Metrolinx Vegetation Guideline

Updated 2022

METROLINX

Table of Contents

List of Tables

List of Figures

Appendices

GLOSSARY OF TERMS

TERM	DEFINITION
Arborist Report	A technical report identifying the location, species, size and condition of trees and describes maintenance strategies and protection measures to be implemented.
Arborist	An expert in the care and maintenance of trees including an arborist qualified by the International Society of Arboriculture (ISA), a consulting arborist registered with the American Society of Consulting Arborists or a registered professional forester.
Ballast	Ballast or Tack Ballast refers to the track bed upon which the railroad ties are laid. It is used to bear the load of the railroad ties while helping to facilitate drainage of water and suppress vegetation that might otherwise unsafely impede the track.
Basal Area	Common term used to describe the cross-sectional area of a tree measured 1.3 metres above the ground.
Baseline Compensation	An approach to compensation that involves replacement at a 1:1 ratio on an individual tree basis,
Best Practices	Professional procedures that are accepted or prescribed as being correct or most effective.
Bole	Bole (or trunk) is the stem and main wooden axis of a tree.
Boundary Tree	A tree situated with any portion of the trunk growing across Metrolinx Lands and an existing private or public property.
Bylaw Compensation	An approach to compensation that involves adhering to applicable bylaws or regulations.
Bylaw + Ecological Compensation	An approach to compensation that involves adhering to applicable bylaws or regulations in addition to replacement above and beyond the bylaw or regulation, if determined necessary based on the ecological compensation approach.
CAA	*Conservation Authorities Act*, 1990.
Cantilever	A beam that is supported by a pole at only one end and carries the load of the electrification equipment on top of tracks. At multiple track locations where cantilever frames are not practical, portal structures should be utilized.
Catenary System	An assembly of overhead wires consisting of, as a minimum, a messenger wire, carrying vertical hangers that support a solid contact wire which is the contact interface with operating electric train pantographs, and which supplies power from a central power source to an electrically-powered vehicle, such as a train.

TERM	DEFINITION
Chemical Control	Chemical pesticide or herbicide used to minimize incompatible plant communities while protecting compatible plants from pests, disease and overgrowth. This form of vegetative control is regarded as an important tool in railway vegetation management, particularly in areas such as track ballast where there are no effective non-chemical control alternatives available.
Compensation	The replacement of a lost/altered natural feature or area and its functions, services, and value.
Contact Wire	A solid grooved, bare aerial, overhead electrical conductor of an overhead contact system (OCS) that is suspended above the rail vehicles and which supplies the electrically powered vehicles with electrical energy through roof-mounted current collection equipment - pantographs - and with which the current collectors make direct electrical contact.
Cut Surface	A form of chemical control that involves manual cutting treatments for controlling woody vegetation.
Designated Natural Area	Designated natural areas include natural heritage systems, which are made up of natural heritage features and areas, as well as linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. Designated natural areas may include areas identified by resource agencies, municipalities, the government and/or public through legislation, policies or approved management plans.
Diameter at Breast Height (DBH)	The diameter of a tree measured at 1.4 m above ground.
Emerald Ash Borer (EAB)	Emerald Ash Borer (*Agrilus planipennis*) – an introduced beetle native to northeastern Asia that feeds on ash species and is currently causing significant ecological and economic impacts in forested and urban habitats in North America.
Ecological Compensation	An approach to compensation that involves replacement of trees at a ratio representative of their ecosystem functions and services.
Ecological/ Ecosystem Function	The natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socioeconomic interactions.
Ecosystem Services	The benefits to humans and other species, provided by nature.

TERM	DEFINITION
Ecosystem Structure	The living and non-living form and composition of ecosystems that give each system its own definition and function.
Ecological Land Classification (ELC)	Ecological Land Classification. The system in place in Ontario for defining ecological units on the basis of bedrock, climate, physiology, and vegetation.
ESA	Environmentally Significant Area. These are natural areas which are particularly significant or sensitive requiring additional protection to preserve their environmental qualities and significance.
ESA, 2007	The Ontario Endangered Species Act, 2007.
Feeder	A current-carrying electrical connection between the overhead contact system and a traction power facility (substation, paralleling station or switching station).
Foliar	A form of herbicide application that involves the use of a manually operated pressurized backpack sprayer or a handgun – most effectively used when a target vegetation is actively growing.
GIS	Geographic Information Systems. GIS systems are designed to capture, store, visualize, manipulate, analyze, manage, and present spatial or geographical data.
Good Arboricultural Practice	Tree planting, maintenance and removal performed in accordance with the American National Standards, ANSI 3000 and best management practices identified by the International Society of Arboriculture.
Hazard Tree	A hazard tree can generally be defined as a tree with structural defects likely to cause the failure of all or part of the tree and is at risk of causing damage or injury to life or property. Risk is related to the chance that the tree could potentially strike a target if left untreated.
Higher Value Tree	Higher value trees are defined as trees that can potentially be used for lumber and are identified based on the tree species as well as size and wood quality. Higher value trees can be identified in the field as those with a straight trunk at least 3 m long, a minimum diameter at breast height (DBH) of 15 cm, no large branches (greater than 5 cm diameter) and no visible defects. Once these trees are felled, their potential for re-use and diversion will need to be re-examined, as some defects would not visible during field surveys.
Hi-Rail Vehicle	A road-rail vehicle which can operate both on rail tracks and a conventional road.

TERM	DEFINITION
Inure or Injury	Any act that will harm a tree's health in any manner, including failure to protect in accordance with respective municipal and regional standards.
Invasive Species	Invasive plant species include those that threaten the biodiversity and ecological integrity of an ecosystem.
IVM	Integrated Vegetation Management: A system, typically involving a stepwise framework, for managing and controlling incompatible and compatible vegetation.
Lower Value Tree	Any tree not identified as a higher value tree.
MBCA	*Migratory Birds Convention Act*, 1994.
Mechanical/ Manual Control	A form of vegetative control used to minimize incompatible plant communities and protect plants from pests, disease and overgrowth – typically referring to such methods as hand pulling and cutting, weed trimming, mowing and brush cutters, and chain saws.
MECP	Ontario Ministry of the Environment, Conservation and Parks
Metrolinx Lands	Includes any Lands owned by Metrolinx and Rail Corridor Rights of Way on which Metrolinx operates.
Mitigation Measure	Actions that remove or alleviate, to some degree, the negative effects associated with the implementation of an alternative.
MNRF	Ontario Ministry of Natural Resources and Forestry.
NHIC	Natural Heritage Information Centre.
Noxious Plants	A noxious plant, otherwise known as a noxious or harmful weed, is a species that has been designated by a governing authority as an injurious to natural habitats or ecosystems, habitats, or agriculture.
Overhead Contact System (OCS)	The acronym for the Overhead Contact Systems (OCS), which is comprised of: The aerial supply system that delivers 2x25 kV traction power from traction power substations to the pantographs of Metrolinx electric trains, comprising the catenary system messenger and contact wires, hangers, associated supports and structures including poles, portals, head spans and their foundations), manual and/or motor operated disconnect switches, insulators, phase breaks, section insulators, conductor termination and tensioning devices, downguys, and other overhead line hardware and fittings. Portions of the traction power return system consisting of the negative feeders and aerial static wires, and their associated connections and cabling.

TERM	DEFINITION
Overhead Structure	A structure that allows a road to cross over a railway underneath.
Pest/Pest Population	A destructive inset or animal that is harmful to terrestrial or aquatic life form, human or farm animal health, or interferes with economic activities.
PIN	Property Identification Number
Proponent	A person who carries out or proposes to carry out an undertaking or is the owner or person having charge, management or control of an undertaking.
PTE	Permission to Enter.
Radiarc Sprayer	A precision sprayer mounted to the side of a hi-rail spray vehicle that may be used for the foliar application of selective weed and brush control herbicides to right-of-ways.
ROW	Right of Way: The portion of land adjacent to tracks owned by the Railway (Metrolinx, Canadian Pacific Railway (CP), Canadian National Railway (CN), etc.). Can be synonymous with rail corridor.
SAR	Species at Risk: These are plants or animals that are considered by the Government of Ontario to be endangered, threatened, of special concern, or extirpated.
SARA	Species at Risk Act.
Self-Sustaining Vegetation	Means vegetation dominated by native plant species that can grow and persist without direct human management, protection or tending.
Static Wire	A wire usually installed aerially adjacent to or above the catenary conductors and negative feeders, that connects overhead contact system (OCS) supports collectively to ground or to the grounded running rails to protect people and installations in case of an electrical fault.
Sustainable/ Sustainability	Meeting the needs of the present without compromising the ability of future generations to meet their own needs through responsible resources use and management, environmental protection measures, and enhancements to quality of life and economy.
Switching Station (SWS)	Switching stations are traction power facilities that are required approximately mid-way between Traction Power Substations in order to split the electrical sections.
Tree	Any species of woody perennial plant including its root system which has reached or can reach a height of at least 4.5 metres

TERM	DEFINITION
	(15 feet) at physiological maturity. The term “tree” refers to all parts of the tree; roots, branches, leaves, seed/fruit and stem.
Threshold	The point at which the abundance of pests, noxious plants, and incompatible vegetation is causing, or is likely to cause, risk indicating that control is necessary or desirable.
TPZ	Tree Protection Zone. A distance from the stem set aside for the protection of a tree's crown and roots to provide for the viability and stability of the tree.
TRCA	Toronto and Region Conservation Authority.
Vegetation Type/Vegetation Community	An ecosystem as described by its vegetation composition and form and as defined by the *Ecological Land Classification System for Southern Ontario.*
Wick/Wipe-On	A form of chemical control that involves the use of a wick soaked with an herbicide solution that is wiped or dragged over the foliage of a target vegetation.

EXECUTIVE SUMMARY

This Vegetation Guideline provides Metrolinx's approach to managing vegetation on Metrolinx Lands, including removal and compensation of trees. It is an updated approach to managing vegetation that will allow Metrolinx to address the need to provide safe and reliable transport in addition to providing social, economic and ecological benefits. The need for the update was identified to accommodate Metrolinx's transit initiatives and expansion programs including GO Expansion, Rapid Transit and Subway Programs As part of the infrastructure work planned under these transit programs , vegetation removals will be required by planned upgrades such as grade separations, new track, subway portals, layover facilities, new stations and station improvements, construction staging, as well as implementation of electrification infrastructure. This Vegetation Guideline has been developed to provide frameworks for: (1) vegetation compensation; (2) tree end use; and (3) integrated vegetation management (IVM), which can be applied across various Metrolinx projects happening now or in the future.

All three components outlined in this guideline have been developed to satisfy regulatory requirements, environmental assessment commitments, as well as Metrolinx sustainability goals and corporate policy priorities

Vegetation Compensation

This guideline includes a vegetation compensation framework, developed to outline the approach for determining and implementing compensation for the removal of trees from the Metrolinx Lands, as well as public and private lands. It is a landscape science-based approach that exceeds the requirements of applicable bylaws and regulations.

The compensation approach addresses the removal of trees based on property ownership, bylaws, regulations, and location with respect to ecological functioning. Compensation will follow one of three approaches (ecological, baseline or bylaw) or a combination of approaches (**Table E1**).

Table E1: Compensation Approach Based on Tree Location

Location	Applicable Bylaw with Compensation Approach	Within a Designated Natural Area	Compensation Approach
Metrolinx Lands	No	No	Baseline Compensation
Metrolinx Lands	No	Yes	Ecological Compensation
Public/Private Land	Yes	No	Bylaw Compensation
Public/Private Land	Yes	Yes	Bylaw + Ecological Compensation
Public/Private Land	No	Yes	Ecological Compensation
Public/Private Land	No	No	Baseline Compensation

The compensation approach recommended in this guideline applies to tree removals associated with Metrolinx capital projects only and does not apply to vegetation removal associated with routine operational maintenance work on Metrolinx Lands to ensure safe operations and sightlines.

Metrolinx, as a Provincial Agency, is not subject to municipal permits and approvals, including compensation requirements, for tree removals within Metrolinx owned property. Trees within Metrolinx Lands will be compensated for using an approach developed specifically for Metrolinx. Compensation for trees within Metrolinx Lands that are located within a designated natural area will reflect the principles of the Toronto and Region Conservation Authority's (TRCA) *Guideline for Determining Ecosystem Compensation* (June 2018) (ecological compensation). All other trees within Metrolinx Lands will be compensated for at a 1:1 ratio (baseline compensation).

For trees within public or private lands and all Boundary Trees, compensation will follow applicable bylaws/regulations including compensation requirements. Metrolinx will work directly with residents to address the loss of trees on private property, including obtaining necessary permits to satisfy applicable bylaws and regulations.

The vegetation compensation framework outlined in this guideline will provide compensation to all stakeholders impacted by tree removal required for the GO Expansion Program and can also be applied to future tree removal within and outside of Metrolinx Lands. Furthermore, it meets Metrolinx sustainability goals and corporate policy priorities, most notably the *Metrolinx Sustainability Strategy* goal to minimize the impact on ecosystems by considering the effects of infrastructure and services on ecosystems and associated services and make best efforts to manage, preserve or protect them.

Tree End Use

In an effort to improve sustainability practices, this guideline includes a framework for tree end use. The framework consists primarily of processing an anticipated 95% of the wood generated from tree removals into wood chips. Much of the chipped material will be re-used as mulch within the Metrolinx rail corridor. The wood chips re-used within the corridor will be applied a minimum of 3 m from ballast and focused in areas where trees were removed. Chippings in excess of what can be applied in the corridor will be removed off site and may be used by a community partner.

The framework also outlines a process for diverting tree removals debris to end use for community partners, so that future vegetation removals can be completed in a manner that minimizes impact on infrastructure, can potentially be cost effective, and implements sustainable practices. One of the objectives of this program is to reduce wood removal debris from being disposed into a landfill.

Essential components of the tree end use framework include 1) providing end use options 2) defining higher value trees; 3) outlining transportation and storage plans; and 4) building the distribution and re-use plan.

This framework provides a method for identifying higher value trees, defined as trees that can potentially be used for lumber and are identified based on the tree species as well as size and wood quality. Higher value trees can be cut into sawlogs and can be used as lumber for construction wood and other purposes. All other trees, including trees less than 10 cm diameter at breast height (DBH) and all ash trees, will be mulched or chipped and spread on site, unless the volume of mulch generated exceeds the capacity of on-site disposal (i.e. maximum mulch depth disposed on site is 10 cm). Excess material will be shipped off site and re-used as mulch for gardening, pulp wood, biofuel, and other uses. Any disease-ridden trees will not be transported outside of quarantine areas and all distribution and transportation will comply with Canadian Food Inspection Agency (CFIA) regulations.

