are proposed, landscape architects are encouraged to create a visually interesting environment by taking into account the plant materials' buds, foliage, flowers, and fruit. Interesting planting designs can be created through the implementation of basic planting principles of: repetition, variety, balance, emphasis, sequence, and scale.

8. Naturalize steep embankments with native trees and shrubs as appropriate to stabilize slopes, reduce long term maintenance costs, improve aesthetics, and provide local wildlife habitat and cover.

9. Where light standards are present, provide a minimum 6.0 m setback between the light standard and the proposed tree plantings.

10. Where sidewalks and/or multi-use trails are present, provide a minimum setback of 1.5 m between the trunk of the proposed deciduous tree and existing infrastructure. For coniferous trees, provide a minimum 1.0 m setback between infrastructure and the estimated drip line at 15 years.

11. Where noise walls are present, provide a minimum 1.5 m setback between the trunk of the tree and the noise wall. Where noise walls are absent and planting of trees on private property is not possible, provide a minimum 0.15 m setback between the trunk of the tree and the property line.

12. Where shrub plantings are proposed, provide a minimum 1.0 m setback from pedestrian sidewalks or multi-use trails to ensure pedestrian security.

13. Vines may also be planted to soften the appearance of noise walls and improve right-of-way aesthetics where minimum setbacks for trees and shrubs are not available.

14. Planting of trees in above ground planters is not recommended. Planters should only

be used for shrubs and annuals where at-grade plantings cannot be accommodated and irrigation is available. Planters should be insulated, made of durable material such as concrete, and bottomless with minimum dimensions of 1.5 m x 1.5 m x <0.75 m (ht.). Planters should only be installed where adequate separation is available and sight line and hazard zone issues do not exist.

15. The median planting of trees is encouraged where the median is greater than 5.5 m in width to enhance the visual diversity of the right-of-way. The planting zone must have an adequate volume of planting substrate for the long term health and viability of the trees. Slight topographic variation (i.e. mounding) is recommended to enhance visual diversity, provide a distinct visual separation between opposing lanes of traffic, and ensure proper drainage of salt laden run-off. An irrigation system or the use of green infrastructure to direct drainage from hardscaped areas within the streetscape to landscaped areas in the median is preferable and supports plant health and survival.

Groundcovers and Erosion Control

Groundcovers are important to control wind and water erosion, and are essential in eliminating dust and mud problems within the right-of-way of a road. Groundcovers also reduce roadside glare, air pollution, heat extremes, and visual pollution problems.

CVC has developed native seeds groups to be sowed in specific areas in conjunction with the Ontario Seed Company. A link to the native seed mixes for multiple uses is available at:

https://www.oscseeds.com/ecommerce/native-seed-/

All slopes steeper than 4:1 should be protected with durable erosion control measures such as biodegradable fabrics comprised of wood or a mixture of wood fibre and wheat straw (i.e. Curlex - American Excelsior Company, SC15O - North American Green or approved equivalent,) or a bonded fibre matrix (i.e. Soilguard or approved equivalent,) until the soils are stabilized by the establishment of vegetation. The erosion control product specified should be on the Ministry of Transportation Designated Sources List.

Roadside groundcovers should be recommended based on an evaluation of the following characteristics:

- low maintenance requirements (i.e. reduced mowing, fertilizer and pesticide requirements);
- demonstrated tolerance to drought, salt, pollution, and heat;
- aesthetics; and,
- potential invasiveness

The following groundcovers have been developed for roadside use and are suitable for the following applications:

Commercial, Urban, or Industrial Boulevards and Medians:

40% Shortstop Tall Fescue cultivar

40% Mustang Tall Fescue cultivar

20% Bronco Kentucky Bluegrass cultivar

- Developed by Pickseed Canada Inc., this seed mix is known as "Futura Boulevard" for boulevard and roadway use, designed to produce a stand of deep rooted, moisture scrounging grasses.
- Developed to be tolerant of salt, traffic, and heat (including reflection off pavement.)
- Recommended to be fertilized at a rate of 2.1 kg of Nitrogen/100 m² and mown to a height of 50 mm.
- Not recommended for use adjacent to natural areas as these species are non-native and potentially invasive.

Additional seed mixes or sods may be developed by others and can be specified for boulevard and median use if they are evaluated by the Region to have desirable characteristics. Where site conditions permit and where turf grass is not required, native species tolerant of both drought and salt, such as those specified below, are preferred.

- Black-eyed Susan (*Rudbeckia hirta var. pulcherrima*)
- Gray-stemmed Goldenrod (*Solidago nemoralis ssp. nemoralis*)
- New England Aster (*Symphyotrichum novae-angliae*)
- Virginia Wildrye (*Elymus virginicus var. virginicus*)

Rural Roadsides:

Annual Cover Crop (see below)

Native graminoids and herbaceous species mix (see below)

- An annual cover crop, such as Buckwheat (Fagopyrum esculentum) for drier sites and Cultivated Oats (Avena sativa) for moist sites, should be used to reduce weed establishment during the initial seeding.
- Seed mixes should be tailored to the site conditions to ensure planting success, by taking into account soil moisture and road salt or pollution levels i.e. Dry Roadside Areas

%	Plant Species
35%	Virginia Wildrye (*Elymus virginicus var. virginicus*)
15%	Evening Primrose (*Oenothera biennis*)
10%	New England Aster (*Symphyotrichum novae-angliae*)
10%	Black-eyed Susan (*Rudbeckia hirta var. pulcherrima*)
10%	Canada Goldenrod (*Solidago canadensis var. canadensis*)
10%	Heath Aster (*Symphyotrichum ericoides var. ericoides*)
5%	Canada Anemone (*Anemone canadensis*)
5%	Wild Bergamot (*Monarda fistulosa*)

Moist Roadside Areas:

%	Plant Species
35%	Virginia Wildrye (*Elymus virginicus var. virginicus*)
20%	Fox Sedge (*Carex vulpinoidea*)
10%	Blue Vervain (*Verbena hastata*)
10%	Canada Goldenrod (*Solidago canadensis var. canadensis*)
10%	New England Aster (*Symphyotrichum novae-angliae*)
10%	Panicled Aster (*Symphyotrichum lanceolatum ssp. lanceolatum*)
5%	Fowl Bluegrass (*Poa palustris)*

For additional information on suggested native seed mixes and application rates for roadside naturalization projects, the following document provides a good starting point and receives updates regularly as new information becomes available: Credit Valley Conservation Seed Mixes, Version 1.1 (CVC, August 2014).

Embankment Slopes:

As embankment slopes are often located adjacent to natural areas and represent significant corridors through the Region, it is encouraged to plant species native to the Region of Peel where growing conditions permit. By planting native species, it is possible to increase species diversity and provide habitat for pollinators and other wildlife. Depending on the site conditions, such as the grade of slope, additional slope stabilization methods including vegetated retaining walls may also be employed. The following native species are tolerant of dry, windy, full sun conditions and can be sown directly onto prepared soil in the fall with an appropriate cover crop species:

- Black-eyed Susan (*Rudbeckia hirta var. pulcherrima*)
- Canada Goldenrod (*Solidago canadensis var. canadensis)*

- Common Milkweed (*Asclepias syriaca*)
- Evening Primrose (*Oenothera biennis*)
- New England Aster (*Symphyotrichum novae-angliae*)
- Virginia Wildrye (*Elymus virginicus var. virginicus*)
- Wild Bergamot (*Monarda fistulosa*)

An example of an appropriate seed mix supplier and suggested application rates for these conditions may be found in the CVC Seed Mixes document under Mix 7 (Upland Native Meadow Mix) (CVC, 2014).

The Guelph Turfgrass Institute at the University of Guelph is currently conducting experiments to develop low-maintenance roadside turf mixes. As new groundcover mixtures are developed, test plots should be implemented within the Regional Municipality of Peel to determine their suitability.

Signage should be installed to identify areas where mowing will be eliminated and natural regeneration encouraged. Natural regeneration is the ecological term used to describe the natural process of allowing adjacent woody vegetation to establish within the limits of the right-of-way. The natural regeneration process is initiated by the dispersal of seeds from an adjacent seed bank and the germination of those seeds resulting in the production of seedlings within the right-of-way (MTC, 1983).

Recommended areas for natural regeneration are as follows:

- areas inaccessible to mowing equipment;
- areas of existing natural regeneration;
- steep embankment slopes; and,
- areas within ravine, valley, river and stream corridors, adjacent to woodlot edges, wetlands, other natural areas, or within stormwater management facilities.

Maintenance of natural regeneration areas should be minimal and include periodic inspections during the appropriate season to ensure that driver sightlines are not restricted and that snow drifting problems do not develop.