The tree end use framework provided in this guideline is consistent with Metrolinx's goal to develop and implement strategies that enhance its responsibility to the community and its goal to improve sustainability. It meets the *Metrolinx Sustainability Strategy* goals to minimize diversion to landfills, incorporates sustainability requirements within procurement practices, supports the local workforce through the creation of wood servicing jobs, and promotes community involvement in the design process.

Integrated Vegetation Management

Integrated vegetation management (IVM) has been widely adapted to effectively meet the needs of vegetation management programs in ROWs and has been applied to transportation corridors with success. The IVM framework presented in this guideline provides an approach to managing vegetation along the ROW that is not only compatible with the GO Rail Expansion and Subway Program, but also minimizes impact on infrastructure, provides a cost-effective approach, and implements sustainable practices, such as minimizing the presence and spread of invasive plant species and planting/seeding with native plant species. The IVM approach presented in this guideline addresses both electrified and non-electrified rail corridors as well as other Metrolinx Lands as applicable.

Metrolinx has managed and maintained existing non-electrified corridors through a variety of measures in accordance with the *Vegetation Management Guidelines* (Metrolinx, 2013). The *Vegetation Management Guidelines* (Metrolinx, 2013) informed five-year contracts for routine track and signal maintenance and are now superseded by this Vegetation Guideline. Consistent with Metrolinx's focus on providing safe and reliable service, key management objectives for IVM in a rail corridor and on Metrolinx Lands are to:

- Prioritize worker and operational safety;
- Maintain reliable service by minimizing disruption caused by fallen trees, tree limbs, and debris; and
- Protect rail infrastructure.

Metrolinx's IVM program is presented in five (5) steps and should be interpreted as a cyclical and adaptive framework (**Figure E1**).

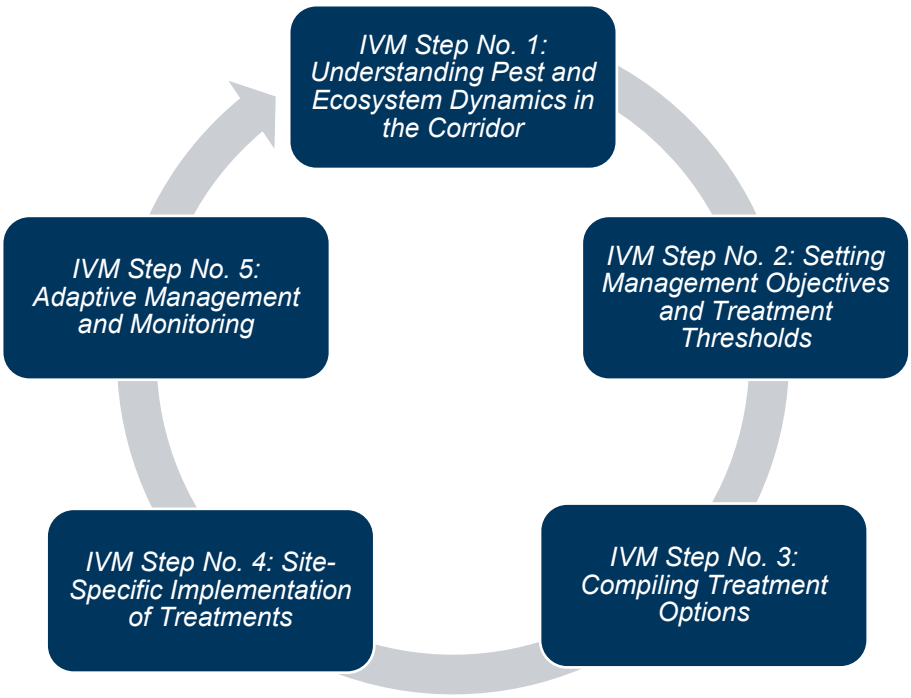


Figure E1: The Cyclical Steps of Integrated Vegetation Management

IVM Step No. 1

The first step in conducting IVM is to develop and maintain a working knowledge of the vegetation on Metrolinx Lands. This involves undertaking an inventory of vegetation conditions, monitoring plant community composition and structure, and monitoring the presence of incompatible and compatible species.

IVM Step No. 2

Once an understanding of the ecosystem has been established, it is used to inform management objectives and tolerance levels on Metrolinx Lands. The goal of IVM Step No. 2 is to minimize, to the greatest extent possible, the percentage of incompatible vegetation on Metrolinx Lands to ensure that biodiversity and safety are upheld. This involves setting treatment thresholds that aim to minimize and prevent the establishment of incompatible species as well as enabling required vegetation removal while retaining compatible vegetation.

A vegetation clearance zone is required in order to provide safe electrical clearances from infrastructure to any existing vegetation along the rail corridors. A vegetation clearance zone is required along non-electrified rail corridors as well.

As part of the *GO Rail Network Electrification Transit Project Assessment Process* (TPAP), a 7 m clearing zone for vegetation along the corridor was determined based on industry standards. It is intended to ensure safety and reliability by reducing the risk of

limbs or trees falling on the tracks and the Overhead Contact System (OCS) electrification infrastructure. The 7 m vegetation clearance zone is made up of the following:

- 2.9 m clearance from the track to the Overhead Contact System (OCS) pole to ensure clearance of the train to the OCS pole;
- 2.5 m vegetation clearance from the electrical components to the limits of the trees; and
- Up to 1.6 m to account for tree grow back (regrowth zone).

Based on management objectives and tolerance levels, five (5) IVM zones have been developed to address Metrolinx infrastructure, including the 7 m vegetation clearance zone. While the focus of IVM is on the 7 m vegetation clearance zone, guidance on planting within the corridor in areas beyond the 7 m vegetation clearance zone is also provided.

Similar to the vegetation clearance zones that have been developed to address electrified corridors, the IVM framework within this Vegetation Guideline provides clearly defined areas – also measured from the centerline of the outermost track – for non-electrified rail corridors. Consistent with the *Vegetation Management Guidelines* (Metrolinx, 2013), this IVM framework outlines vegetation control measures for maintaining rail operation and maintenance safety while identifying opportunities for the planting of compatible native plant species.

Tolerance levels within each zone are quantified by treatment thresholds, which provide a measurement tool for determining whether action (i.e., treatment) is required to manage vegetation within or on Metrolinx Lands. In general, vegetation that exceeds a treatment threshold requires a management action or decision. This IVM framework provides guidance on how to measure the existing vegetation on Metrolinx Lands against treatment thresholds to determine if treatment is needed.

IVM Step No. 3

Once a decision has been made that treatment is required, the next step (IVM Step No. 3) is to develop of a treatment method (chemical, mechanical and/or cultural) that meets the needs of ecological, economic, and stakeholder concerns. This involves developing a treatment approach that effectively meets site-specific conditions and encourages the establishment of a compatible, self-sustaining vegetative cover.

IVM Step No. 4

Implementation of treatment (IVM Step No. 4) is tailored to varying site conditions, needs, and sensitivities, with the goal of meeting IVM targets/objectives while considering indirect and direct impacts to the environment and society, as well as cost. This involves adhering to the selection criteria / decision-making process to determine which potential control type and method (pruning, mowing, foliar chemical application, seeding, native plantings in Zones 3, 4 and 5 to create screening, etc.) best addresses management constraints (site conditions, environmental sensitivities, timing windows etc.).

IVM Step No. 5

In the final step of IVM (IVM Step No. 5), post-treatment monitoring will be undertaken to evaluate the success of implemented treatments. The monitoring and evaluation will work to inform adaptive management needs, provide guidance for future work, allow for ongoing improvement to the IVM based on learned experiences, and allow for IVM to meet new objectives and conditions. The IVM approach will involve annual monitoring and the use of a GIS database system to inform decision-making, maintenance schedules and plans.

The IVM approach is consistent with Metrolinx's goal to develop and implement strategies that enhance the health of ecosystems. Moreover, it is a policy that satisfies the *Metrolinx Sustainability Strategy* goal to minimize service and infrastructure related impacts on ecosystems through better management, preservation, and protection practices.

1 INTRODUCTION

Metrolinx was established by the Government of Ontario under the Metrolinx Act (2006) with a mandate to support "*a high quality of life, a sustainable environment and a strong, prosperous and competitive economy*". The *Metrolinx Sustainability Strategy* has since been developed and outlines how Metrolinx can implement projects, plans and activities to achieve meaningful progress towards sustainability within its own operations. Integrating sustainability into how to plan, build and operate to is now part of Metrolinx's mandate.

Metrolinx and its partners are delivering on a bold, forward-looking transportation plan to transcend borders and foster connections between all our communities in the Greater Toronto Hamilton Area (GTHA). The delivery of the GO Expansion, Rapid Transit and Subway Programs will provide significant new travel choices for the GTHA residents, which may include electrified service on Metrolinx's rail corridors, amongst other alternative transportation methods. This will include trains efficiently running every 15 minutes, as well as two-way all-day service on weekdays, during the evenings and on weekends in core areas.

The infrastructure work planned under Metrolinx's transit expansion programs, includes new tracks, new stations, grade separations, subway portals and tunneling, guideways, construction staging as well as electrification. Vegetation removals are necessary for construction, maintaining the integrity of the infrastructure, and keeping riders and operators safe. For example, under the GO Rail Expansion Program, there will be an increase in trains on the rail corridor, an increase in frequency of trains going in and out of stations, and an increase in duration of time. In order to maintain this goal it is necessary that vegetation is removed to decrease the amount of leaf fall on tracks (leaves on the tracks creates less friction which causes the train wheels to spin and therefore start and stop inefficiently), decrease the amount of tree debris on tracks, increase visibility along the corridor, prevent trees/limbs from falling on tracks and to prevent damage to rail infrastructure.

Electrification is new infrastructure that Metrolinx will be introducing into the rail network that requires the installation of overhead lines, which is a fundamental change to the rail infrastructure. The installment of electrified infrastructure will demand vegetation removals be taken on a much larger scale than is typically seen with the construction of traditional rail. Required vegetation removal will include trees from Metrolinx properties as well as adjacent municipal, government, private and conservation authority (CA) lands.

With the addition of electrification, the rail network will become subject to unique safety and regulatory requirements specific to electrical infrastructure. Electrical infrastructure is highly susceptible to the hazards that tree debris (e.g. fallen limbs) can pose within the rail network and thus have a lower tolerance for tall or climbing vegetation. Given the added risk to safety, a greater number of trees will need to be removed during both the implementation and operation of electrification.

To ensure that vegetation removals are carried out in a manner consistent with Metrolinx's ecological, social and policy priorities, the Vegetation Removal and Compensation Program (the Program) has been established. As part of the Program, this guideline has been developed to provide a framework for vegetation compensation, tree end use and integrated vegetation management (IVM).

This guideline aims to support the *Metrolinx Sustainability Strategy* by focusing on how to:

- Ensure the sustainability of infrastructure projects;
- Minimize the environmental impacts of services expansion;
- Leverage investments to support communities; and
- Maintain a safe and reliable transportation system.

Furthermore, the guideline has been developed with consideration of the five priority sustainability goals identified in the *Metrolinx Sustainability Strategy*:

- Goal 1: Become Climate Resilient;
- Goal 2: Reduce Energy and Emissions;
- Goal 3: Integrate Sustainability in our Supply Chain;
- Goal 4: Minimize Impact on Ecosystems; and
- Goal 5: Enhance Community Responsibility.

The intent of this Vegetation Guideline is to provide Metrolinx with a framework to manage vegetation within Metrolinx Lands that can be applied and adapted to various Metrolinx projects in the future.

2 BACKGROUND

The *Initial Business Case (IBC) for the Metrolinx Vegetation Policy Framework* was developed by Metrolinx to evaluate options for the Vegetation Removal and Compensation Program. The preferred options identified in the IBC were used to inform the development of the approach to vegetation management presented in this guideline. The result is a set of frameworks outlining the necessary steps and processes to carry out and implement vegetation compensation, tree end use and integrated vegetation management (IVM).

Vegetation Compensation

Prior to the development of this guideline, Metrolinx did not have a vegetation compensation policy in place. As part of the GO Rail Expansion Program, it was identified that appropriate compensation for the removal of trees would need to be implemented. Thus, Metrolinx took the opportunity to develop a vegetation compensation program that describes how compensation will be managed, outlines the preferred compensation approaches and provides a framework for implementing the recommended program.

While it is recognized that tree removal will be required as part of Metrolinx projects, the intent of this program is to provide an approach to compensation only when avoidance and mitigation are not feasible options. Minimizing impacts to trees is consistent with an established guiding principle commonly applied to ecological offsetting programs: the mitigation hierarchy. The mitigation hierarchy calls for the avoidance of impacts first, then minimization followed by mitigation, with compensation as a final option (MNRF, 2015). Compensation can be defined as the creation or restoration of habitat to offset the loss that could not be avoided, minimized or mitigated. Where compensation is the only option, a net gain or overall benefit to the ecosystems and ecosystem services should be pursued.

Development of the compensation approach included consultation with conservation authorities and municipalities. It is intended that the vegetation compensation approach will meet the expectations of all relevant stakeholders including but not limited to elected officials, municipal staff, conservation authorities, community groups and affected property owners. Moving forward Metrolinx will engage with Indigenous Nations regarding their interests.

The vegetation compensation program presented in this guideline supports the goals of Metrolinx's *Sustainability Strategy* by meeting the following actions and measures of success:

- Minimize the impact of new and existing infrastructure on ecosystems and look for ways to enhance the health of ecosystems (i.e., species, habitat, biodiversity).
  - Integrate requirements into Metrolinx procurement practices to manage and mitigate impacts of new and existing infrastructure on ecosystems.
  - Identify and implement opportunities to support and enhance biodiversity (i.e. habitat and species) conservation efforts to meet or exceed applicable legislation and guidelines.
  - Identify opportunities to enhance ecosystems to meet or exceed applicable legislation and guidelines. This includes but is not limited to consideration of native and pollinator species.
- Minimize impacts on communities through identification of areas along the corridors where replanting of native vegetation may be possible.

The vegetation compensation framework outlines a strategy to mitigate ecological and community impacts due to vegetation removal. The strategy has been developed based on the recommended option presented in the IBC as well as current approaches to compensation.

Tree End Use

Through this guideline, Metrolinx is initiating the development of a policy specific to tree end use. In the past, vegetation removal and disposal was typically completed on a scale of less than 2 ha and managed by a Contractor. Vegetation would be chipped on site if the volume of chips was small enough to be safely handled and carried out by a two-

person crew. If the volume of chips was of a larger scale, or if access to the ROW was challenging, the Contractor would remove whole logs and transport them off site for disposal. Due to the size and scope of transit projects, the need to develop an approach suited for large-scale removals was identified.

Development of a tree end use program is consistent with Metrolinx's goal to develop and implement strategies that enhance its responsibility to the community and its goal to improve sustainability. It meets the *Metrolinx Sustainability Strategy* goal to minimize diversion to landfills, incorporates sustainability requirements within procurement practices, supports the local workforce through the creation of wood servicing jobs, and promotes community involvement during the design process.

In following these targets, the purpose of the tree end use framework is to promote an approach to tree disposal and end use that:

- Satisfies safety requirements;
- Promotes the integrity of a healthy ecosystem;
- Is cognizant of the full life-cycle impact of tree removal and disposal practices;
- Minimizes, to the greatest extent possible, vegetative debris from entering the landfill;
- Maximizes, to the greatest extent possible, the repurposing of higher value trees on Metrolinx Lands; and
- Aims to support the local workforce by creating wood removal servicing jobs; for example, it provides the opportunity to support local artists through the commissioning of art projects made from higher value trees, etc.

The tree end use framework outlines a process for identifying higher value trees and establishing end use options for all removed trees. The tree end use framework also provides strategies for removal, storage and distribution of higher value trees.

Integrated Vegetation Management

To date, Metrolinx has undertaken maintenance of its lands utilizing a variety of vegetation control methods suitable to existing needs and operations, including mechanical cutting, manual brushing/mowing, and the application of herbicides. In order to address the vegetation clearance requirements associated with electrification and the increasing train service, Metrolinx began exploring options for a vegetation management program that would accommodate electrification. The IBC identified IVM as a solution to managing vegetation within the ROW and Metrolinx Lands that is not only compatible with the GO Rail Expansion Program, but also minimizes the impact on infrastructure, provides a cost-effective approach, and implements sustainable practices.

Integrated vegetation management can be defined as a system of information gathering, planning, implementing, reviewing and improving vegetation treatments (Nowak and Ballard, 2005). This approach has been widely adapted for ROW management for roads and highways, hydro corridors as well as rail corridors.

Developing an IVM program for Metrolinx's rail corridor addresses the fundamental need to provide safe and reliable transport in addition to providing social, economic and ecological benefits. This is consistent with Metrolinx's mandate and sustainability goals, including but not limited to consideration of native and pollinator species. Several additional, important objectives of the IVM are to:

- Establish and maintain a vegetation clearance zone which protects ballast sections and infrastructure from incompatible vegetation growth;
- Where feasible plant or seed with native low-lying and low-maintenance vegetation that is compatible with best practices as well as federal and provincial railway and electrification requirements; and
- Control the growth and overgrowth of vegetation, including noxious weeds and invasive species.

The IVM framework provides an outline for managing vegetation within the corridor. It is a cyclical approach that is, in part, defined by its adaptive nature. Bi-annual monitoring of the ecological conditions of the corridor and the effects of management actions is a vital component that informs subsequent management decision and actions. The framework presented in this guideline has been developed based a review of numerous IVM plans for rail, road and hydro corridors.

Data Collection Recommendations

All three (3) components outlined above are informed by the existing conditions on site, particularly trees within and adjacent to the project limits. Integrated vegetation management requires frequent (annual) up-to-date inventories of existing conditions within Metrolinx Lands including but not limited to trees and, as such, information regarding the data to be collected as part of IVM is outlined in **Section 5**. The vegetation compensation and tree end use frameworks provided in this guideline require detailed information to be collected on trees; thus, **Appendix A** provides recommendations for data collection to enable the implementation of the vegetation compensation and tree end use programs.

3 VEGETATION COMPENSATION

The following provides a framework intended to guide compensation for the loss of trees that cannot be avoided or mitigated. Providing compensation for tree removals occurring on Metrolinx Lands and in both publicly owned (e.g., municipal and conservation authority) and privately-owned lands is consistent with Metrolinx's goal to minimize impacts on ecosystems and ecosystem services. The vegetation compensation approach outlined below has been based on the natural capital approach that Metrolinx has developed to date, as outlined in the IBC, and will largely be determined by property ownership, bylaws/regulations and location with respect to ecological functioning. The intent of this compensation framework is to guide any future compensation work for trees removed as part of Metrolinx projects. The compensation approach recommended in this guideline applies to tree removals associated with Metrolinx capital projects only and does

not apply to vegetation removal associated with routine operational maintenance work on Metrolinx Lands to ensure safe railway operations and sightlines.

3.1 Potential Compensation Approach Options and Guidance Documents

The following provides a summary of the IBC, the Ontario Power Generation (OPG) Biodiversity Policy and Procurement Program and the Toronto and Region Conservation Authority's (TRCA) *Guideline for Determining Ecosystem Compensation (June 2018)*, which were key reference documents considered in development of this vegetation compensation program. It should be noted, however, that not all components of the reference documents have been carried forward in the vegetation compensation framework provided in this guideline.

3.1.1 Initial Business Case for the Metrolinx Vegetation Policy

The IBC was developed for the purpose of evaluating options for the Vegetation Removal and Compensation Program, and specifically addressing compensation. The following three (3) options were reviewed to identify the preferred alternative:

- Option 1 – Minimal Compensation
- Option 2 – Full Compensation Approach Following Tree Bylaws
- Option 3 – Full Compensation Approach Following Tree Bylaws and Ecological Restoration

Option 3 – Full Compensation with Ecological Restoration was identified in the IBC as the Recommended Option. This option involved compensation for bylaw trees according to the applicable bylaw, compensation to residents for loss of private trees, as well as compensation for the loss of trees within Metrolinx Lands through ecological restoration.

The recommended compensation approach, as outlined in the IBC, involved the following key components:

- A Project Coordinator would be responsible for overseeing the design, coordination, implementation, monitoring and reporting on ecological restoration and outcomes;
- Compensation would be provided though ecological restoration, such as the creation or enhancement of habitat; and
- No funds will be diverted towards the acquisition of property.

The IBC outlined a conceptual framework for funding, which involved distribution of funds from Metrolinx to qualifying external project partners. It was recommended that external partners would be responsible for the coordination of ecological restoration projects, including maintenance, monitoring, and reporting, as well as plant material replacement actions.

3.1.2 Ontario Power Generation Biodiversity Policy and Procurement Program

Ontario Power Generation (OPG) is an Ontario-based electricity generation company focused on the efficient production and sale of electricity while operating in a safe, open and environmentally responsible manner.

OPG's Environmental and Biodiversity Policies and its programs are managed by an Environmental Management System (EMS) that is registered and audited both internally and externally in order to retain its registration. This ensures that biodiversity issues are an integral component of on-going operations.

Biodiversity conservation initiatives supported by OPG include multi-year woodland, wetland, grassland, lake and rivers projects, such as restoration and enhancement through the planting of native trees and shrubs. Partnerships with external organizations, such as conservation authorities, have been successful for project implementation and community recognition. This is done through project funding awarded to pre-qualified vendors through a competitive process. OPG works with project partners to identify priority sites for protection, restoration and conservation within Ontario.

3.1.3 Toronto & Region Conservation Authority Ecosystem Compensation Protocol

The TRCA's *Guideline for Determining Ecosystem Compensation (June 2018)* (herein referred to as the TRCA ecosystem compensation protocol) presents an approach for replacing natural features lost through development and/or infrastructure under circumstances where impacts cannot be avoided. It recognizes ecosystem compensation as a tool to help ensure that the critical ecosystem functions and services lost though development and infrastructure are restored. It provides guidance on how to determine the total amount of compensation required to replace lost or altered ecosystems in a repeatable and transparent manner. It promotes strategic and effective implementation of compensation restoration and attempts to provide a standard and consistent approach informed by science and decades of experience in the application of natural heritage planning and ecological restoration. Finally, it is intended to set standards to ensure that compensation projects are adequately financed and successfully implemented for the long term.

The TRCA ecosystem compensation protocol outlines two main approaches to compensation, which are often used in tandem: (1) replicating ecosystem structure and (2) replicating the land base. Replicating the land base, however, involves securing or acquiring land, which will not be done as part of Metrolinx's approach to vegetation compensation. Thus, replicating the land base is not suitable and only the replicating ecosystem structure approach has been carried forward for consideration in developing the vegetation compensation framework.

The TRCA ecosystem compensation protocol acknowledges that compensation requirements for the loss of trees may be met under existing bylaws or authorization under

the *Endangered Species Act (ESA), 2007*. In circumstances where compensation approaches are already in place, this protocol can be adapted to achieve unique objectives and approaches.

In order to determine compensation requirements, the TRCA ecosystem compensation protocol recommends calculating basal area of the ecosystem that will be impacted. Where the basal area approach is not suitable for determining compensation, tree replacement ratios can be determined using an individual tree approach. In cases where only a portion of the feature is being removed, the TRCA ecosystem protocol recommends that the average basal area be calculated based on the entire feature, not just the portion being removed. Since most transit projects represent linear infrastructure, removal of trees required to support these projects will be limited to small portions and/or edges of treed ecosystems and access to the feature outside of Metrolinx Lands will be limited. As such, quantifying impacts will be completed using the individual tree approach in most cases; however, where possible, the basal area approach is recommended.

The TRCA ecosystem compensation protocol identifies a number of factors that should be considered for the implementation of ecosystem compensation projects and in establishing agreements for ecosystem compensation plans. Those appropriate for the implementation of this framework have been carried forward in Metrolinx's approach to vegetation compensation.

3.2 Implementation Framework for Vegetation Compensation

The recommended option for vegetation compensation is a landscape science-based approach designed to reflect the basic principles of the TRCA's ecosystem-based approach in addition to following the requirements of applicable bylaws and regulations and providing a solution for trees removed from private properties.

The vegetation compensation framework provides compensation to all stakeholders impacted by tree removal required for the GO Expansion Program and can also be applied to future tree removal within and outside of the Metrolinx Lands. It exceeds what is required by Metrolinx in effort to meet regulations, environmental assessment commitments and stakeholder expectations. Future iterations of this framework will consider feedback in an effort to improve engagement with Indigenous Nations. Furthermore, it meets Metrolinx's sustainability goals and corporate policy priorities, most notably the *Metrolinx Sustainability Strategy* goal to minimize the impact on ecosystems.

Compensation will follow one or a combination of the following approaches: ecological, baseline, or bylaw. The compensation approach will largely be determined by property ownership, applicable bylaws/regulations and ecological functioning.

Baseline Compensation involves replacement at a 1:1 ratio on an individual tree basis.

Bylaw Compensation involves meeting applicable municipal bylaws or regulations.

Ecological Compensation involves replacement of trees at a ratio representative of their ecosystem functions and services. Ecological compensation ratios can be determined by one of two methods: the basal area approach or the individual tree approach.

Bylaw + Ecological Compensation involves meeting applicable bylaws/regulations in addition to replacement above and beyond the bylaw/regulation, if determined necessary. In other words, where ecological compensation is greater than bylaw/regulation requirements, the bylaw/regulation shall be followed and the difference between the two shall be implemented through ecological compensation.

Table 1 provides a summary of the compensation approach based on the location of each tree. Details outlining each compensation approach are provided in the following subsections.

Table 1: Compensation Approach Based on Tree Location

Location	Applicable Bylaw with Compensation Approach	Within a Designated Natural Area	Compensation Approach
Metrolinx Land	No	No	Baseline Compensation
Metrolinx Land	No	Yes	Ecological Compensation
Public/Private Land	Yes	No	Bylaw Compensation
Public/Private Land	Yes	Yes	Bylaw + Ecological Compensation
Public/Private Land	No	Yes	Ecological Compensation
Public/Private Land	No	No	Baseline Compensation

Designated natural areas include natural heritage systems, which are made up of natural heritage features and areas, as well as linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. For the purpose of determining compensation approach, designated natural areas may include those identified by resource agencies, municipalities, the government and/or public through legislation, policies or approved management plans. An up-to-date list of designated natural areas will be maintained by Metrolinx and can be made available upon request.

Figure 2 provides an illustrative flowchart for determining vegetation compensation.