Natural Regeneration of Rural Roadside Ditches

As rural roadways often bisect natural areas throughout the Region, they present a unique opportunity for natural regeneration within their drainage ditches. Although roadways are essential for the transport of people and goods, they have also been shown to act as a vector for the dispersal of invasive species (von der Lippe and Kowarik, 2007). Roadside ditches often provide inhospitable growing conditions

due to fluctuating moisture levels and the high concentrations of road de-icing salts which can accumulate in them. These conditions also provide the ideal environment for European reed (Phragmites australis ssp. australis) to colonize and displace native species. European reed is an aggressively spreading grass species, which can reach heights of over 5 m and densities of over 200 plants per square metre (OPWG, 2015). The threat to native species which European reed poses was highlighted in 2005, when it was recognized as Canada's worst invasive plant by scientists at Agriculture and Agri-food Canada.

The Region recognizes the negative impacts that European reed may have on native species and their habitats, as well as the impacts to stormwater infrastructure and existing hydrological conditions of roadside drainage ditches. Additionally, where European reed establishes adjacent to roadways, it can block sight lines and create safety hazards for pedestrians and motorists alike (OPWG, 2015). Due to the highly aggressive nature of this species, the use of herbicides is often required to ensure the successful removal of established populations.

When identifying sites for European reed removal, areas should be prioritized based on the following considerations:

1. Does the European reed patch block sightlines along roads, or is it currently impacting the performance of stormwater culverts, drainage ditches, or other infrastructure?
2. Is the patch adjacent to a sensitive feature, such as a wetland, creek, stream, or river?

Once an area has been selected for treatment, ensure that the timing of herbicide treatments will not negatively impact nesting birds, or breeding reptiles and amphibians. This is important to reduce potential wildlife mortality, and also to adhere to relevant legislation such as the Migratory Birds Convention Act (MBCA) (1994) and Endangered Species Act (ESA) (2007). It is recommended that herbicide applications occur from late summer to late fall and that wet roadside ditches are not treated with herbicides until they are dry, as currently available products are not intended for use in aquatic environments.

The following information is considered the current best practices for European Reed removal within regional roadways in the Region of Peel; however this information should be updated as new herbicides become available for use.

1. When a site has been identified for European Reed removal, record the exact location of the patch, the approximate length and width of the patch, plant density, and a site description. Also include potential constraints to control implementation, such

as wet conditions, steep slopes, or high traffic volumes, to help plan an efficient removal strategy.

2. Regardless of the herbicide selected for treatment, activities should be timed to reduce potential harm to nesting birds, fish, reptiles, and amphibians which may inhabit roadside ditches. A site inspection by a qualified biologist or ecologist is recommended in order to ensure that harm to wildlife is reduced.

3. The ideal timeframe for herbicide applications in the Region of Peel is late July to the beginning of October, as this allows time for wet sites to dry out, and minimizes potential impacts to wildlife. Herbicide application has been found to be most effective when dead stalks from the previous year are cut down prior to application. If the infested ditch is to be excavated, then it is recommended that herbicide application occur three weeks prior to the work being undertaken.

4. Of the two products currently available for use in Canada to control European reed, WeatherMAX® (registration No. 27487) is recommended for use in roadside ditches as it binds to the plant more quickly and therefore has fewer weather-related restrictions for application. The recommended concentration of this product is 4.5% - 5% for controlling Phragmites. It is important to note that no products currently available in Canada can be applied over water. It is also recommended that the surfactant MSO Concentrate Methylated Seed Oil (commercial name: Adjuvant® registration number 28385) also be added at a 1% concentration to increase plant uptake and improve herbicide effectiveness.

5. A hose and handgun applicator, using a medium-sized spray system (950 litre tank and motorized pumping system,) is a typical herbicide application method. Since both herbicides affect a broad spectrum of plants, it is important not to over apply and to minimize pesticide drift, especially near natural areas or adjacent waterbodies. Do not apply herbicides if the plants are wet from dew or rain, or if temperatures are not appropriate.

6. Do not cut down treated European reed for a minimum of three weeks after herbicide application, as this may reduce treatment effectiveness.

7. Ensure that all heavy equipment is cleaned, and that transported plant materials are contained to limit the spread of viable seeds or other plant parts.

8. Options for the disposal of treated European Reed include: composting with organic

materials (to a temperature greater than 57°C,) burning, or covering with at least 3m of overburden.

9. Once the European Reed patch is eradicated, the area can be seeded in the spring or fall with a native seed mix, as discussed below. If the patch requires multiple years of treatment, or if there is a high likelihood of erosion in the treatment area, the area may be seeded with an annual cover crop, such as cultivated oats, to reduce the potential for soil erosion and weed re-establishment until conditions are appropriate to apply a native species seed mix.

For additional information on identifying European Reed, additional control methods and pesticide application methods, and steps to prevent further spread of European reed during removals, refer to the Smart Practices for the Control of Invasive Phragmites along Ontario's Roads (OPWG, 2015).

In order to prevent European Reed from re-invading roadside ditches which have already received removal treatments, it is essential to ensure that a healthy population of native species becomes established in its place. The most effective prevention against future invasions is establishing a dense cover of native vegetation with a vigorous and well-established root system which will tolerate the harsh growing conditions. When purchasing plant materials, ensure to consult with suppliers to determine whether a seed mix or live plants are best suited to project conditions. It is also recommended that the chosen supplier obtains their seeds locally. As with any other planting project, follow-up site visits and regular maintenance are required for the first 2-3 years in order to ensure a successful project.

Plant selection will vary on a site by site basis; however the following are a list of species native to the Region of Peel which are fast growing, tolerant of hydrological conditions found within roadside ditches, and show a degree of salt tolerance.

An example of an appropriate seed mix supplier and suggested application rates for these conditions may be found in the CVC Seed Mixes document under Mix 6 (Early Successional Wet Meadow Mix) however the substitution of salt tolerant species such as those listed above may also be required (CVC, 2014).

Bioengineering

Bioengineering is the implementation of engineering techniques through the use of mechanical elements (or structures) in combination with biological elements (such as plants) to arrest and prevent slope failures and erosion. The biological and mechanical elements must function together in an integrated and complementary fashion (Gray and Leiser, 1982).

Bioengineering emphasizes the use of indigenous materials, such as earth, rock, timber and vegetation (i.e. Cornus spp., Salix spp. and Viburnum spp.,) in contrast to artificial materials such as steel and concrete. In many instances or critical situations an effective and attractive design may require the blending of traditional engineering solutions with a bioengineered solution (i.e. vegetated porous retaining wall).

Opportunities to implement bioengineering solutions are recommended to be explored adjacent to natural areas to reduce construction impacts and costs.

Stormwater Management

The implementation of Best Management Practices (BMPs) for stormwater management is necessary to ameliorate the impacts of urbanization including water pollution, flooding, and erosion.

The naturalization of stormwater management facilities with native trees, shrubs, and groundcovers is recommended to improve the function of stormwater management facilities by enhancing water quality and improving biophysical diversity and facility aesthetics. Planting plans should be prepared based on the hydrology and function of the stormwater management facility. Plant species suitable for the naturalization of stormwater management facilities have been provided in Appendix E.

Substrates containing seeds and plant fragments from wetland pocket removals and ditch clearing operations can be salvaged and placed in stormwater management facilities to assist with naturalization objectives. However, substrates invaded by purple loosestrife (Lythrum salicaria,) European reed, and other invasive non-native species should not be collected and salvaged, as all invasive species displace native wetland plants.

Maintenance

Roadside Plantings

It is recommended that Peel Region contract with pre-qualified, established and reputable landscape contractors that are members in good standing of Landscape Ontario for a minimum of three years to supply, install, maintain, and warranty plant material. A minimum 24 month warranty period should be provided, which also includes a maintenance regime to ensure the healthy establishment of the plant material.

A maintenance holdback should be retained in the amount of 10% of the payment for supply and installation of woody plant material. In addition, a maintenance pay item should also be included in the Contract to cover the cost of plant maintenance for the 24 month warranty period. The amount of the maintenance item shall be equal to 10% of the payment for supply

and installation of woody plant material (see Appendix D-G).

Both the maintenance holdback and maintenance item should be released in two instalments after it has been verified by the Region or its consultant that the Contractor is maintaining the plantings as required. Plant material replaced under warranty shall be of the same quality and requirements prescribed for the original material including the warranty.

It is recommended that the Contractor supply and install a 1.2 x 1.2 sign identifying the project, contract number, Contractor, Landscape Contractor and Notice that "Trees and Shrubs are Maintained by insert Landscape Contractor Name until Date for end of maintenance period" The sign shall be maintained until the maintenance period is completed.

It is recommended that all of the plant material be reserved at the source and set aside for inspection and approval by the Landscape Architect prior to delivery and installation. The plant material should be clearly identified by labels indicating species, size, and supplier.

It is also recommended that the approval of the plant material at the source will not preclude the right of the Landscape Architect to inspect the plants upon arrival on the site, or during the course of construction, and to reject plants which have been damaged or which in any way do not conform to the specifications of the contract. Rejected plants shall be removed from the site within twenty-four (24) hours of notification of the same.

During the maintenance period of a contract (Years 1-2), the maintenance requirements of the Contractor shall include all procedures consistent with proper horticultural practices to ensure normal, vigorous and healthy growth of all plants installed. This includes watering with a root probe once a week from May through August, applying shredded bark mulch to a depth of 75 mm, pruning, cultivation, weed, disease and pest control as required. All tree attachments (i.e. stakes, tree guards, and wires) shall also be maintained.

At the end of the warranty/maintenance period, the contractor must remove all stakes, collars and wires. All planting beds and mulched plant saucers should be weed free and re-mulched as required to ensure that 75 mm of mulch is present.

After the maintenance period of a contract has expired, the maintenance requirements of the Region will include watering, re-mulching, pruning, and spraying as required or as per maintenance agreements.

It is recommended that the Region implement a Landscape Contractor's Performance Report program. At the completion of a contract, the

Contractor or subcontractor should be reviewed for adherence to the specifications and special provisions, public relations, field supervision and layout and the condition and adequacy of the equipment. The reports should have a bearing on a Contractors rating and assist with the pre-qualification of the Contractor for future work.

Removal of dead trees or sod and mortally damaged trees should occur as soon as possible once damages are observed. Suitable replacements should be installed within a year and during the preferred planting season of spring or fall (depending upon the species). During the warranty period, the contractor is responsible to provide replacements, after the warranty period replacement is the responsibility of the Region.

Saturate all coniferous plantings in the fall before the ground has frozen to protect evergreens from desiccation during the winter.

Salt laden snow should never be plowed onto or adjacent to planting beds. Salt concentrations should be diluted with water, and grit accumulations swept away from the median and boulevards as soon as possible in the spring to assist with the healthy re-establishment of existing groundcover.

Turf maintenance operations should be based on existing maintenance specifications and implemented by qualified staff.

Maintenance of Green Infrastructure

The Region is currently updating its Standard Operating Procedures to including new green infrastructure systems such as bioswales and infiltration chambers. As new types of green infrastructure come on-line SOP's will continue to be updated. In-depth guidance on maintenance of green infrastructure can be found within the TRCA's document "Low Impact Development Stormwater Inspection and Maintenance Guide" at the following link:

http://www.sustainabletechnologies.ca/wp/home/urban-runoff-green-infrastructure/low-impact-development/low-impact-development-stormwater-practice-inspection-and-maintenance-guide/

Snow Control and Storage

A third of winter maintenance costs can be attributed to winter maintenance on rural roads in Ontario. Drifting snow and winter maintenance costs can be reduced by the strategic development of vegetated roadside windbreaks (Perchanok, 1994). Additionally, the installation of 3 m berms approximately 10 m apart allows for the collection of snow, and staggered rows of conifer trees planted on the berms or at grade results in snow deposition (Perchanok, 1994).

Snow fences are used to prevent or minimize the drifting of snow on roads, increase driver safety and lessen the need for increased plowing and

salting due to drifting snow. Locations of snow fence installations are prioritized based on need. The Region has implemented a strategy of using available private corn crops left unharvested throughout the winter as a proven and natural "low cost" snow fence barrier. Participating farms receive remuneration for the use of their corn crop for the winter season. Natural snow fences are a low-cost and environmentally friendly solution to prevent drifting snow problems and should be pursued as an option when appropriate.

A 1.0 m wide clear zone is recommended adjacent to the boulevard curb of urban roads to provide an area for the storage of salt and grit laden snow. The clear zone could be reduced to 0.5 m in width along the median curb. Adequate drainage should be provided across the clear zone to ensure that salt laden runoff drains to the road. The clear zone should be made of concrete or asphalt in residential and commercial areas, and asphalt in industrial areas. Impressed concrete is recommended to differentiate the clear zone where the pedestrian sidewalk and clear zone are in close proximity. Decorative concrete unit pavers are not recommended as a clear zone material.

References

Credit Valley Conservation (CVC). 2017. Fish and Wildlife Crossing Guidelines.

Credit Valley Conservation (CVC). 2016. Guidelines for Monitoring Fish and Wildlife Crossings, Version 1.0. (Draft).

Gray, D.H. and Leiser, A.T. 1982. Biotechnical Slope Protection and Erosion Control. Van Nostrand Reinhold: New York, N.Y.

Lumis, G.P., G. Hofstra and R. Hall. 1973. Sensitivity of roadside trees and shrubs to aerial drift of deicing salt. HortScience 8: 475-477.

Michael Dirr. 1976. Selection of Trees for Tolerance to Salt Injury. Journal of Arboriculture 10: 209-216.

OMNR. 2013. Reptile and Amphibian Exclusion Fencing: Best Practices, Version 1.0. Species at Risk Branch Technical Note. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. 11 pp.

Ontario Ministry of Transportation and Communications, Transportation Technology and Energy Branch. 1983. Natural Regeneration Techniques to Stabilize Ontario's Roadsides.

Ontario Phragmites Working Group (OPWG). 2015. Smart Practices for the Control of Invasive Phragmites Along Ontario's Roads. Version 1.

Ontario Road Ecology Group (OREG,) Toronto Zoo. 2010. Guide to Road Ecology in Ontario, prepared for the Environment Canada Habitat Stewardship Program for Species at Risk.

Perchanok, M. S. 1994. Evaluation of a video system for remote monitoring of winter road surface conditions. Ontario. Prepared for the Ontario Ministry of Transportation, Research and Development Branch.

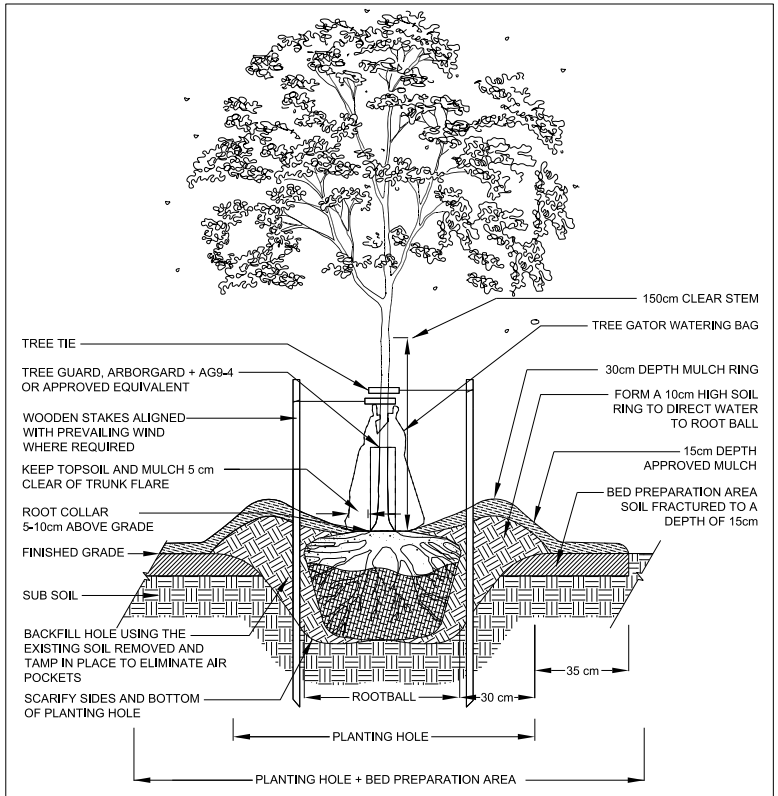
Peel Region Urban Forest Strategy (2011). Available from: https://www.peelregion.ca/planning/climatechange/reports/. Accessed: March 3, 2017.

von der Lippe, M. and Kowarik, I. 2007. Long-Distance Dispersal of Plants by Vehicles as a Driver of Plant Invasions. Conservation Biology, Vol. 21, No. 4 (Aug., 2007), pp. 986-996. Wiley for Society for Conservation Biology.

White, D.J. and E. Haber. 1992. Invasive Plants of Natural Habitats in Canada, Part 1: Wetland species. Report prepared for Canadian Wildlife Service.