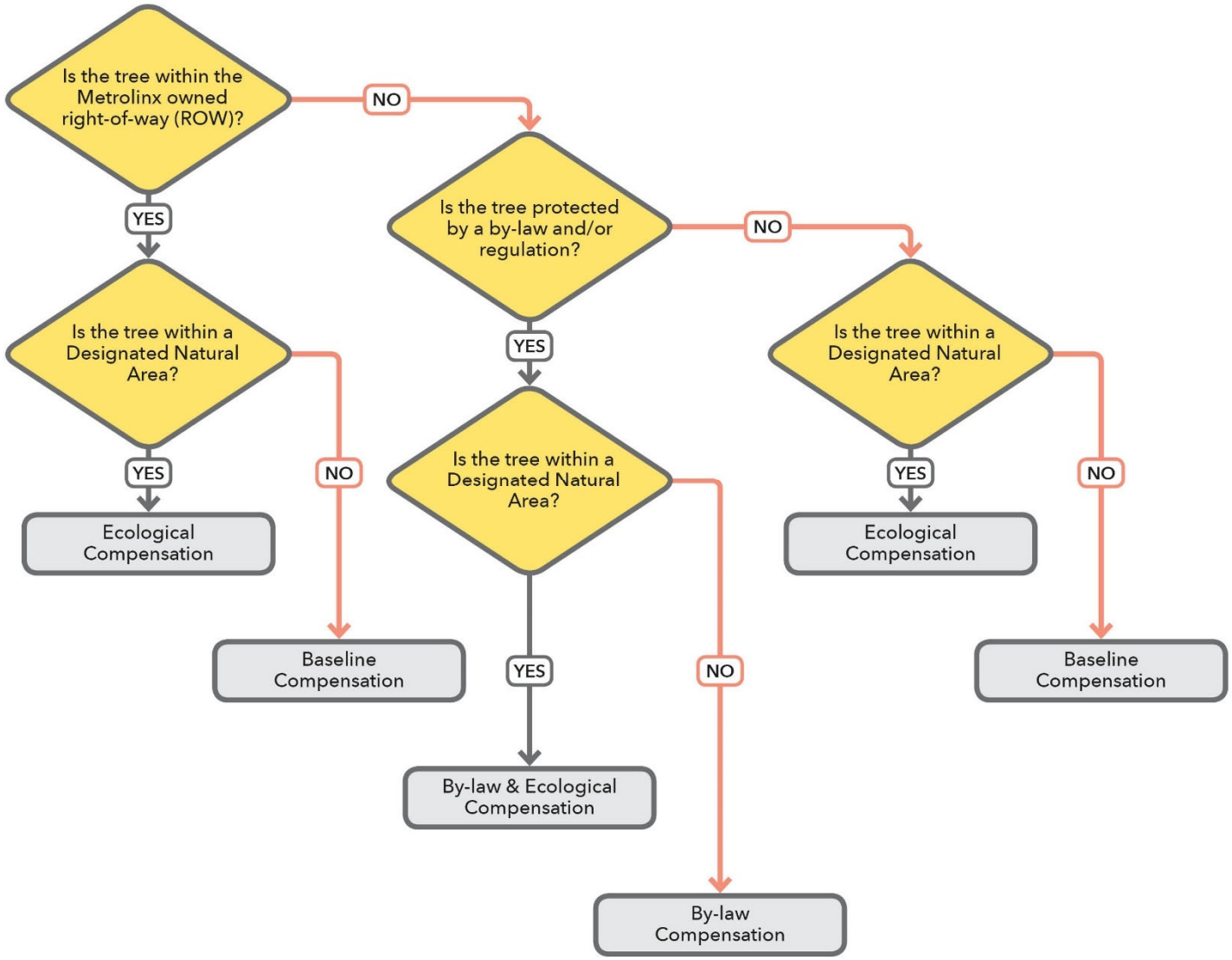


Figure 2: Vegetation Compensation Flowchart

3.2.1 Determining Compensation Approach

3.2.1.1 Metrolinx Lands

Metrolinx, as a Provincial Agency, is not subject to municipal permits and approvals, including compensation requirements, for tree removals within Metrolinx owned property. However, all trees (10 cm or greater DBH) within Metrolinx Lands will be compensated for using either an ecological or baseline approach. Where tree removals are located within a designated natural area, an approach based on the principles of the TRCA ecosystem compensation protocol will be implemented (ecological compensation). Where removals are outside a designated natural area, a 1:1 ratio approach will be implemented (baseline compensation).

As noted in **Section 3.1.3**, the TRCA ecosystem compensation protocol outlines two main approaches to compensation: (1) replicating ecosystem structure and (2) replicating the land base. Replicating the land base, however, involves securing or acquiring land, which will not be done as part of Metrolinx's approach to vegetation compensation.

3.2.1.2 Public/Private Lands

Compensation for trees within public and private lands, including those on the boundary between Metrolinx Lands and public or private lands as well as lands used for construction for access and laydown and easements, will follow the requirements of applicable bylaws and regulations. Trees that are not subject to bylaws/regulations and are located outside of a designated natural area will be compensated for at the baseline 1:1 ratio

For trees within a designated natural area, compensation will be ecological. In cases where trees are both subject to bylaws/regulations and are located within a designated natural area, a combined approach (i.e. bylaw + ecological compensation) will be taken such that the total compensation is equivalent to the most conservative approach. This will involve determining compensation based on bylaw/regulation requirements and an ecological approach.

3.2.2 Determining Compensation Ratios

3.2.2.1 Baseline Compensation

Following the baseline compensation approach, trees (10 cm DBH or greater) will be compensated for at a 1:1 ratio

3.2.2.2 Bylaw Compensation

Following the bylaw compensation approach, the replacement ratio for trees will be determined based on the requirements of the applicable bylaw/regulation. A summary table providing information on bylaw compensation is provided in **Appendix B**. Applicable bylaws should be reviewed at the time of implementation to ensure up-to-date information regarding compensation is utilized.

3.2.2.3 Ecological Compensation

Compensation for the removal of any tree (10 cm DBH or greater) located within a designated natural area will be based on the ratio determined following the ecological compensation approach. As noted above, ecological compensation can be determined by one of two methods: the basal area approach or the individual tree approach. Considering much of Metrolinx Lands is a linear corridor, it is anticipated that the individual tree approach will be implemented in many cases; however, whenever possible, the basal area approach is recommended.

Basal Area Approach

The basal area approach is suitable in cases where the average basal area for the entire feature (not just the portion being removed) can be measured. In most cases, this will require access to areas outside of Metrolinx Lands.

Basal area is a standard forestry measurement used to describe the cross-sectional area occupied by tree stems. It can be calculated by conducting a tree tally or prism sweep within any given vegetation type, classified in accordance with the *Ecological Land Classification for Southern Ontario* (ELC) system. Guidance on how to perform the basal area calculation can be found in the ELC Field Guide (Lee *et al*., 1998) or the Ontario Tree Marking Guide.

Based on the basal area of the feature being impacted (i.e., the feature from which trees will be removed), a compensation ratio will be determined following **Table 2** below.

Table 2 Ecological Compensation Ratios Based on Basal Area

Basal Area (m^2/ha)	Compensation Ratio (ha:ha)
0 – 10	1:1
10.1 – 20	3:1
20.1 – 30	5:1
30.1 – 50+	8:1

To calculate ecological compensation on a per hectare basis, the cost will be equivalent to the restoration of the compensation ratio area (in hectares) based on market price at the time of removal. For example, if one (1) ha of trees within a vegetation type with a basal area of 24 m^2/ha is being removed, the compensation ratio will be 5:1; thus, the cost to compensate will be equivalent to the cost to restore 5 ha. **Table 3** includes typical budget items that shall be included in the cost for restoration of one (1) hectare of treed vegetation type.

Table 3: Ecological Compensation Costing

Treed Restoration Planting Typical Budget Items (ha)

Site Preparation	**Notes**
Equipment	4 days of equipment time for minor grading, tilling, seeding. (Truck, trailer, tractor, tractor implements, ATV)
Materials	(50 kg) cover crop
Labour	Plan design and construction
Contingency	10%
Planting	**Notes**
Equipment	Truck, trailer, ATV
Materials	1,000 bareroot tree seedlings; 1,000 shrubs potted (2 gal), 500 conifers potted (2 gal, 500 deciduous potted (2 gal), (4 kg) native seed, and mulch
Labour	Plan design and installation
Contingency	10%
Plant Replacement	25% replacement of material
Habitat Installation	**Notes**
Equipment	4 days of equipment time for minor grading and structure installation. (Truck, trailer, tractor, tractor implements, ATV)
Materials	4 days of installation (Bird boxes and woody debris)
Labour	Plan design and installation
Contingency	10%
Planning	**Notes**
Project Management	Initiating, planning, executing, controlling, and closing
Monitoring	3 visits (year 1, 3 and 5) with reporting

Individual Tree Approach

The individual tree approach is suitable in cases where the entire feature from which trees are being removed cannot be accessed or where stand-alone or scattered trees require removal. In cases such as these, where the basal area cannot be determined, the compensation ratio will be determined on an individual tree basis following **Table 4**.

Table 4: Ecological Compensation Ratios based on Individual Tree Size

DBH (cm)	Compensation Ratio
10.1 – 20	3:1
20.1 – 30	10:1
30.1 – 40	15:1
40.1 – 50	20:1
50.1 – 60	30:1
60.1 – 70	40:1
70.1+	50:1

To calculate ecological compensation on a per tree basis, the cost will be based on replacement of a minimum 60 mm wire basket caliper tree based on market price at the time of removal. For example, if one (1) 35 cm DBH tree is removed, the compensation ratio will be 15:1; thus the cost to compensate will be 15 times the cost of replacement of one (1) minimum 60 mm wire basket caliper tree based on market price at the time of removal[1].

3.2.2.4 Bylaw + Ecological Compensation

Any tree that is subject to a bylaw or regulation will be compensated in compliance with the applicable bylaw or regulation. For trees (10 cm DBH or greater) that are subject to a bylaw or regulation and located within a designated natural area, additional compensation may be provided if and when ecological compensation is greater than bylaw/regulation requirements. For example, trees removed from public property within a Ravine and Natural Features Protection Area (RNFP) in the City of Toronto may be determined to have a 10:1 replacement ratio based on ecological compensation and a 3:1 ratio based on the RNFP bylaw. The 3:1 RNFP Bylaw Compensation will be provided to the City of Toronto and the funds to replace 7:1 will be part of Metrolinx led compensation work.

3.2.3 Implementing Compensation

The following provides an outline of the approaches to implementing compensation. Refer to **Appendix C** for a flowchart illustrating each approach. General principles for implementing the Metrolinx baseline and ecological compensation are provided in **Appendix D**. As sound reforestation efforts include implementing both shrub and tree plantings, Metrolinx may plant ten (10) shrubs in place of one (1) tree where ecologically appropriate.

[1] To be reviewed and approved by Metrolinx on an as-needed basis.

3.2.3.1 Compensation for Public Lands

Bylaw compensation on public lands may include provision of cash in lieu to municipalities based on bylaw removal and compensation requirements, in which case municipalities would be responsible for the use of funds.

For trees that are subject to a bylaw or regulation and are within a designated natural area, additional compensation may be provided if and when ecological compensation is greater than the bylaw compensation approach. Ecological compensation above and beyond the bylaw requirements will be part of Metrolinx led compensation work.

In cases where there are no applicable bylaws or regulations, Metrolinx will consult with the landowner (e.g. municipality) regarding the need to remove trees and will arrange for tree removal. Compensation for the trees will be based on their location within (ecological) or outside of (baseline) a designated natural area and will be part of Metrolinx's compensation work.

3.2.3.2 Compensation for Private Lands

Metrolinx will work directly with residents to address the loss of trees. In cases where the tree is subject to bylaws or regulations, Metrolinx will consult with the resident regarding permission to enter the property and the need to remove trees, initiate the permitting process, submit the permit application, and arrange for tree removal upon issuance of the permit. Metrolinx will work with the resident develop a compensation plan that meets the bylaw requirements.

In cases where there are no applicable bylaws or regulations, Metrolinx will consult with the resident regarding permission to enter the property and the need to remove trees and will arrange for tree removal. Metrolinx will work with the resident to develop a compensation plan consistent with the baseline restoration approach at a 1:1 ratio, unless determined otherwise by Metrolinx through consultation with the resident.

For trees that are located within a designated natural area, additional compensation may be provided if and when ecological compensation is greater than the applicable compensation approach (bylaw or baseline). For example, trees removed from private property may be determined to have a 5:1 replacement ratio based on ecological compensation and a 3:1 ratio based on the private tree bylaw. Metrolinx will work with the resident to develop a compensation plan that meets the bylaw requirements. The remaining difference (i.e., 2:1) will be part of Metrolinx's compensation work.

3.2.3.3 Compensation for Metrolinx Lands

Ecological and baseline compensation for loss within Metrolinx Lands will be implemented on a project-by-project basis. The cost of compensation will be determined based on the number of trees removed and the resulting compensation ratios for ecological and baseline compensation. The project team should allocate the necessary budget needed to implement compensation.

3.2.4 Procurement for Ecological and Baseline Compensation

Metrolinx implements a wide variety of transit infrastructure projects across different locations and jurisdictions. Each one of these projects has a unique scope and goals to achieve.

Given the wide variety of Metrolinx undertakings, a one-size-fits-all procurement approach for compensation work may not meet the unique needs of each project. For example, a project with minimal tree removals may be able to carry out compensation planting within the project location itself. While projects with large scale tree removals may not have the option of implementing compensation planting within or close to the project location. For projects with a low number of tree removals, compensation planting may be built into the construction contract. For projects with a large number of tree removals, a more involved procurement process may be necessary.

Therefore, a singular procurement model is not recommended. Each project should develop their own procurement model that works best to meet the principals of this guideline while respecting the circumstance of the individual project. Pre-planning work should include consideration to the potential procurement model and ensure that sufficient budget and resources are allocated, and an effective implementation framework is in place for the compensation work.

4 TREE END USE

The following framework for tree end use outlines practical and economical tree end use options for all removed trees, including trees removed from within Metrolinx Lands as well as trees removed outside of Metrolinx Lands. The first step involves determining the value of trees to be removed. Higher value trees can be diverted for different end uses that could include community, ecological and commercial uses such as local art projects, public school/park furniture, habitat restoration, lumber, etc. A list of potential community groups, organizations and institutions (non-profit and commercial) who may be interested in receiving diverted wood will be maintained by Metrolinx and made available upon request. This framework also outlines how removal, storage and distribution of trees will be implemented.

4.1 Potential Tree End Use Options and Guidance Documents

The IBC was developed for the purpose of evaluating options for the GO Expansion Vegetation Removal and Compensation Program, and specifically addressed removal and disposal of vegetation. In addition to the IBC, policies and best practices surrounding the upcycling of felled trees across national and international jurisdictions were reviewed to guide the development of the tree end use framework. Though these examples are useful, the concept of end use is an emerging one. As such, policies and practices are scarce; however, the *Toronto Directory of Urban Wood Products and Services* in particular served as a fundamental guide in the development of the tree end use framework.

The following provides a summary of the options for tree end use policies and practices, all of which have been considered in the development of the recommended tree end-use program.

4.1.1 Initial Business Case for the Metrolinx Vegetation Policy

The IBC described the base case for vegetation and removal disposal in addition to outlining two (2) options for consideration, as follows:

- Base Case – Current Removal and Disposal Practices
- Option 1 – Minimum Diversion and Maximum Mulching
- Option 2 – Maximum Diversion and Minimum Mulching

The IBC identified Option 1 – Minimum Diversion and Maximum Mulching as the Recommended Option, which endorsed planning for realistic goals for diversion to community partners, with an estimated 5% diversion of higher value trees for sustainable end uses (where feasible; actual numbers of higher value trees and potential for removal from the corridor may limit the amount). This option also included maximizing mulching within Metrolinx Lands, with an estimated 95% of all trees being mulched.

As part of the preferred option, it was recommended that clearing of vegetation be completed in a single pass to minimize noise impacts. This would also provide a cost-effective approach to removals. Mulching chipped material on site is a cost-effective and logistically efficient way to handle wood debris. Logged wood and diversion of wood to community partners, however, were noted to present a number of logistical challenges. For example, logging wood within the rail corridor would be logistically challenging because there may not be enough clearance between the removal zone and track to safely fell a tree. Access along the rail corridor also creates challenges for moving logs to a location from where they can be transported. The timely and safe distribution of wood to end use partners who have suitable equipment and facilities to receive the diverted wood can also present challenges.