This Page Intentionally Left Blank

Appendix B - Planting Details



TREE PLANTING SPECIFICATIONS

MYCORRHIZAL INOCULANTS:
- INSTALL MYKE PRO LANDSCAPE G

WATERING:
- SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AFTER PLANTING
- INSTALL 75 LITRE TREE GATOR WATERING BAG

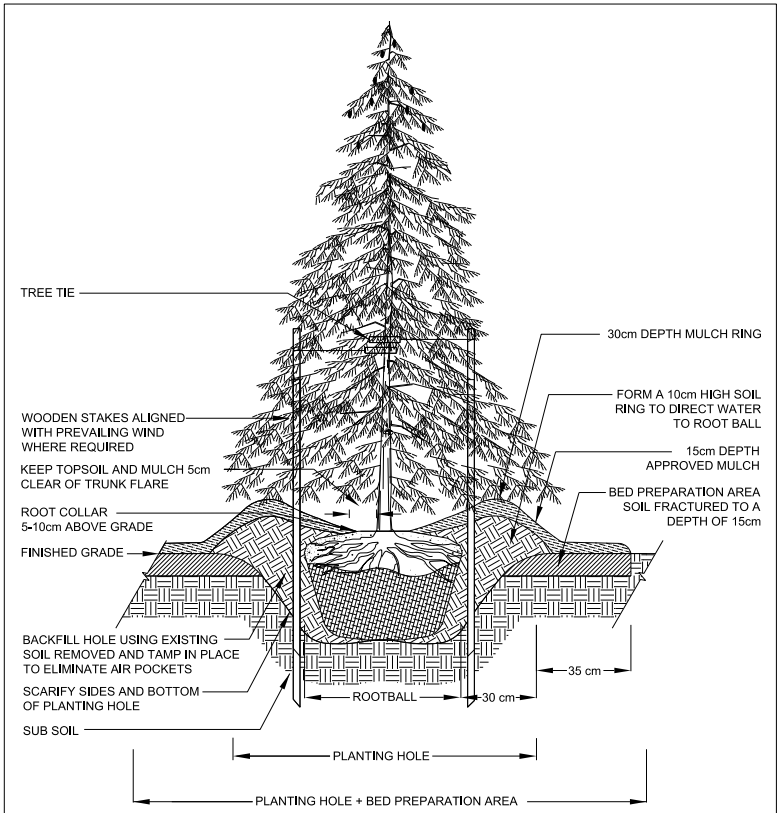
ROOTBALL, BURLAP, TWINE
- CUT AND REMOVE ALL WIRE, ROPE, BURLAP AND TWINE FROM THE TOP 1/3 OF THE ROOTBALL

CROWN PRUNING
- PRUNE AT PLANTING TO CAREFULLY REMOVE DEAD, BROKEN, DISEASED OR DAMAGED BRANCHES

Region of Peel Working for you — Public Works

CALIPER DECIDUOUS TREE PLANTING DETAIL FOR SOFTSCAPE BOULEVARDS

DATE: JAN 2016			SCALE N.T.S.
REV.	X	X	NHF–01



TREE PLANTING SPECIFICATIONS

MYCORRHIZAL INOCULANTS:
- INSTALL MYKE PRO LANDSCAPE G

WATERING:
- SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AFTER PLANTING

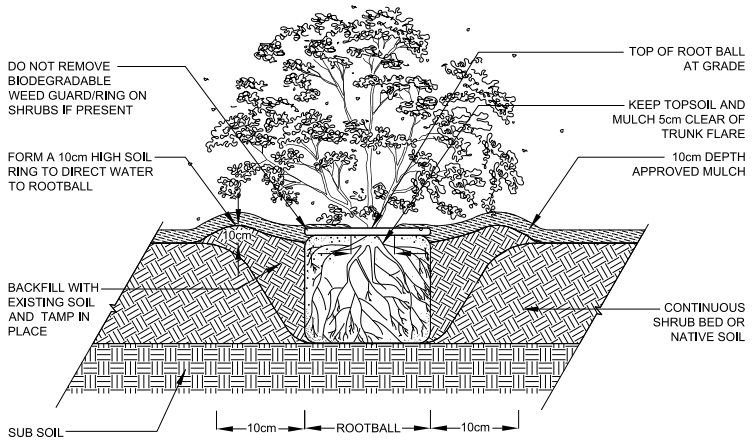
ROOTBALL, BURLAP, TWINE
- CUT AND REMOVE ALL WIRE, ROPE, BURLAP AND TWINE FROM THE TOP 1/3 OF THE ROOTBALL

CROWN PRUNING
- PRUNE AT PLANTING TO CAREFULLY REMOVE DEAD, BROKEN, DISEASED OR DAMAGED BRANCHES

Region of Peel Working for you — Public Works

CALIPER CONIFEROUS TREE PLANTING DETAIL FOR SOFTSCAPE BOULEVARDS

DATE: JAN 2016			SCALE N.T.S.
REV.	X	X	NHF–02



SHRUB PLANTING SPECIFICATIONS

WATERING:

- SOAK THE ROOTBALL WITH 20 LITRES OF WATER IMMEDIATELY AFTER PLANTING. THE WATER SHALL BE MIXED WITH 10-52-10 WATER SOLUBLE FERTILIZER IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS

ROOTBALL AND CONTAINER

- THE CONTAINER MUST BE REMOVED PRIOR TO PLANTING
- SHAVE OUTSIDE OF ROOTBALL TO REMOVE CIRCLING ROOTS IF PRESENT

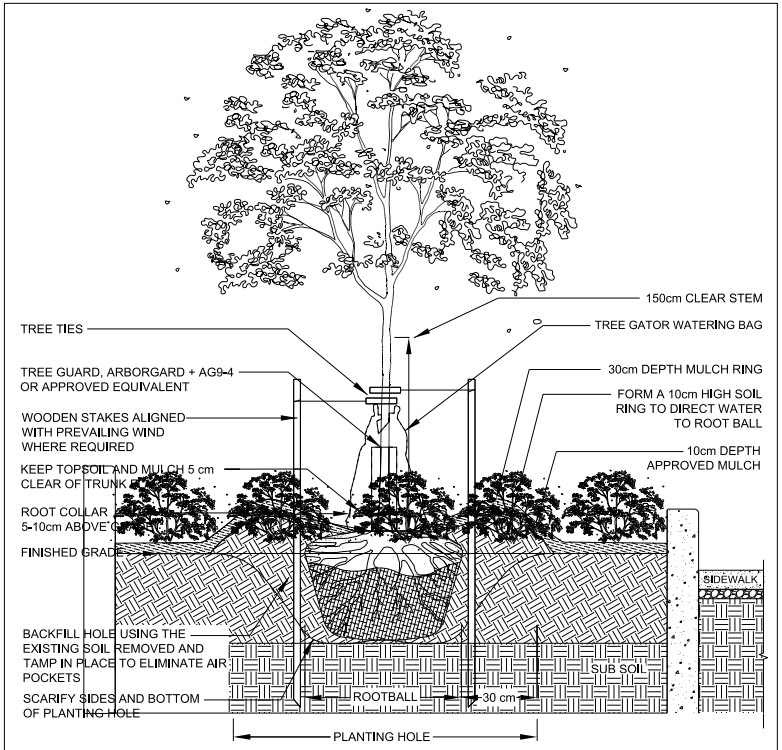
PRUNING

- REMOVE ALL DEAD AND DAMAGED BRANCHES

Region of Peel — Working for you — Public Works

CONTAINER GROWN SHRUB PLANTING DETAIL

DATE:	JAN 2016		SCALE N.T.S.
REV.	X	X	NHF–03



TREE PLANTING SPECIFICATIONS

MYCORRHIZAL INOCULANTS:

- INSTALL MYKE PRO LANDSCAPE G

WATERING:

- SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AFTER PLANTING
- INSTALL 75 LITRE TREE GATOR WATERING BAG

ROOTBALL, BURLAP, TWINE

- CUT AND REMOVE ALL WIRE, ROPE, BURLAP AND TWINE FROM THE TOP 1/3 OF THE ROOTBALL

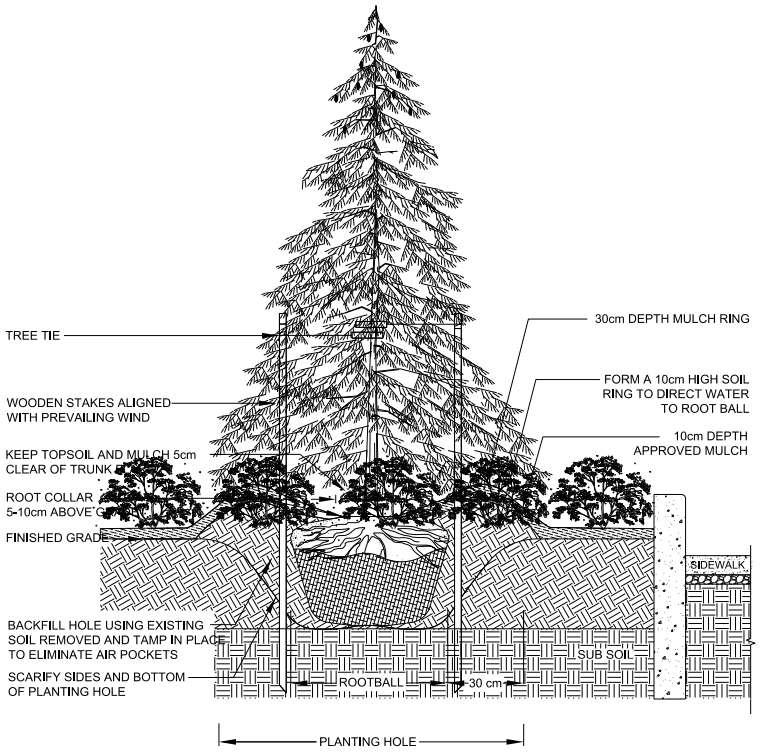
CROWN PRUNING

- PRUNE AT PLANTING TO CAREFULLY REMOVE DEAD, BROKEN, DISEASED OR DAMAGED BRANCHES

Region of Peel — Working for you — Public Works

CALIPER DECIDUOUS TREE PLANTING DETAIL FOR LANDSCAPED BEDS

DATE:	JAN 2016		SCALE N.T.S.
REV.	X	X	NHF–17



TREE PLANTING SPECIFICATIONS

MYCORRHIZAL INOCULANTS:
- INSTALL MYKE PRO LANDSCAPE G

WATERING:
- SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AFTER PLANTING

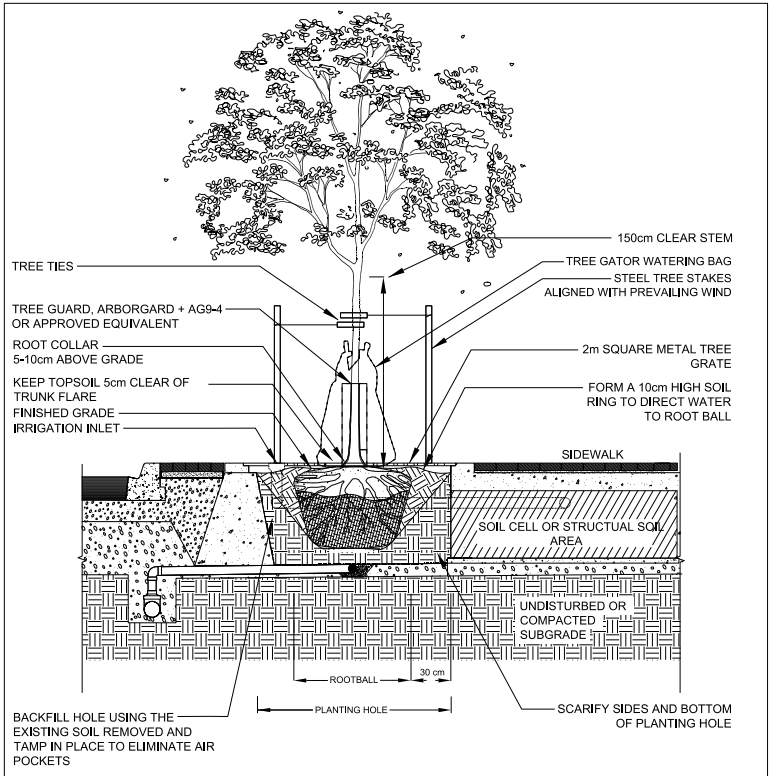
ROOTBALL, BURLAP, TWINE
- CUT AND REMOVE ALL WIRE, ROPE, BURLAP AND TWINE FROM THE TOP 1/3 OF THE ROOTBALL

CROWN PRUNING
- PRUNE AT PLANTING TO CAREFULLY REMOVE DEAD, BROKEN, DISEASED OR DAMAGED BRANCHES

Region of Peel — Working for you — Public Works

CALIPER CONIFEROUS TREE PLANTING DETAIL FOR LANDSCAPED BEDS

DATE:	JAN 2016		SCALE N.T.S.
REV.	X	X	NHF–18



TREE PLANTING SPECIFICATIONS

PLANTING DETAIL TO BE READ IN CONJUNCTION WITH THE REGIONS SPECIFICATIONS FOR TREE PLANTING

MYCORRHIZAL INOCULANTS:
- INSTALL MYKE PRO LANDSCAPE G

WATERING:
- SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AFTER PLANTING

ROOTBALL, BURLAP, TWINE
- CUT AND REMOVE ALL WIRE, ROPE, BURLAP AND TWINE FROM THE TOP 1/3 OF THE ROOTBALL

CROWN PRUNING
- PRUNE AT PLANTING TO CAREFULLY REMOVE DEAD, BROKEN, DISEASED OR DAMAGED BRANCHES

Region of Peel — Working for you — Public Works

CALIPER DECIDUOUS TREE PLANTING DETAIL FOR TREE GRATE PLANTER

DATE:	JAN 2016		SCALE N.T.S.
REV.	X	X	NHF–19

This Page Intentionally Left Blank

Appendix C - Policy Changes

Since 2011, the Region has completed studies, updated policies and initiated new practices and programs that provide context for the updates to the Toolbox. Also, emerging trends in transportation have highlighted the need to address broader issues related to health and the environment leading to the formation of a partnership between Region of Peel Public Works, Health and the Credit Valley Conservation Authority to update the Toolbox. The partnership team has contributed their expertise to the content and direction of the update.

The team conducted an extensive scan to review current transportation planning and changes to applicable policies, best practices, complete and green street guidelines, health guidelines, and transportation design guidelines to identify gaps within the existing document and opportunities for improvement. See the References section for the full list of documents reviewed.

The updated document has been guided by the following documents and in particular, the Road Characterization Study (RCS) has been used to provide a framework for its modifications.

Regional Road Characterization Study

The 2013 RCS brought together multiple stakeholders including transportation planning, sustainable transportation, integrated planning and public health in order to develop a set of guidelines to establish ROW priorities, meet multi-modal roadway demands, and support existing and future land use. This exercise resulted in the identification of six road characters and related cross section designs within the Regional road network. Because the scope of the RCS is broad the Toolbox update provides an opportunity to make recommendations that are specific and more detailed within the road typologies. Alignment of the Toolbox with the RCS is discussed in greater detail in Section 3.0.

Health Principles

The importance of creating environments that support health, particularly through active transportation is now well recognized. A well-designed streetscape improves the safety, comfort and convenience of traveling by foot or bike and makes public spaces more inviting. The streetscape can promote increased physical activity, community interaction and accessibility, while reducing the incidence of crime and traffic-related pedestrian and cycling injuries and fatalities[1].

Active Transportation Improvements

A wider variety of active transportation facilities are now being considered and implemented on Regional roads. While active transportation

facilities along Regional roads have typically been allocated within the boulevard, cycle tracks and on-street cycling facilities are now also being recommended where appropriate.

AODA standards

The Accessibility for Ontarians with Disabilities Act (AODA)1 sets specific standards for the design of public spaces. Within the Regional right-of-way, cross section elements including exterior paths of travel must adhere to technical requirements outlined in the act. While AODA was in effect at the time of the original writing, the revised toolbox presents an opportunity to include cross-sections elements that further complement AODA standards to increase accessibility along Regional roadways.

Placemaking

Placemaking is a multi-faceted approach to the planning, design and management of public spaces. It looks at a local community's assets, inspiration and potential to help create public spaces that promote health, happiness and well-being.

As applied to the Toolbox, Placemaking can be achieved through consistent treatment of streetscape and landscape features. A distinct identity can be reinforced through streetscaping elements such as decorative lighting and signage, benches, public gathering places waste receptacles, art, landscaping of gateways and roundabouts.

Roundabouts

A review of landscape design for roundabouts was not included in the original writing of the document as no roundabouts were planned for construction at the time. Since 2011, multiple roundabouts have been built and roundabouts are considered in the planning stage of all intersection improvement projects. Roundabouts improve traffic safety through the elimination of T-type collisions; improve traffic flow and reduce vehicle emissions by eliminating unnecessary stopping and idling at intersections. Roundabouts may also provide opportunities to improve aesthetics along a road corridor through the use of landscaping or as a gateway feature.

Jurisdiction over Elements in the Right-of-Way

The Municipal Act, 2001 determines the jurisdiction of various road elements within road ROW. Within Regional road right-of-ways, area municipalities are responsible for the planning, financing and maintenance of transportation elements such as sidewalks, multi-use trails and transit infrastructure. The Region is responsible for the construction of transit facilities and sidewalks/multi-use trails, and construction

and maintenance of roads, curbs and gutters, noise and retaining walls, ditches, culverts and bridges, lighting and stormwater infrastructure.

Responsibility for sidewalks/multi-use trails is being reviewed through Council as part of the Regional Arterial Road Rationalization, and in some cases, has been transferred back under the Region's authority. Responsibility and maintenance of assets on Regional roads continues to be part of an on-going discussion.

Environmental Concerns

Roads and related transportation infrastructure have been identified as a leading source of urban runoff and runoff pollution. The province of Ontario is working to support actions by municipalities to plan for water sustainability and to implement innovative stormwater solutions through various strategies and legislation. A brief summary of guiding strategies and Acts are provided below with links provided in the References section.

Peel Climate Change Strategy (CCS)

The CCS recognizes the urgent need to respond to climate change at the local level through mitigation and adaptation strategies. Region policies that support the CCS include Transportation Demand Management to reduce greenhouse gases and the current 4-year term TOC priorities, Leading and Thriving, that commit us to contribute to the well-being of the community; promote healthy and age friendly environments; and adapt to and mitigate the effects of climate change. Stormwater management that uses green infrastructure helps to manage stormwater quantity and quality.