4.1.2 Toronto Directory of Urban Wood Products and Services

When the salvage of felled trees for wood products was recognized as an economically feasible means for re-using urban trees after urban tree die-offs, the City of Toronto's Economic Development and Culture division created the Urban Wood Initiative, *Neighbour Wood*, which is a directory that was developed to encourage homeowners and commercial enterprise to salvage and re-use Toronto's valued local trees. The purpose of this directory is to link homeowners and commercial enterprise to the companies that can provide services and make products from urban wood when the need arises to remove a local tree.

The Toronto Urban Wood Directory listed within their re-use table, any potential end user with lumber yard properties, which can be interpreted as room for storage. The Toronto Urban Wood Directory also included some potential commercial application for Toronto's most popular tree species. The commercially valuable trees include Black Walnut, White

Oak, Red Oak, Butternut, fruit trees, hard maples, Black Cherry, White Cedar, American Elm, ash trees, Black Locust, and Basswood. The potential commercial applications of the higher value trees include furniture, flooring, outdoor applications, music instruments, and construction lumber. The common characteristics of the higher value trees to be used for lumber are identified as great strength, durability, resiliency, shock, and decay resistance.

4.1.3 Ontario Municipalities

Municipalities in Ontario have been tasked with managing the significant loss of felled ash (*Fraxinus* spp.) trees that were devastated following the infestation of the Emerald Ash Borer (EAB). While most municipalities have, and continue to, respond to this urban wood crises by diverting felled ash trees into landfills and simple recycled products, the City of Guelph and Town of Ajax commissioned local artists to use the trees for the creation of art installations within their respective communities.

In 2015, the City of Toronto implemented a similar initiative to beneficially repurpose dead ash trees. The City launched a pilot project at its Nashdene Public Works Yard, working with a local contractor to mill the felled ash trees into lumber for sale and use in the local wood industry.

4.2 Identifying Higher Value Trees

Determining the most suitable end use for a tree involves first determining its value. The IBC presented a reference to tree value that categorized trees by species. The high, medium, and low value species identified by Hilts and Mitchell, 2009 are provided in **Table 5**. For the purposes of this guideline, these high, medium and low value species (with the exception of white ash) are being carried forward as Category 1, 2 and 3, respectively, and collectively referred to as “higher value”. Because ash trees in the project area have high possibility of being infested with EAB, white ash is not being considered a higher value species in an effort to reduce the potential for accidental movement outside of the regulated area.

Any disease-ridden trees will not be transported outside of quarantine areas and all distribution and transportation will comply with Canadian Food Inspection Agency (CFIA) regulations. As such, the tree species identified as higher value will need to be reassessed on an as-needed basis to ensure compliance with the CFIA.

Table 5: High, Medium and Low Value Tree Species (Hilts and Mitchell, 2009)

High Value (Category 1)	Medium Value (Category 2)	Low Value (Category 3)
Black Walnut	Basswood	Aspen
Black Cherry	Tulip Poplar	Beech
Red Oak	Yellow Birch	Hop Hornbeam
White Oak	White Birch	Hemlock

High Value (Category 1)	Medium Value (Category 2)	Low Value (Category 3)
White Ash*	Red Maple	White Cedar
Sugar Maple	White Pine	Butternut
	Red Pine	Hickory
	White Spruce	Elm

* Because ash trees in the GTHA have high possibility of being infested with EAB, white ash is not considered a higher value species for the purposes of this framework.

Higher value trees are defined as trees that can potentially be used for lumber and are identified based on the tree species as well as size and wood quality. Higher value trees can be identified in the field as those having a straight trunk at least 3 m long, a minimum diameter at breast height (DBH) of 15 cm, no large branches (greater than 5 cm diameter) and no visible defects.

Higher value trees will be identified by a qualified arborist. If, after being cut, a tree is found to have a defect (e.g. rotting core), it may no longer qualify as higher value or be suitable for distribution to end users. Thus, following cutting, a qualified arborist should re-evaluate higher value trees to confirm their suitability for end use.

4.3 End Use Options for Removed Trees

The following provides end use options for all trees to be removed, including both higher value trees and those not identified as higher value (herein referred to as lower value trees), as well as guidance on how to determine the most suitable end use option.

End use options have been developed based on:

- Suitability for end use based on tree type (i.e. higher or lower value);
- Caliper size;
- Suitability for removal as a sawlog and transportation off site; and
- Areas available on site for use of chipped material as mulch.

The flow chart below (**Figure 3**) provides a summary of the step-by-step process for determining tree end use. The first step is to determine the tree value for each tree identified to be removed. If a tree is determined to be higher value tree, the tree will be cut into log length and can be re-used as lumber for furniture, construction wood, carving and other specialty uses. If a tree is not a higher value tree, the tree will be chipped. Trees having DBH less than 10 cm will also be chipped and spread on site, unless volume of mulch generated exceeds the capacity of on-site disposal (i.e. maximum mulch depth disposed on site is 10 cm).

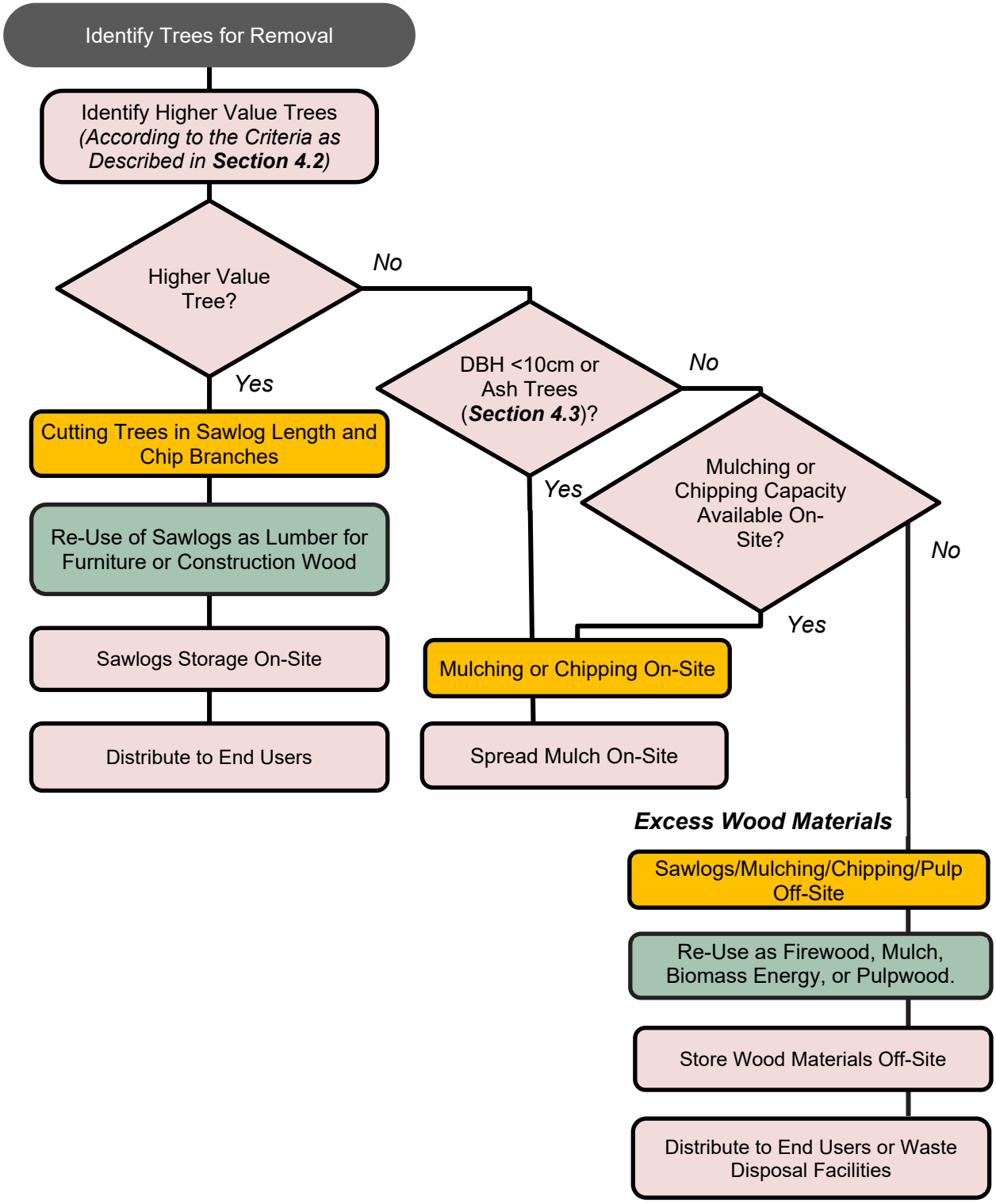


Figure 3: Tree End Use Flowchart Process

Any disease-ridden trees will not be transported outside of quarantine areas and all distribution and transportation will comply with Canadian Food Inspection Agency (CFIA) regulations. As such, the tree species identified as higher value will need to be reassessed on an as-needed basis to ensure compliance with the CFIA.

All ash trees will be chipped and spread out on site within Metrolinx property, in order to prevent spreading the EAB during transportation; however, some ash trees may have a DBH that is too large for the chipper to process on site, therefore, ash logs could be made into lumber and then moved in accordance with Emerald Ash Borer Approved Facility Compliance Centre (EABAFCP) requirements (for more information, refer to **Section 4.3.2.2**).

Trees having DBH less than 10 cm will also be chipped/mulched and spread on site, unless volume of mulch generated exceeds the capacity of on-site disposal (i.e. maximum mulch depth disposed on site is 10 cm). Excess mulch/chip will be shipped off site and re-used as mulch for gardening, pulp wood, biofuel, or for pulp or other uses. Trees that are too large to be chipped on site may be removed as logs for chipping off site.

Potential end users are identified depending on which type of wood product that will be generated, i.e. tree lumber or mulch/chips/pulp. Transportation and storage plans that define how the wood residues would be collected, stored, transported, and eventually delivered to the right end users for higher value trees are described in this report.

4.3.1 End Use Options for Higher Value Trees

Following removal, higher value trees will be cut into sawlog size, transported as logs and reused as lumber. Higher value trees can be diverted to community partners or sold as commercial grade wood where feasible. Options for re-purposing higher value trees include:

- Selling commercial grade lumber to local sawmills and other businesses;
- Park infrastructures such as benches or picnic tables;
- Art installations; and

Habitat features for ecological restoration projects (i.e., salamander logs, cover for small animals, bat houses, bird nesting structures, etc.).It is important to note that in cases where a higher value tree is near the Metrolinx property boundary and is thus a potentially a boundary tree, the recommended removals action for the tree may be re-evaluated on a case-by-case basis, pending ownership confirmation and the review of a qualified arborist. The sawlogs from felled trees are to be stacked in the storage area and sorted/inspected by a qualified arborist to verify that all felled trees are higher value trees and appropriate for distribution to end users based on quality, species, and size or other factors.

4.3.2 End Use Options for Lower Value Trees and Other Tree Materials

It is anticipated that most of the trees to be removed within Metrolinx Lands will be younger trees with low commercial value due to small size, crooked growth, or wide growth rings.

These trees are typically unsuitable as sawlogs or any reuse as lumber. Lower value trees and other tree materials that will require removal include:

- Trees that have <10 cm DBH;
- Ash trees; and
- Branches and foliage removed from trees that need to be pruned.

The majority of trees to be removed from Metrolinx Lands will be mulched on site. There will be circumstances under which lower value trees and other tree materials will be required to be transported off site. The following provides information on chipping and mulching, EAB, and calculating wood residue volume and biomass, all of which will be considered in determining tree end use options for lower value trees and other tree materials.

4.3.2.1 Chipping and Mulching

Lower value trees and other tree materials can be chipped on site, and either used for mulch on site or transported off site. The recommended tree end use option identifies that a large volume of chipped material will be produced and re-used within Metrolinx Lands. Use of the material as mulch can be considered a complete system, with felling and processing being completed in one step, and no extraction or off-site utilization of the processed material. Using the chipped material for mulch on site will reduce the cost of transport and disposal of the removed trees as waste products. The wood chips should be applied a minimum of 3 m from the ballast, especially in areas where trees were removed, since the removal of trees and undergrowth may encourage the establishment of invasive species, which readily colonize areas of exposed soil. The depth of the mulch should be between 8 and 10 cm where supression of undesirable plant growth is required. In areas to be seeded with desirable species, the depth of mulch should be kept to a depth that allows the seeds to germinate (this depth will be species-dependent and will vary depending on the length of time between spreading of mulch and seeding).

Chipping and mulching on site is an option except where the available space limits the amount of chipped material to be spread. The on-site disposal capacity of mulch can be calculated by the tree removal area multiplied by the maximum depth of 10 cm. If the mulch/wood chips to be generated exceeds the on-site disposal capacity, excess wood chips will be transported off site and used to produce material for pulpwood, pellets, hog fuel, gardening and landscaping, or other uses such as the production of compost. Trees can also be chipped into uniform wood chips. The size of the chips can be adjusted by equipment settings depends on the end users' requirements.

It is anticipated that much of the vegetative debris will require removal, either to landfill or to a community partner who may be able to take reuse the wood chips for pulp, fuel, or compost. If the wood chips are to be used as fuel, the chipping process will have to be tailored to the end user as variables such as woodchip size, moisture content and source material must be compatible with the energy generation process. As an example, “GF60” is a common wood chip category which specifies a moisture content between 10-30% and a chip gradation as follows: 0-3.5 mm: <8%, 3.5-30 mm: <7%, 30-60 mm: 80-100%, 60-100 mm: <3% and 100-120 mm: <2%.

It is anticipated that Metrolinx will be able to use most debris from lower value trees as mulch within the corridor.

4.3.2.2 Emerald Ash Borer (EAB) and Ash Trees

Removal, handling and transport of ash trees must be done in a manner compliant with the Ministerial Order which has been issued by the Federal Government restricting the movement of wood out of the regulated area.