Ontario Great Lakes Strategy

The 2012 Ontario Great Lakes Strategy is a guide to future actions to protect the Great Lakes. Urban growth that is not properly planned and managed can lead to increased stormwater runoff that can put unwanted contaminants and stress on the Great Lakes ecosystem. For more information, refer to https://www.ontario.ca/document/ontarios-great-lakes-strategy.

Water Opportunities Act

The 2010 Water Opportunities and Water Conservation requires municipalities and other water service providers to prepare municipal risk assessment and water sustainability plans for water, wastewater and stormwater infrastructure. For more information, refer to https://www.ontario.ca/laws/statute/10w19.

2014 Provincial Policy Statement

The recently updated 2014 Provincial Policy statement includes additional sections that speak directly to considering the impact of climate change on infrastructure and the environment. For more information, refer to http://www.mah.gov.on.ca/page10679.aspx.

Proposed Growth Plan for the Greater Golden Horseshoe (May 2016)

The Growth Plan incorporates requirements for "low impact development" and "green infrastructure". For more information, refer to:

https://www.placestogrow.ca/index.php?option=com_content&task=view&id=420&Itemid=12.

Ministry of the Environment and Climate Change (MOECC) Stormwater Update

The MOECC will soon be releasing updated stormwater management guidance that will require the use of green infrastructure to meet the volume reduction targets.

Complete Streets

Municipalities across Canada are now adopting a Complete Street approach in transportation planning. A Complete Street is designed for all ages, abilities, and modes of travel. Complete Streets provide safe and comfortable access for pedestrians, bicycles, transit users and the mobility-impaired as an integral planning feature.

Appendix D – Streetscape Plant List

[1]Salt Tolerance: The lower the number the greater the tolerance:
A rating of 1 indicates no twig dieback or needle browning of conifers and no dieback, tufting or inhibition of flowering or deciduous trees and shrubs;
A rating of 5 represents complete branch dieback and needle browning of conifers an complete dieback, evidence of previous tufting and lack of flowering of deciduous trees and shrubs;
Ratings of 2, 3 and 4 encompass slight, moderate and extensive gradations of the above injury symptoms (taken from Lumis et al., 1973).

Non-Native and Rare Species: Species not native to the Region of Peel, which are not currently known to be invasive have been denoted with an asterisk (*) and highlighted in orange. Species that are native to the Region of Peel but are rare within the watershed have been denoted with two asterisks (**) and are highlighted in yellow. These species should never be used for naturalization projects or adjacent to natural areas and/or regulated areas.

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application			
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Boulevard	Median	Intersection	Naturalization
Deciduous Trees:															
Acer nigrum	Black Maple	18	12	Slow to Moderate	4-9			X	Rounded	4	L	X			X
Acer nigrum 'Green Column'	Green Column Black Maple	18	6	Slow to Moderate	4-9			X	Pyramidal to Rounded	4	L	X			
Acer rubrum	Red Maple	12-18	10-13	Moderate to Fast	3-9			X	Rounded	3	M-L	X			X
Acer saccharinum	Silver Maple	18	18	Fast	3-9			X	Vase to Rounded	2	M	X			X
Acer saccharum	Sugar Maple	18-23	15-18	Slow to Moderate	4-9			X	Rounded to Oval	3	L	X			X
Acer x *freemanii*	Freeman's Maple	15-25	15-25	Moderate to Fast	4-9			X	Rounded to Oval	3	M	X			X
*Aesculus glabra**	Ohio Buckeye	12	12	Moderate	3-7				Round to Oval	3	M	X	X		
Amelanchier arborea	Downy Serviceberry	4-9	4-5	Moderate	3-9	X		X	Grafted Tree Form	4	L-M	X			X
Amelanchier laevis	Smooth Serviceberry	4-9	4-5	Moderate	3-9	X		X	Grafted Tree Form	4	L-M	X			X
Betula papyrifera	Paper Birch	18	6-10	Moderate	3-6			X	Upright to Pyramidal	2	L	X			X
Carya cordiformis	Bitternut Hickory	15	12	Slow	4-9				Irregular to Oval	3	L	X			X

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application			
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Boulevard	Median	Intersection	Naturalization
Carya ovata	Shagbark Hickory	18	8	Slow	4-9				Open Oval	4	H	X		X	X
*Celtis occidentalis***	Common Hackberry	15	12	Moderate to Fast	2b-9			X	Upright to Oval	3-4	H	X	X	X	
*Cladrastis kentukea**	Yellowwood	12	6	Slow to Moderate	4-8		X	X	Rounded to Vase	3	M	X	X		
*Corylus colurna**	Turkish Hazel	12	9	Slow	5-9				Formal Pyramidal	4	H	X	X	X	
*Ginkgo biloba**	Maidenhair Tree	18-20	12	Slow	3-9		X	X	Pyramidal	3-4	H	X	X	X	
Gleditsia tricanthos var. *inermis* * (Native to Ontario)	Thornless Honey-locust	20	12-16	Fast	4-9	X	X	X	Broad Pyramidal	1	H	X	X	X	
*Gymnocladus dioicus**(Native to Ontario)	Kentucky Coffee-tree	18	12	Slow to Moderate	3-8			X	Irregular Oval	3	M	X	X		
Juglans nigra	Black Walnut	18	12-15	Moderate to Fast	3b-9			X	Broad Oval	3	M	X			X
*Liriodendron tulipifera** (native to Ontario)	Tuliptree	20-25	10-15	Fast	5-9	X		X	Narrow Oval	2-3	M-L	X			
Liriodendron tulipifera 'Fastigiata'*	Columnar Tuliptree	16-18	5-6	Moderate to Fast	5-9	X		X	Narrow Columnar	2-3	M-L	X	X	X	
Ostrya virginiana	American Hop-hornbeam	9	3-9	Slow	3-9			X	Broad Oval	3-4	M	X		X	X
*Platanus occidentalis***	Sycamore	22	22	Fast	4-9				Open to Rounded	3	H	X		X	
Populus balsamifera	Balsam Poplar	15-24	10-15	Fast	2-9			X	Pyramidal to Open	2	M-H				X

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application			
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Boulevard	Median	Intersection	Naturalization
Populus deltoides ssp. *deltoides*	Large Tooth Aspen	15-24	10-15	Fast	2-9			X	Pyramidal to Open	2	M-H				X
Populus tremuloides	Trembling Aspen	15-20	10-15	Fast	2-9			X	Oval to Rounded	2	M-H				X
Prunus serotina	Black Cherry	15-24	9-15	Fast	3-9	X		X	Pyramidal to Oval	3	L				X
Quercus alba	White Oak	20	15-20	Slow to Moderate	4-9			X	Broad Pyramidal	2-3	M-L	X			X
*Quercus bicolor***	Swamp White Oak	18	18	Slow	4-9			X	Open to Rounded	3	H	X	X		
Quercus macrocarpa	Bur Oak	20	15-20	Slow	2-9			X	Pyramidal	2-3	M-H	X			X
*Quercus palustris** (Native to Ontario)	Pin Oak	17	8-13	Moderate	4-9			X	Pyramidal	2-3	M-H	X		X	
Quercus robur 'Fastigiata'*	Pyramidal English Oak	12	3-5	Moderate-Fast	5-9				Narrow Columnar	2-3	H	X	X	X	
Quercus rubra	Red Oak	20-25	13-16	Moderate	3-9			X	Broad Pyramid	3	M-H	X			X
Tilia americana	Basswood	20	10	Moderate	3-9		X	X	Broad Pyramidal	3	M-L	X			X
Tilia cordata 'Greenspire'*	Greenspire Little-leaf Linden	15	8	Moderate	3-9		X	X	Narrow Pyramidal	4	H	X	X		
*Zelkova serrata 'Green Vase'**	Green Vase Japanese Zelkova	15	15	Moderate	5-8			X	Vase -Shaped	3	H	X	X		
Coniferous Trees:															
Abies balsamea	Balsam Fir	20	6-8	Slow	1-9				Pyramidal	4	L	X		X	X
*Abies concolor**	Silver Fir	20	5-10	Slow to Moderate	4-9	X	X	X	Narrow Pyramidal	4-5	L	X			