Metrolinx’s lands are within the EAB regulated area, and all ash trees in the regulated area are considered in danger of being EAB infested and therefore will be chipped and disposed on site. If ash materials (bark, chips, branches, fresh leaves, or wood) are to be moved to non-regulated areas, the ash trees will be chipped to a diameter of less than 2.5 cm in any two (2) dimensions, on-site prior to moving. Between October 1 and March 31 of any year, an alternate condition may be implemented to move ash materials – they may be shipped without delay to an approved. Emerald Ash Borer Approved Facility Compliance Centre (EABAFCP) to be processed in accordance with EABASCP requirements. Ash logs may be made into lumber which may then be moved after it either has had all of the bark and at least 1 cm of sapwood removed, or it has been treated to attain a minimum core temperature of 56ºC throughout the profile of the wood (including the core) for a minimum of 30 minutes, or so long as it has been processed at an approved EABAFCP to be processed in accordance with EABAFCP requirements. For more details, refer to the latest information provided by the CFIA.

All ash trees are proposed to be chipped on site and used as mulch in order to prevent spreading the EAB that can result from transportation. Where they must be moved, they will be moved in a manner compliant with the Ministerial Order.

4.3.2.3 Wood Residue Volume and Biomass

Determining the feasibility of end use options will require consideration of the wood residue volume – the volume of trees to be removed or pruned.

The wood residue volume and biomass can be estimated using the *National Volume Estimator Library*, which was developed by the United States Department of Agriculture (USDA) Forest Service. Different models and equations for volume estimation depends on the region where the tree is located as well as tree species. The tree height and DBH, and coefficients of different species are then fed into the equation for computing the tree

volume/biomass for each tree to be removed or pruned. Refer to *Tree Volume and Biomass Equations for the Lake States* (Hahn, 1984) for guidance.

4.4 Tree End Use Partners

Trees that are to be removed can be transported from Metrolinx Lands and provided to tree end use partners, such as local artists, schools, and conservation authorities. An up-to-date list of tree end use partners will be maintained by Metrolinx and can be made available upon request. The list will include the details on the contact information of various tree end use partners. Tree end use partners will be reviewed and approved by Metrolinx on an as-needed basis to ensure that partners meet goals from a financial and liability standpoint. Potential partners include:

- Conservation Authorities;
- Indigenous Communities;
- Organizations dedicated to Ecological Restoration;
- Municipalities;
- NGO's and Foundations focused on Enhancing Urban Trees and Parks;
- Events related to Urban Tree Enhancement (Tree Planting) and Repurposing;
- Wood Products and Services – Sawmills, Companies/Artists dedicated to Carving, Woodturning, Furniture and Wood Products;
- Wood Products and Services - Other Organizations (Firewood, Paper Mill, Purchasers/Users of Bulk Wood, NGO); and
- Wood Products and Services – Biofuel.

Determining tree end use partners will involve communication with potential partners to identify those interested in receiving wood diverted for re-use, as well as relevant information such as their delivery location or ability to pick up at another location, and the type of wood product (e.g. tree lumber or mulch/chips/pulp) that will be of use to the partner(s). Transportation and storage plans that define how the wood residues would be collected, stored, transported, and eventually delivered to the appropriate end users for both higher value trees and lower value trees are described in **Section 4.5**.

Once it has been determined that removal of a tree suitable for end use is required, partners will be contacted to identify their interest in receiving the available product and to determine a plan for transportation, storage and delivery.

4.5 Implementation Framework for Tree End Use

The recommended tree end use program has been developed based on the IBC as well as a review of various end-use models as described in **Section 4.1**.

Consistent with the preferred option identified in the IBC, the recommended program endorses planning for realistic goals for diversion to community partners, with an estimated 5% diversion of the total tree removal as high value trees for sustainable end

uses (where feasible; actual numbers of high value trees and potential for removal from the Metrolinx Lands may limit the amount). This option also includes maximizing mulching within Metrolinx Lands, with an estimated 95% of all trees being mulched.

The anticipated 5% diversion for higher value trees towards community partners may be challenging from a removals perspective, due to availability and accessibility of higher value trees. Available storage for collecting, sorting, and/or processing removed trees will need to be considered as it may be limiting. Appropriate facilities will be required to process lumber, firewood, chips, and mulch. Coordination of the transportation and collection of wood materials within communities must address challenges such as noise, access, and traffic considerations. The movement of wood would also need to comply with regulations restricting transportation, as mentioned above, under the CFIA.

4.5.1 Transportation and Storage Plans for Trees

Urban areas along Metrolinx Lands may present a challenge for collecting wood residues. Therefore, early groundwork, such as finding end users, organizing collection and transportation must be completed in advance. The storage and transportation plan must identify the delivery of wood products to identified end users in a timely and cost-effective manner.

4.5.1.1 Equipment Requirements

Mulching or chipping trees will be carried out using mulchers or chippers. Mulchers cut and chop or grind vegetation into particles that are usually left on-site as mulch. Mulchers are capable of reducing limbs, tops, and cut material to shredded particles that are left on the ground and can better hold runoff and degrade more quickly back into the soil than larger material. Chippers are capable of chipping the tree to uniform size. Equipment such as graders, will be needed to spread out the mulch on site to make sure the mulch does not excess the maximum depth of 10 cm.

During removal of higher value trees, it is important to minimize any impact from felling the trees as this can cause internal checking and damage to the tree's bole. The higher value trees can be removed and cut into sawlog length by using a harvester. The harvester is capable of felling, de-limbing, and bucking a tree to a desired length; however, the capability is limited by the size of the tree for the harvester, which is based on the various models.

Once the stems have been bucked into a series of log lengths, a grapple truck/skidder is required to sort the logs and stack them into piles. Once enough logs of a specific sort have been accumulated, and a truck arrives, they can be loaded onto the truck and transported to their destination.

A bucket truck and pruning equipment as well as staff trained to apply proper pruning techniques (identified by the International Society of Arboriculture and Landscape Ontario) will be required for pruning trees.

The use of hi-rail equipment may be required in some isolated areas, especially if there are no suitable access points.

4.5.1.2 Storage Strategy

Before wood residues can be delivered to end users, a practical and cost-efficient method of wood storage will need to be identified. The wood storage method will depend on the type, volume and duration of storage. Metrolinx prefers that higher value trees be stored on Metrolinx property prior to distribution to end users.

As noted above, if, after being cut, a tree is found to have a defect (e.g. rotting core) it may no longer qualify as higher value or be suitable for distribution to end users. Thus, following cutting, a qualified arborist should re-evaluate higher value trees to confirm their suitability for end use.

Ideally, designated wood storage areas, where there is sufficient space to store both sawlogs and wood chips, will be created within Metrolinx property near the access points. The designated storage areas would also be required to have enough space to allow off-site mulching/chipping, sorting sawlogs and any other necessary wood processing.

According to OPSS180-Table 1 Excess Material Management Conditions, the natural wood material (e.g. stumps, trunks, branches, debris from tree and shrub removal, and wood products that are not treated, coated, or glued) slated for re-use (**re-use only and not stockpiling for disposal**) cannot be stockpiled less than **30 m** to water bodies.

In cases where species at risk are identified within waterbodies within the project study area, stockpile locations shall not be within proximity to the waterbody. It is anticipated that stockpiles will be required to be located at least 50 m from the waterbody; however, up-to-date correspondence with relevant agencies shall be undertaken to ensure adequate protection.

Any natural wood required to be stockpiled for waste disposal shall be stockpiled at off-site locations. As per OPSS 180, the natural wood materials that are to be held for **disposal** cannot be stockpiled on site and the off-site location must comply with the following distance separation requirements:

- A minimum of 2 m above the level of ground water;
- A minimum of 30 m from waterbodies;
- A minimum of 100 m from any water wells; and
- A minimum of 100 m from residences.

Stockpiling of wood chips on site shall not exceed three (3) months and shall be avoided so as not to create a fire hazard and to prevent reducing the quality of the wood chips (e.g. due to mold and insects). In cases where wood chips are piled, compliance with Ontario Fire Code (*O.Reg. 213/07*) Section 3.2.3 (Outdoor Storage of Wood Chips), Article 3.2.3.6 regarding outdoor storage spacing is required, as follows:

(*1) Space shall be maintained between chip piles and exposing structures, yard equipment or stock equal to*

(a) Twice the pile height for combustible stock or buildings, or

(b) The pile height for noncombustible buildings and equipment.

(2) Despite Sentence (1), space between chip piles and exposing structures, yard equipment or stock shall not be less than 9 m.

This **9 m** buffer is where mulching or chipping can be spread within these on-site areas (providing these areas are within Metrolinx property). Spreading wood chips or mulch on site requires Metrolinx approval.

Wood chips shall not be left on site where there is a risk to property, assets or the operational railway (Rail Network, 2018). Any remaining chipped material shall be a minimum of **3 m** from any running rail and chipped material shall be spread evenly to a depth no greater than **10 cm**. Cut wood material that has been stacked in piles shall not be left on slopes with a gradient steeper than or equal to **33 degrees**, since cut and stacked material can move over time and present a hazard.

The Ontario Fire Code (OFC) addresses the outdoor storage of wood chips in the guideline OFM-TG-03-1998. The storage area for wood chips must satisfy the following conditions:

- Surface of the ground should be well drained and level, solid ground or paved with asphalt, concrete or other hard surface material;
- Weeds, grass and similar vegetation shall be removed from the yard;
- Portable open-flame weed burners shall not be used in chip storage yards;
- Piles shall not exceed **18 m** in height, **90 m** in width and **150 m** in length unless temporary water pipes with hose connections are laid on the top surface of the pile;
- The area is fenced, has fire department access, smoking is prohibited, and fire extinguishing provisions are available;
- The maximum storage period for these wood chip piles should be no longer than **3 months**;
- Compaction of the pile should be avoided;
- The piles should be periodically wetted down, especially during dry conditions, to minimize the possibility of a surface fire; and
- The maximum height of the wood pile should be **7.5 m**.

Additionally, the following recommendations (Ministry of the Solicitor General, 2019) should be followed to reduce the risk of fire:

- Check piles periodically for any signs of hotspots, smouldering or unusual odour that could indicate the on-set of a fire;

- Keep other combustible materials away from wood chip piles;
- Eliminate any ignition sources near the wood chip piles; and
- Prepare a pre-fire plan.

Where substantial wood volumes need to be processed or stored for a longer time period, another option is to create wood collection yards or utilization centers (hubs) for wood residues along the Metrolinx corridor. The suitable wood yards should have the following features for wood storage:

- Fence with a locked gate to minimize theft and dumping;
- Paved all-weather surface without parking bumpers, so vehicles will not get stuck in inclement weather and the lot can easily be cleaned;
- Large enough to store wood lumber on one side of the yard and chips on the other side, while allowing ample space for truck traffic during sales and cleanup; and
- Available for the full duration of the nearby removals.

A transportation plan should be developed in conjunction with need of end users to minimize the storage time of wood residues and avoid paying for wood collection yards.

4.5.1.3 Access Requirements

Only certain types of access points allow access for tree removal equipment and hauling trucks. Potential types of access points include vehicular access points, level crossings, and train stations. Tree removal access points will need to be identified as part of transportation plans. It should be noted that some access points may only exist on one side of the railway. Temporary access points may need to be identified if there are no suitable existing access points to complete the required tree removals or pruning.

The use of hi-rail access may be required in some isolated areas. If hi-rail is required, it would need to be loaded onto a “dead” track from the nearest GO Station and track protection would need to be implemented.

4.5.1.4 Transportation

Transporting chips requires a trailer that can safely carry chips without losing material while being loaded and unloaded. Open top trailers are used where chips will be loaded either by a chipper or grinder with a conveyor capable of pushing the chips over the top of the trailer, or by a loader capable of dumping loads of chips over the top of the trailer. The load capacity of a standard size dumping tuck is 7.8 ton for one load.

Full-length logs can be transported by stinger-steer log trailers or fixed length log trailers. Where only log length material is being transported, a straight truck with a trailer may be used. The standard size logging truck is capable of carrying 40 m^3 of sawlogs.

Trees will be transported from the on-site storage areas to loading storage areas. It is anticipated the tree end user will haul the wood residues off site. This will require coordination with the tree end use to confirm capacity of equipment.

4.5.2 Distribution and Re-Use Plan for Trees

4.5.2.1 Higher Value Trees Distribution

It is anticipated that most of the higher value trees will be distributed to end use partners that fall under the Wood Product and Service category, which include sawmills, companies or artists dedicated to carving, woodturning, furniture and wood products. Higher value trees can also be distributed to end users focused on enhancing urban trees or events related to Urban Tree Enhancement and Repurposing.

4.5.2.2 Tree Distribution Logistics

Potential end users will be identified by their proximity to the tree removal area. Metrolinx-approved potential end users will need to be contacted for the following information to determine their suitability as tree end use partners:

- Their capacities (what types of processing and/or transportation can the business handle);
- Their need (what species, quality and quantity of wood are they interested in); and
- Their location and distribution/storage centres.

It is also important to determine the storage space and transportation costs, equipment, and capacity of all potential end use partners. The ideal end users should be able to process wood to its desired end product and have wood storage areas and trucks available to haul the wood residues to its destination. This way, the time and cost of wood processing and the need for on-site storage would be significantly reduced. Potential end users like companies/artists dedicated to carving, woodturning, furniture and wood products may not have the ability of accepting, transporting or processing large quantities of wood residues. Therefore, these end users may not be feasible for the higher value tree distribution. Sawmills or companies with sawmill facilities may have the capacity to deal with large quantity of wood residues and are more suitable for higher value trees distribution and should be considered and contacted first.

5 INTEGRATED VEGETATION MANAGEMENT

The following provides a framework intended to guide an IVM program for managing vegetation on Metrolinx Lands, including both electrified and non-electrified rail corridors. The IVM approach outlined below provides the basis for initiating the program as well as decision-making guidance on how to continue/modify practices in the long term.

The compensation approach recommended in this guideline applies to tree removals associated with Metrolinx capital projects only and does not apply to vegetation removal

associated with routine operational maintenance work on Metrolinx Lands to ensure safe railway operations and sightlines.

5.1 Potential IVM Approach Options and Guidance Documents

In addition to the IBC, policies and best practices surrounding IVM were reviewed to inform the development of the IVM framework. The following provides a brief summary of the IBC as well as a list of established and comparable approaches that were key to the development of the IVM framework presented in this Guideline.

5.1.1 Initial Business Case for the Metrolinx Vegetation Policy

The IBC presented two options for the maintenance program:

- Option 1 – Base Case
- Option 2 – Integrated Vegetation Management Program

The IBC identified Option 2 – Integrated Vegetation Management Program as the Recommended Option.

As part of the IVM Program, the IBC proposed maintaining a 7 m clearance zone around electrical infrastructure, which is consistent with the industry standards presented in the *GO Rail Network Electrification Transit Project Assessment Process* (TPAP), and included an initial tree removal and pruning event as well as activities following this event. Furthermore, GIS software applications were identified as a core component in making informed decisions on vegetation control actions, developing work orders and to reducing overall costs in addition to overall delivery of the IVM program.

5.1.2 Other Relevant Guidelines for Integrated Vegetation Management

As part of the review of established and comparable IVM approaches, it was found that IVM plans look relatively similar and are generally built on a step-by-step framework. These frameworks provide the foundation for how owners/operators approach, design, and carry out management within their property or jurisdiction.

Examples used to inform the IVM framework include:

- Canadian Pacific Railway (CPR) Integrated Vegetation Management Plan, 2015;
- British Columbia Railway Company Port Subdivision (Port Sub) Integrated Vegetation Management Plan 2013-2017, 2012;
- Vermont Rail System Integrated Vegetation Management Plan, 2006-2011;
- Government of South Australia Vegetation Management Policy (no date); and
- Kinder Morgan Canada Integrated Vegetation Management Plan (2011-2016), 2011.

It is critical to note that while IVM plans provide the framework for management they do not provide operators with prescriptive details on many IVM components and decisions. Instead, as evidenced in these examples, integrated approaches offer normative and descriptive frameworks for how to apply IVM and undergo decision-making throughout implementation.

The lack of prescription within these IVM plans is not an oversight but a strategic means of achieving a framework that is adaptable and effective over the long term. As evidenced throughout this section, having a non-prescriptive approach allows IVM managers to continually apply the framework to any management challenge and adjust according to ecological conditions, which should become increasingly self-sustaining over time.

5.2 Integrated Vegetation Management in a Rail Corridor

Metrolinx has managed and maintained existing non-electrified corridors though a variety of measures in accordance with the *Vegetation Management Guidelines* (Metrolinx, 2013). The *Vegetation Management Guidelines* (Metrolinx, 2013) informed five-year contracts for routine track and signal maintenance and are now superseded by this Vegetation Guideline. The IVM approach presented in this guideline addresses both electrified and non-electrified rail corridors.

As noted above, the compensation approach recommended in this guideline applies to tree removals associated with Metrolinx capital projects only and does not apply to vegetation removal associated with IVM and other routine operational maintenance work in the corridor to ensure safe railway operations and sightlines.

5.2.1 IVM in an Electrified Corridor

A vegetation clearance zone is required in order to provide safe electrical clearances from infrastructure to any existing vegetation along the rail corridors. If not managed properly, unwanted vegetation can lead to safety and operational issues if the integrity of key structures (i.e. ballast, overhead lines, operational signals and switches) is compromised. Electrified lines are uniquely subject to the potential of electrical/fire hazards in addition to being subject to the issues associated with standard rail: trackside fires, visual impediment of signals/switches, and compromised employee/ passenger safety.

As part of the *GO Rail Network Electrification Transit Project Assessment Process* (TPAP), a vegetation clearance zone for vegetation along the corridor was determined based on the European standard *EN50122-1:211+A1:2011 (E) Paragraph 5.2.6: Railway Applications - Fixed installations*. This European Standard specifies requirements for the protective provisions relating to electrical safety in fixed installations associated with alternating current (AC) traction systems and to any installations that can be endangered by the traction power supply system.

The vegetation clearance zone entails vegetation removals within the area encompassed by the overhead contact system (OCS) plus an additional 2 m offset area on either side of the OCS components. As a result, the total clearing area is defined as 7 m measured

from the centerline of the outermost tracks to be electrified on either side of each rail corridor. The 7 m zone is considered a maximum removal zone. This IVM framework involves maintenance of a low-growing plant community that is compatible with electrical infrastructure. Representative illustrations of the zones are provided in **Appendix E**.

5.2.2 IVM in a Non-Electrified Corridor

A vegetation clearance zone is required along non-electrified rail corridors as well. Non-electrified corridors are also subject to those issues identified in **Section 5.2.1** as being associated with standard rail: trackside fires, visual impediment of signals/switches, and compromised employee/ passenger safety.

Metrolinx has managed and maintained existing non-electrified corridors though a variety of measures in accordance with the *Vegetation Management Guidelines* (Metrolinx, 2013). The *Vegetation Management Guidelines* (Metrolinx, 2013) provide an overview of vegetation management priorities, approaches to vegetation management, and approaches to tree management issues to ensure a safe operating environment. Vegetation management priorities include:

- Fallen trees and hazard trees that could impact rail operations/service;
- Maintenance of clear sightlines for signal systems and at crossings;
- Maintenance of vegetation-free zones between the rails and on ballast to allow for better visual inspection of track components/equipment and maintain rail integrity;
- Removal and management of select deciduous trees and canopy overhanging and within the railway corridor to reduce leaf volume and address rail adhesion issues; and
- Removal and management of invasive species.

Approaches to vegetation management include use of a variety of control methods including mechanical cutting equipment and manual brushing/mowing. The use of herbicides is generally limited to track and ballast areas, where other methods are impractical.

The approach to tree management issues included removal and trimming of trees within the Metrolinx ROW.

The *Vegetation Management Guidelines* (Metrolinx, 2013) informed five-year contracts for routine track and signal maintenance and are now superseded by this Vegetation Guideline.

Similar to the vegetation clearance zones that have been developed to address electrified corridors, the IVM framework within this Vegetation Guideline provides clearly defined areas – also measured from the centerline of the outermost track – for non-electrified rail corridors. Consistent with the *Vegetation Management Guidelines* (Metrolinx, 2013), this IVM framework outlines vegetation control measures for maintaining rail operation and

maintenance safety while allowing the growth of compatible native plant species. Representative illustrations of the zones are provided in **Appendix E**.

5.3 Implementation Framework for Integrated Vegetation Management

Metrolinx's IVM program has been adapted from the reputable framework conceptualized by scholars Nowak and Ballard (2005). It is presented in five (5) steps and should be interpreted as a cyclical and adaptive framework (**Figure 4**). A detailed flowchart for IVM is provided in **Appendix F**.

In principle, being cyclical and adaptive in nature, IVM will allow for the flexibility needed to (re)adjust to the changes expected to take place on Metrolinx Lands. Over the implementation period, it is anticipated that managerial, operational, and environmental conditions will change. This framework will allow Metrolinx to react and respond as appropriate.

Following this approach, it is expected Metrolinx will move through each step on an as-needed basis, continually cycling through the five (5) step process. Once IVM Step No. 5 has been applied, managers are expected to reassess the effectiveness of the program and potentially reapply or readjust the framework starting at Step No. 1, as necessary.

This implementation framework is intended to guide an IVM program for managing vegetation along Metrolinx's land including electrified and non-electrified rail corridors.

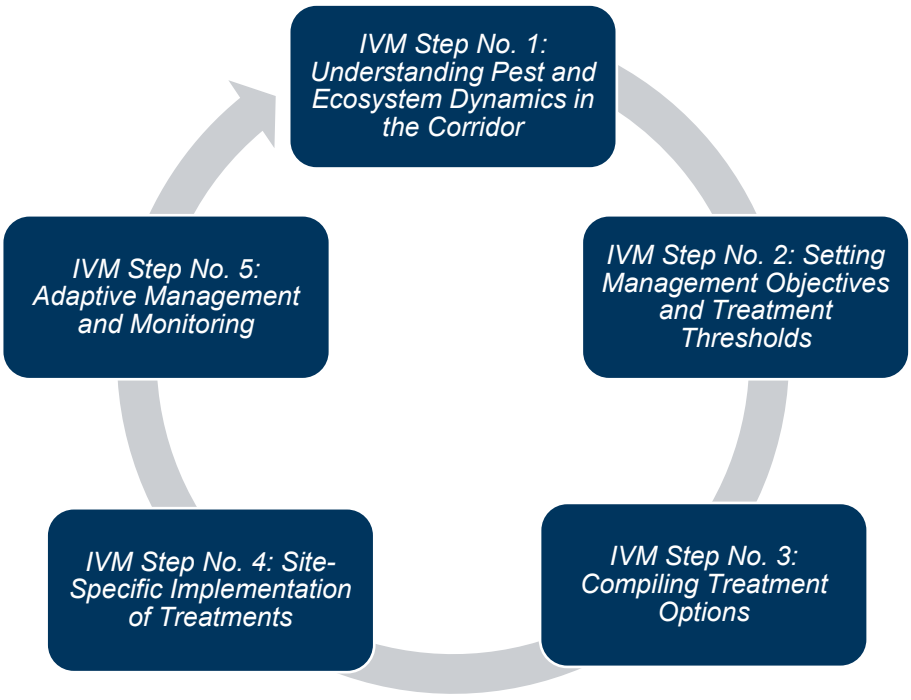


Figure 4: The Cyclical Steps of Integrated Vegetation Management

5.3.1 IVM Step No. 1: Understanding Pest and Ecosystem Dynamics

Goal

Develop and maintain a comprehensive understanding of the existing ecological conditions on Metrolinx Lands.

Objectives

- Undertake an inventory of vegetation conditions;
- Monitor plant community composition and structure; and
- Monitor the presence of incompatible and compatible species within and adjacent to the Metrolinx ROW and land.

The first step in conducting IVM is to develop a working knowledge of the vegetation in the managed system. This information enables managers to determine if existing vegetation is compatible and can be retained or if it is incompatible (i.e. a pest) and requires treatment. Thus, consistent with recommendations outlined in the IBC, this IVM framework begins with the collection of data to document and assess the condition of Metrolinx Lands, including the location, quantity, and character of vegetation.

Throughout implementation, Metrolinx will need to frequently revisit this step to fully capture an understanding of the local ecology. This is especially important given that Metrolinx Lands will be moving through various construction, managerial, and ecological phases that will result in changes to existing conditions.

Metrolinx will develop a strong working knowledge of the ecosystem by undertaking an initial inventory and will maintain that knowledge by completing pre-treatment monitoring as part of the program's bi-annual monitoring of managed sites.

This section details the initial and pre-treatment monitoring events that will take place throughout implementation in order to maintain an understanding of the ever-changing ecosystem dynamics.

5.3.1.1 Initial Inventory

The initial inventory will include documentation of existing vegetation and conditions within and immediately adjacent to Metrolinx Lands as follows:

- Delineation of vegetation types within the inventory limits in accordance with the *Ecological Land Classification for Southern Ontario* (ELC) system;
- A list of all vascular plant species for each type of vegetation community and estimated percent cover;
- Identification and delineation of incompatible herbaceous vegetation;

- Identification and delineation of conditions which may compromise the establishment of compatible vegetation (e.g. contaminated soil, steep slopes, rocky or thin soil);
- Tally woody vegetation with diameters of less than 10 cm within each vegetation community;
- Woody vegetation with diameters of 10 cm or greater, including:
  - Species;
  - Diameter at breast height;
  - Height;
  - Crown extension into corridor;
  - Overall health/condition;
  - Evidence of pests or disease;
  - Physical defects, including lean and direction of lean;
  - Tree canopy growing within/immediately adjacent overhead wires, power lines, or light fixtures, or growing within a fence or other structure; and,
  - Straight, branchless trunk without defects with the potential to be a higher value tree.

Detailed information on data collection for woody vegetation with diameters of 10 cm or greater that will also enable the implementation of the vegetation compensation and tree end use frameworks can be found in **Appendix A**.

Initial inventories can be completed by qualified specialists via field, aerial and high-rail vehicle or train surveys.

5.3.1.2 Bi-Annual Monitoring – Pre-Treatment

Throughout implementation of the IVM program, changes in distribution and abundance of plant species will inevitably occur as a result of management efforts. As such, Step 1 will be re-visited annually as part of the IVM cycle. The pre-treatment component of bi-annual monitoring will serve to maintain an up-to-date record of existing ecological conditions within Metrolinx Lands. Post-treatment monitoring is intended to evaluate the effectiveness of IVM treatments that have been implemented and is discussed as part of Step 5.

Pre-treatment monitoring will include confirming and augmenting data collected during the initial inventory and/or previous monitoring events in addition to the following:

- Delineation of areas represented by compatible plant species that can be retained and may require protection;
- Delineation of areas represented by incompatible plant species that may require treatment;
- The presence of dead, dying, imminently hazardous, and potentially hazardous trees (e.g. leaning trees with other structural defects or health condition issues);

- Identification of tree branches or vines close to OCS poles and any associated electrical structures;
- Access problems to the ROW caused by the presence of incompatible species;
- Problematic vegetation encroachments;
- The location of trees or brush compromising site security and creating safety issues for employees/ passengers (tripping, slipping, or health hazards);
- Breaches, or potential breaches, to treatment thresholds ;
- Width of the ROW edge (especially relative to the 7 m vegetation clearance zone);
- Terrain characteristics that help determine the appropriate work method, such as steep slopes;
- Terrain characteristics such as topographical features, eroded or erosion-prone areas, bare-ground areas, and hazards such as large rocks and stumps;
- Special conditions such as compatible land use issues, property encroachments and other concerns;
- Update to changes in conditions such as vegetation communities, access locations/information, etc.; and
- Incidental observations of wildlife and wildlife habitat.

The findings of the pre-treatment monitoring event will be compared against management objectives and treatment thresholds established as part of Step 2 and will inform the course of action that will be taken to manage vegetation within Metrolinx Lands or select parts of Metrolinx Lands for that year.

5.3.2 IVM Step No. 2: Setting Management Objectives and Tolerance Levels

Goal

Minimize, to the greatest extent possible, the percentage of incompatible vegetation within Metrolinx Lands to ensure that biodiversity and safety are upheld.

Objectives

- Set treatment thresholds that aim to minimize and prevent the establishment of incompatible species.
- Enable required vegetation removal while retaining compatible vegetation.

Once an understanding of the ecosystem has been established, it is used to inform management objectives and tolerance levels within Metrolinx Lands. Consistent with Metrolinx's focus on providing safe and reliable service, key management objectives for IVM in a rail corridor and other Metrolinx Lands are to:

- Prioritize worker and operational safety;
- Maintain reliable service by minimizing disruption caused by fallen trees, tree limbs, and leaves; and

- Protect rail infrastructure.

Tolerance levels within Metrolinx Lands are determined based on the existing vegetation and its alignment with management objectives. Tolerance levels can be quantified by treatment thresholds, which provide a measurement tool for determining whether action (i.e., treatment) is required to manage vegetation. In general, vegetation that exceeds a treatment threshold requires a management action or decision.