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application			
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Boulevard	Median	Intersection	Naturalization
Larix laricina	Tamarack	25	8-10	Slow to Moderate	2-9			X	Pyramidal	4-5	L				X
*Picea glauca***	White Spruce	20	3-6	Moderate	2-9				Pyramidal	4	M	X		X	
*Picea pungens**	Colorado Spruce	15	3-6	Slow to Moderate	2-9	X	X	X	Dense Pyramidal	1	M-H	X		X	
Pinus mugo 'Privacy'*	Privacy Pine	5	3-5	Slow	3				Densely Rounded	1	M-H	X	X	X	
*Pinus nigra**	Austrian Pine	15	6-15	Moderate	4-9				Broadly Pyramidal	1	H			X	
Pinus strobus	White Pine	1520	6-13	Fast	3-9				Broad Pyramidal	5	L				X
Thuja occidentalis	Eastern White Cedar	10-20	3-5	Slow to Moderate	2-8				Broad Pyramidal	4	L-M				X
Tsuga canadensis	Eastern Hemlock	10-20	6-12	Moderate	4-9				Pyramidal	5	L				X
Shrubs:															
Amelanchier arborea	Downy Serviceberry	4-7	4-5	Moderate	4-9	X		X	Rounded Shrub	4	L	X			X
Amelanchier laevis	Smooth Serviceberry	4-7	4-5	Moderate	4-9	X		X	Rounded Shrub	4	L	X			X
Cornus alternifolia	Alternate-leaved Dogwood	5	5-6	Fast	4b-9	X	X	X	Horizontal Branching	4-5	L	X			X
Cornus racemosa	Gray Dogwood	3	3	Moderate	2b-9		X	X	Multi-stemmed	3-4	L-M	X	X		X
Cornus stolonifera	Red-osier Dogwood	2.5	2.5	Fast	4-9			X	Multi-stemmed	5	L-M	X			X
Diervilla lonicera	Northern Bush Honeysuckle	1-1.5	1	Moderate	2b		X	X	Suckering to Mounded	3	H	X	X		X
*Hamamelis virginiana***	American Witch-hazel	4-6	4-6	Moderate	4-9			X	Vase to Rounded	5	L	X			
Juniperus spp.*	Juniper species	<1-4	<1-4	Slow to Moderate	4-9	X	X	X	Varies by Cultivar	2	H	X	X	X	

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application			
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Boulevard	Median	Intersection	Naturalization
Prunus virginiana	Chokecherry	4-9	3-5	Moderate to Fast	2a	X		X	Multi-stemmed	5	H				X
Rhus typhina	Staghorn Sumac	5-8	5-8	Fast	3-9		X	X	Spreading Shrub	1	H	X	X	X	X
Rubus odoratus	Purple-Flowering Raspberry	1-2	2	Fast	4a		X		Mounding	5	L				X
Viburnum acerifolium	Maple-leaf Viburnum	1-2	1	Slow to Moderate	3	X		X	Upright to Rounded	5	L	X			X
Viburnum lentago	Nannyberry	5-7	2-3	Moderate	2-9		X	X	Upright to Spreading	3-4	M-H	X		X	X
Viburnum opulus ssp. *trilobum*	Highbush Cranberry	2.5-4	2.5-4	Moderate	2-9		X	X	Upright to Spreading	3-4	M-H	X		X	X
Low Shrubs, Groundcovers, and Vines:															
*Arctostaphylos uva-ursi**	Common Bearberry	0.15	0.5-1.2	Slow	1-9		X	X	Trailing to Arching	3-4	M-H	X	X	X	
Potentilla fruticosa cultivars*	Shrubby Cinquefoil cultivars	<1	<1	Slow	2-9	X	X	X	Rounded	3	M-H	X	X	X	
Potentilla norvegica	Norwegian Cinquefoil	0.5	0.5	Moderate	4		X	X	Low Mounding	4	L				X
*Rhus aromatica** (Native to Ontario)	Fragrant Sumac	1	1.5-2	Slow to Moderate	3-9		X	X	Sprawling to Low-Spreading	1	M-H	X	X	X	
Rhus aromatica 'Gro-Low'*	Gro-Low Fragrant Sumac	0.3	1-1.5	Slow	4a-9		X	X	Low-Spreading	1	M-H	X	X	X	
Rosa blanda	Smooth Rose	1-1.5	1.5-2	Fast	2		X	X	Mounded to Spreading	4	L	X		X	X
Symphoricarpos albus var. *albus*	Snowberry	1.2	1.2	Fast	5-9		X	X	Rounded to Arching	3	M-L	X		X	

This Page Intentionally Left Blank

Appendix E – Stormwater Management Facility Naturalization Plant List

For additional information on best practices for stormwater management facility planting design and suggested seed mixes refer to the following document:
Stormwater Management Criteria. Appendix D1: Stormwater Management Pond Planting Guidelines (CVC, 2014) and Stormwater Management Pond Planting Guidelines (TRCA, 2007)

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Growth Habit	Planting Application				
		Height (m)	Width (m)				Permanent Pool (Depth 0.5-2m)	Permanent Pool (Depth 0-0.5m)	Permanent Pool Level to Extended Detention Level	Extended Detention Level to 5 Year Storm Level	All Areas Above the 5 Year Storm Level
Aquatics (Submergent, Emergent, and Floating):											
Alisma plantago-aquatica	Water Plantain	1	0.5	Slow	4-9	Emergent		X	X		
Elodea canadensis	Broad Waterweed	0.25	1	Moderate	3-9	Submergent	X				
Iris versicolor	Harlequin Blue Iris	1	1	Fast	2a	Emergent		X	X		
Nuphar variegata	Variegated Pond-lily	0.5	1-2	Moderate	3-9	Floating	X				
Nymphaea odorata ssp. odorata	Fragrant Water-lily	0.15	1-2	Moderate	3-9	Floating	X				
Potamogeton natans	Floating Pondweed	1	1	Fast	4-9	Floating	X				
Sagittaria latifolia	Common Arrowhead	0.5-1	1	Moderate to Fast	4-9	Emergent		X	X		
Stuckenia pectinata	Sago Pondweed	1	1	Fast	5-9	Submergent	X				
Typha latifolia	Broad-leaved Cattail	2	2-5	Fast	1-9	Emergent		X	X		
Graminoids (Grasses, Rushes, and Sedges):											
Calamagrostis canadensis	Canada Blue Joint	1-2	0.5-1	Slow	3-7	Clumping			X		
Carex vulpinoidea	Fox Sedge	0.3-1	0.6	Slow to Moderate	3-7	Clumping			X		
Juncus dudleyi	Dudley's Rush	0.75	0.5	Moderate to Fast	2-9	Upright and Clumping				X	
Juncus effusus	Soft Rush	1.2	1.2	Moderate to Fast	4-9	Upright and Clumping			X		
Schoenoplectus tabernaemontani	Soft-stemmed Bulrush	1-2.5	1-1.5	Moderate	3-9	Upright and Spreading		X	X		

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Growth Habit	Planting Application				
		Height (m)	Width (m)				Permanent Pool (Depth 0.5-2m)	Permanent Pool (Depth 0-0.5m)	Permanent Pool Level to Extended Detention Level	Extended Detention Level to 5 Year Storm Level	All Areas Above the 5 Year Storm Level
Scirpus atrovirens	Dark-green Bulrush	1.5	1.2.5	Fast	3-9	Upright and Spreading			X		
Scirpus microcarpus	Red-tinge Bulrush	1.25	0.5-1	Moderate to Fast	2-9	Upright and Spreading			X		
Herbaceous (Forbs and Wildflowers):											
Anemone canadensis	Canada Anemone	0.5	0.5	Fast	3-8	Low Rounded			X	X	
Chelone glabra	White Turtlehead	0.5-1	0.5	Moderate	3-8	Upright			X		
Euthamia graminifolia	Grass-leaved Goldenrod	0.75	0.5	Slow	3-8	Upright				X	
Eutrochium maculatum var. maculatum	Spotted Joe Pye Weed	1.5	1	Moderate	3-8	Upright			X		
Impatiens capensis	Spotted Jewelweed	1	0.5	Moderate to Fast	2-9	Spreading			X	X	
Rudbeckia hirta var. pulcherrima	Black-eyed Susan	1	0.75	Moderate	3-7	Rounded					X
Solidago altissima var. altissima	Eastern Late Goldenrod	0.5-2	0.5	Fast	3-8	Upright					X
Solidago canadensis var. canadensis	Canada Goldenrod	0.3-2	0.3	Fast	3-8	Upright					X
Symphyotrichum ericoides var. ericoides	White Heath Aster	0.5-1	0.3	Moderate	5-8	Rounded to Upright					X
Symphyotrichum lanceolatum ssp. lanceolatum	Panicled Aster	0.3-1	0.3-1	Fast	3-8	Rounded to Upright			X	X	
Symphyotrichum novae-angliae	New England Aster	1-2	0.5-1	Moderate	4-8	Rounded to Upright			X	X	
Verbena hastata	Blue Vervain	0.3-2	0.3-1	Fast	3-8	Upright			X		

Appendix F – Ontario Hydro Approved Tree List (Tree Canopies Within Aerial Easements)

[1]Salt Tolerance: The lower the number the greater the tolerance:
A rating of 1 indicates no twig dieback or needle browning of conifers and no dieback, tufting or inhibition of flowering or deciduous trees and shrubs;
A rating of 5 represents complete branch dieback and needle browning of conifers an complete dieback, evidence of previous tufting and lack of flowering of deciduous trees and shrubs;
Ratings of 2, 3 and 4 encompass slight, moderate and extensive gradations of the above injury symptoms (taken from Lumis et al., 1973).

Non-Native and Rare Species: Species not native to the Region of Peel, which are not currently known to be invasive have been denoted with an asterisk (*) and highlighted in orange. Species that are native to the Region of Peel but are rare within the watershed have been denoted with two asterisks (**) and are highlighted in yellow. These species should never be used for naturalization projects or adjacent to natural areas and/or regulated areas.

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application	
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Planted ≥3 m from pole line:	Planted ≥4.5 m from pole line:
Deciduous Trees:													
Acer nigrum 'Green Column'	Green Column Black Maple	18	6	Slow to Moderate	4-9			X	Pyramidal to Rounded	4	L	X	X
Acer rubrum 'Bowhall'	Red Maple	13	5	Moderate to Fast	3-8			X	Broad Columnar	3	M-L	X	X
Acer rubrum 'Karpick'	Red Maple	12	7	Moderate to Fast	3-9			X	Narrow Columnar	3	M-L	X	X
Acer saccharum 'Endowment'	Sugar Maple	17	6	Moderate	4-9			X	Upright Narrow	3	L		X
Acer x freemanii 'Armstrong'	Armstrong Maple	15	8	Fast	4-9			X	Narrow Upright	3	M		X
Amelanchier arborea	Downy Serviceberry	4-9	4-5	Moderate	3-9	X		X	Grafted Tree Form	4	L-M	X	X
Amelanchier laevis	Smooth Serviceberry	4-9	4-5	Moderate	3-9	X		X	Grafted Tree Form	4	L-M	X	X
*Corylus colurna**	Turkish Hazel	12	9	Slow	5-9				Formal Pyramidal	4	H		X
Gleditsia tricanthos var. *inermis* 'Shademaster'	Shademaster Honey-locust	17	10	Fast	4-9	X	X	X	Broad Pyramidal	1	H		X
Gleditsia tricanthos var. *inermis* 'Skycole'	Skyline Honey-locust	15	13	Fast	4-9	X	X	X	Broad Pyramidal	1	H		X

Scientific Name	Common Name	Size		Growth Rate	Canadian Plant Hardiness Zone	Seasonal Berries, Flowers, or Foliage Colour			Growth Habit	Tolerance		Planting Application	
		Height (m)	Width (m)			Spring	Summer	Fall		Salt[1]	Pollution	Planted ≥3 m from pole line:	Planted ≥4.5 m from pole line:
Tilia americana 'Boulevard'	Boulevard Linden	20	10	Moderate	3-9		X	X	Broad Pyramidal	3	M-L		X
Tilia cordata 'Greenspire'*	Greenspire Linden	16	12	Moderate	3-9		X	X	Oval	4	H		X
Tilia x *flavescens* 'Glenleven'*	Glenleven Linden	16	12	Moderate	3-9		X	X	Pyramidal	4	H		X
Zelkova serrata 'Green Vase'*	Green Vase Japanese Zelkova	16	13	Moderate	5-8			X	Vase -Shaped	3	H		X
Zelkova serrata 'Musashino'*	Musashino Japanese Zelkova	15	5	Moderate	5-8			X	Narrow Vase -Shaped	3	H		X
Coniferous Trees:													
*Picea glauca***	White Spruce	20	3-6	Moderate	2-9				Pyramidal	4	M		X
*Picea pungens**	Colorado Spruce	15	3-6	Slow to Moderate	2-9	X	X	X	Dense Pyramidal	1	M-H		X
*Pinus nigra**	Austrian Pine	15	6-15	Moderate	4-9				Broadly Pyramidal	1	H		X

Appendix G - Roadside Ditch Plant List

Plant selection will vary on a site by site basis; however the following are a list of species native to the Region of Peel which are fast growing, tolerant of hydrological conditions found within roadside ditches, and show a degree of salt tolerance:

Scientific Name	Common Name	Size		Growth Rate	Growth Habit	Salt Tolerance	Roadside Ditch Planting Application		
		Height (m)	Width (m)				Permanent Standing Water	Temporarily Wet Areas	Permanently Dry Areas
Bidens cernua	Nodding Beggarticks	1	1	Moderate	Upright	3		X	
Carex vulpinoidea	Fox Sedge	1	0.5	Moderate	Clumping	1		X	
Euthamia graminifolia	Grass-leaved Goldenrod	0.75	0.5	Moderate	Upright	5		X	
Geum fragarioides	Barren Strawberry	0.05	0.3	Slow to Moderate	Groundcover	1			X
Iris versicolor	Harlequin Blue Iris	1	1	Fast	Emergent	3	X	X	
Juncus effusus	Soft Rush	1.2	1.2	Moderate to Fast	Upright Clumping	3	X	X	
Monarda fistulosa	Wild Bergamot	1	0.75	Moderate	Upright	3			X
Rudbeckia hirta var. pulcherrima	Black-eyed Susan	1	0.5	Moderate	Upright	1			X
Schoenoplectus tabernaemontani	Soft-stemmed Bulrush	1-2.5	1-1.5	Moderate	Upright	1	X	X	
Scirpus atrovirens	Dark-green Bulrush	1.5	1.2.5	Fast	Upright	3	X	X	
Symphyotrichum ericoides var. ericoides	Heath Aster	1	0.5	Moderate	Rounded to Upright	3			X
Symphyotrichum lanceolatum ssp. lanceolatum	Panicled Aster	0.3-1	0.3-1	Fast	Rounded	5		X	X
Symphyotrichum novae-angliae	New England Aster	1-2	0.5-1	Moderate	Rounded to Upright	3			X
Symphyotrichum puniceum	Swamp Aster	1-1.5	1	Moderate	Upright	3		X	
Typha latifolia	Broad-leaved Cattail	2	2-5	Fast	Emergent	3	X	X	
Verbena hastata	Blue Vervain	0.3-2	0.3-1	Fast	Upright	3		X	

[1]Salt Tolerance: The lower the number the greater the tolerance: A rating of 1 indicates no twig dieback or needle browning of conifers and no dieback, tufting or inhibition of flowering or deciduous trees and shrubs; A rating of 5 represents complete branch dieback and needle browning of conifers an complete dieback, evidence of previous tufting and lack of flowering of deciduous trees and shrubs; Ratings of 2, 3 and 4 encompass slight, moderate and extensive gradations of the above injury symptoms (taken from Lumis et al., 1973).

This Page Intentionally Left Blank

Appendix H - Road Character Matrix

Road Typology	Area Context	Through Lanes	Desired Operating Speed**	Transit Role	Area for Pedestrian and Other Facilities	Bicycle Facilities	Drainage Conditions	Freight Role
Rural Road	Rural agricultural, scenic and greenlands	2 to 4	40* to 80	Very limited and site specific	Shoulder	Shoulder or bike Lane	Rural ditch / swale	Primarily local deliveries, aggregates and agricultural material. Transport with restrictions through village centres
Rural Main Street	Rural Village Centre	2 to 4	40* to 50	Limited to designated stops or stations	Village specific – 1.5 min. sidewalk (wider where appropriate + furnishing/ planting zone + splash strip +utility zone	Behind the curb where design speeds exceed 50 km/h. , otherwise share the road	Curb and gutter	Local deliveries
Urban Main Street	Urban Village Centred mixed use	4 to 6	40* to 50	Major	Location specific 1.5 min. sidewalk (wider where appropriate + furnishing/ planting zone + splash strip + utility zone	Behind the curb	Curb and gutter	Local deliveries
Suburban Connector	Includes some residential areas with reverse frontages and associated intersections that have neighbourhood service retail	4 to 6	50 to 70	Moderate to Major	Desired - 1.5 min. sidewalk (wider where appropriate + furnishing/planting zone + splash strip + utility zone	1. For new construction or reconstruction accommodate in a 3m off-street multiuse trail 2. In transitional situations provide a 1.5m striped on-street bicycle lane	Curb and gutter	Yes
Commercial Connector	Commercial uses including employment lands/office campus and regional service retail	4 to 6	50 to 70	Moderate to Major	Desired - 1.5 min. sidewalk (wider where appropriate + planting zone + splash strip + utility zone	On-street when less than 50 km/h posted speed or behind the curb where posted speeds exceed 50 km/h. Otherwise share the road.	Curb and gutter	Yes
Industrial Connector	Industrial and warehousing areas and routes from those areas to 400 series highways	4 to 6 (professional judgement to be used if climbing lanes are necessary)	60 to 80	Moderate to Major	Desired - 1.5 min. sidewalk (wider where appropriate + planting zone + splash strip + utility zone	Recommended use professional judgment in high truck volume traffic areas where access points to adjacent uses or intersection less than 300m apart.	Curb and gutter or rural swale depending on adjacent uses	Yes

* The Region is committed to designing for active transportation. ** Desired operating speed equals range up to posted speed. Design speed equals 20km/hr greater than posted speed (Source: Road Characterization Study)