The following sections present further discussion on determining treatment thresholds and defining compatible and incompatible vegetation. They provide clear guidance on how to measure the existing vegetation within Metrolinx Lands against treatment thresholds to determine if treatment is needed.

5.3.2.1 Key Determinants of Treatment Thresholds

Treatment thresholds identified in this guideline have been determined based on a review of ROW IVM plans as well as ecological, operational, and safety considerations. They have been established to address both electrified and non-electrified rail infrastructure as discussed in **Section 5.2**.

In this IVM framework, treatment thresholds have been developed to manage the level of vegetative height and surface cover (expressed as a percentage of the total area) that can be tolerated before safety and integrity are compromised. Beyond these levels, vegetation becomes incompatible and may pose risks to operation and infrastructure and thus, requires treatment.

5.3.2.2 Compatible and Incompatible Vegetation

Defining incompatible and compatible vegetation is an important component of this step. For the purposes of the IVM program, compatible vegetation is defined as vegetation that can exist without interfering with rail operations and safety. Conversely, incompatible vegetation includes vegetation that presents a potential risk to safe and reliable rail service. Irrespective of height and density, the presence of invasive species, hazard trees, and hazardous vegetation within Metrolinx Lands and along the corridor does not meet management objectives. Thus, incompatible vegetation includes:

- Vegetation breaching threshold tolerance levels (in height and/or density);
- Hazard trees;
- Hazardous vegetation; and
- Invasive species.

Vegetation Height and Density

Vegetation height and density are characteristics that can be measured and compared against treatment thresholds. Height and density treatment thresholds will vary depending on the location within Metrolinx Lands relative to the rail infrastructure.

Height tolerance is largely based on the existing or potential height of vegetation relative to its proximity to infrastructure. Plant species that grow tall enough to potentially interfere with infrastructure are considered incompatible. A strict tolerance applies to the Overhead Contact System (OCS) and electrified infrastructure within the vegetation clearance area given the risk of damage and subsequent possibility of electrical fire.

Density helps determine whether the amount of vegetation present is enough to warrant treatment. For example, the ballast area demands a stricter tolerance to prevent damage to sensitive rail infrastructure and derailment.

Hazard Trees

A hazard tree can generally be defined as a tree with structural defects likely to cause the failure of all or part of the tree and is at risk of causing damage or injury to life or property. Risk is related to the chance that the tree could potentially strike a target if left untreated, thus a tree is only considered hazardous when it poses a risk to life or property.

For the purposes of the IVM framework, hazard trees are further defined or classified by high or moderate risk – which gives an indication of the imminence of action (with high risk hazard trees necessitating more urgent care than those classified as moderate). High risk hazard trees will need to be removed from Metrolinx Lands.

High risk trees are those requiring immediate attention that are defined by the following characteristics:

- Having serious defects (are in poor condition with lean towards the corridor, or dead condition) with likelihood of failure being imminent or probable; and/or
- Trees where the rail line or electrification infrastructure is within the potential fall zone.

Moderate risk trees are those which require attention on a short-term basis, within 12 months. These trees are characterized as:

- Having serious defects (any of the following: are in poor condition, or dead, or have a lean towards the corridor) where the likelihood of failure is possible; and/or
- The rail line or electrification infrastructure is within the fall zone.

Detailed information on the assessment of hazard trees is provided in **Appendix A**.

Hazardous Vegetation

Hazardous vegetation includes species that may pose serious safety issues (such as blindness or poisoning) to employees due to their growing in unsuitable locations. Examples of hazardous plant species include Giant Hogweed (*Heracleum mantegazzianum*) and Water Hemlock (*Cicuta maculata*).

Invasive Species

The management of vegetation within Metrolinx Lands is important not only for safety, but also for the control of non-native species (Bordadegua, 2017). For the purposes of this IVM, invasive plant species include those that threaten the biodiversity and ecological integrity of the ecosystem within Metrolinx Lands.

Invasive species tend to be fast-growing and difficult to control once established. The ability to manage invasive species within Metrolinx Lands will be challenging. This IVM framework applies a strict tolerance level intended to control the presence of invasive species within and near Metrolinx Lands to the greatest extent possible. A key component of IVM is to avoid creating suitable conditions for dispersal and establishment of non-native species - especially during construction and maintenance activities (Bordadegua, 2017).

Throughout IVM implementation, invasive species will be managed in accordance with all relevant federal and provincial regulations and the latest research. Over time, IVM plans will require updating to capture and adjust to any legislative changes or scientific understanding accordingly.

Relevant regulations that apply to the spread of invasive species include the federal *Plant Protection Act* and *Seeds Act* as well as the provincial *Invasive Species Act* and *Weed Control Act*. A summary of each Act as it applies to this IVM framework is provided in **Appendix G**.

Due to the broad range of invasive species, few generalizations can be provided for management guidelines. Instead, appropriate management for invasive species will be species- and site-specific. In some cases, it may be most effective to focus on management techniques that directly target a specific species. A combination of various management possibilities is likely to be most effective whether targeting a single species or multiple species (Bordadegua, 2017).

While the *Invasive Species Act* does not set out obligations to remove already established species, this IVM framework has been developed with the intent of controlling invasive plant species to the extent possible. The provincial *Invasive Species Act* prohibits activities that will result in the further establishment of four (4) restricted invasive species including: Black Dog-strangling Vine (*Cynanchum louiseae*), Dog-strangling Vine (*Cynanchum rossicum*), Japanese Knotweed (*Reynoutria japonica* var. *japonica*), and European Common Reed (*Phragmites australis* ssp. *australis*). A recommended management plan for each of these species is provided in **Appendix H**.

Outside of the federal and provincial realm, there are a number of non-regulated woody and herbaceous invasive species considered to be threats within local, regional, and conservation authority jurisdictions. A list of woody plant species that have been identified as priority invasive plant species (categories 1 to 3) by the City of Toronto, York Region, the Toronto Region Conservation Authority (TRCA), the Lake Simcoe Region Conservation Authority (LSRCA), Credit Valley Conservation (CVC), Central Lake

Ontario Conservation Authority (CLOCA), Conservation Halton (CH), and Ontario's Invading Species Awareness Program (OISAP) is provided in **Appendix I**. A list of non-woody plants identified as invasive species is provided in **Appendix J**.

The presence and abundance of invasive species will be used to inform management actions. Action decisions should include the following considerations:

- The consequence of not treating;
- The invasiveness of the species (Category 1 to 3);
- The potential safety, economic, and ecological impacts likely to be caused by its spread;
- Site characteristics – including adjacent land uses and proximity to environmental sensitive areas; and
- Species composition on the site and percentage cover.

It is recommended that the removal of all regulated and non-regulated species be undertaken in accordance with the Best Management Practices established by the Ontario Invasive Plant Council (OIPC).

5.3.2.3 Integrated Vegetation Management Zones in Electrified Corridors

Vegetation management within Metrolinx railway corridor and Metrolinx Lands is driven primarily by safety concerns and, as such, management is different depending on location within the corridor and Metrolinx Lands. The ballast and ballast shoulder are to be kept free of vegetation to avoid infrastructure deterioration.

Based on management objectives and treatment thresholds, IVM zones have been developed to address electrification infrastructure, including the 7 m vegetation clearance zone, which is comprised of Zones 1, 2 and 3. The IVM zones are intended to apply to the electrified Metrolinx ROW corridor. Zones 4 and 5 will not require treatment based on vegetation height and density; however, a maximum height of vegetation within these zones has been established to guide future planting within these zones. For adjacent land not owned by Metrolinx, Zones 4 and 5 serve as guidance only.

Zone 1: This zone includes the ballast (main track, siding, back track, storage track) as well as the 2.9 m area from the centerline of the track to the OCS poles. This area is to be kept free of all vegetation.

Zone 2: This zone includes the 2.5 m area from the electrical components. This area is to be kept free of all vegetation.

Zone 3: This is a 1.6 m wide low growth zone within the vegetation clearance zone. Within this area, vegetation up to a height of 1.4 m is compatible.

Zone 4: This is a 5.5 wide area outside of the vegetation clearance zone (between 7 m and 12.5 m from the track centerline). This zone does not require treatment of existing vegetation (unless deemed hazardous); however, in cases where this zone is being

replanted, it is recommended that vegetation be composed of medium height species that grow up to 4 m tall.

Zone 5: This is a 3.5 m wide area outside of the vegetation clearance zone (between 12.5 and 16 m from the track centerline). This zone does not require treatment of existing vegetation (unless deemed hazardous); however, in cases where this zone is being replanted, it is recommended that vegetation be composed of species that grow up to 8 m tall.

Table 6 provides a summary of detailed management objectives specific to each zone and treatment thresholds for vegetation within electrified corridors. Representative illustrations of the zones are provided in **Appendix E**.

Table 6: Integrated Vegetation Management Zones and Treatment Thresholds for Electrified Corridors

Zone	Location/Description	Management Objective	Treatment Threshold
Zone 1	Ballast area (which includes the main track, siding, back track and storage track)	No growth zone	3% cover
Zone 1	2.9 m clearance from the track centerline to the Overhead Contact System (OCS)	No growth zone	3% cover
Zone 2	2.5 m clearance from the Overhead Contact System (OCS) and electrified infrastructure	No growth zone	20% cover 0.5 m or less in height **OR** 10% cover 0.5 m to 1.4 m in height
Zone 3	1.6 m maintenance zone starting immediately adjacent to the Exclusion Zone infrastructure	Low growth zone comprised of non-woody vegetation.	10% cover 1.4 m or more in height
Zone 4	5.5 m area (between 7 and 12.5 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Medium growth zone comprised of shrubs and non-woody species that grow up to 4 m high when mature.	N/A

Zone	Location/Description	Management Objective	Treatment Threshold
Zone 5	3.5 m area (between 12.5 and 16 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Tall growth zone comprised of trees, shrubs, and non-woody species that grow up to 8 m high when mature.	N/A
All	Invasive species	Minimize presence	Species-specific
All	Hazard trees	Minimize presence	0% tolerance level
All	Hazardous plants	Minimize presence	0% tolerance level

5.3.2.4 Integrated Vegetation Management Zones in Non-Electrified Corridors

Based on management objectives and infrastructure, IVM zones have been developed to address non-electrified Metrolinx ROW corridors. These IVM zones are similar to those developed for electrified corridors, with the exception of the 2.5 m area from electrical components. The resulting IVM zones include Zones 1 to 4. Akin to Zones 4 and 5 within electrified corridor, non-electrified Zones 3 and 4 do not require treatment based on vegetation height and density. The maximum height of vegetation within these zones has been established to guide future planting within these zones. For adjacent land not owned by Metrolinx, non-electrified Zones 3 and 4 serve as guidance only.

Zone 1: This zone includes the ballast (main track, siding, back track, storage track) as well as the 2.9 m area from the centerline of the track. This area is to be kept free of all vegetation.

Zone 2: This is a 1.6 m wide low growth zone within the vegetation clearance zone. Within this area, vegetation up to a height of 1.4 m is compatible.

Non-Electrified Zone 3: This is a 5.5 wide area outside of the vegetation clearance zone (between 4.5 m and 10 m from the track centerline). This zone does not require treatment of existing vegetation (unless deemed hazardous); however, in cases where this zone is being replanted, it is recommended that vegetation be composed of medium height species that grow up to 4 m tall.

Non-Electrified Zone 4: This is a 3.5 m wide area outside of the vegetation clearance zone (between 10 m and 13.5 m from the track centerline). This zone does not require treatment of existing vegetation (unless deemed hazardous); however, in cases where

this zone is being replanted, it is recommended that vegetation be composed of species that grow up to 8 m tall..

Table 7 provides a summary of detailed management objectives specific to each zone and treatment thresholds for vegetation within non-electrified corridors. Representative illustrations of the zones are provided in **Appendix E**.

Table 7: Integrated Vegetation Management Zones and Treatment Thresholds for Non-Electrified Corridors

Zone	Location/Description	Management Objective	Treatment Threshold
Zone 1	Ballast area (which includes the main track, siding, back track and storage track)	No growth zone	3% cover
Zone 1	2.9 m clearance from the track centerline	No growth zone	3% cover
Zone 2	1.6 m maintenance zone starting immediately adjacent to the Exclusion Zone infrastructure	Low growth zone comprised of non-woody vegetation.	10% cover 1.4 m or more in height
Non-Electrified Zone 3	5.5 m area (between 4.5 and 10 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Medium growth zone comprised of shrubs and non-woody species that grow up to 4 m high when mature.	N/A
Non-Electrified Zone 4	3.5 m area (between 10 and 13.5 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Tall growth zone comprised of trees, shrubs, and non-woody species that grow up to 8 m high when mature.	N/A
All	Invasive species	Minimize presence	Species-specific
All	Hazard trees	Minimize presence	0% tolerance level

Zone	Location/Description	Management Objective	Treatment Threshold
All	Hazardous plants	Minimize presence	0% tolerance level

5.3.2.5 Incidental Observations and Ad-Hoc Treatments

In some instances, ad-hoc treatments – those carried out as needed – may be triggered by the following:

- Vegetation interfering with access to railway equipment;
- Vegetation compromising site security or causing safety issues for employees (such as tripping, slipping, or health hazards);
- Vegetation compromising, or potentially compromising, communication and signal installations and yard and station grounds; or
- Any problematic vegetation that has been identified from a complaint from an adjacent property owner or an employee.

In these instances, it may not be possible to determine whether treatment is needed based on the common indicators of vegetation height or surface cover. Instead, determining the need for action will be based on factors such as the likelihood of harm to property or people.

5.3.2.6 Summary

Treatment thresholds are an important part of the management decision-making process for IVM. They provide a proactive means to address incompatible species that, if left untreated, would otherwise come to harm operations and infrastructure. Ensuring that these thresholds are maintained will reduce the associated risks and costs, thus promoting in the long-term protection of infrastructure integrity and investment and the provision of a reliable transportation network.

In order to achieve these benefits of IVM, the following is recommended:

- Appropriate action is taken when necessary;
- Necessary action is applied in a timely manner;
- Vegetation is maintained in accordance with the treatment thresholds established;
- Treatment thresholds are not breached, particularly so within the 7 m vegetation clearance zone (represented in Zones 1, 2, and 3);
- Invasive species, hazard trees and hazardous vegetation are handled in accordance with this framework and opportunities for appropriate native vegetation planting identified;
- Any problematic or other incompatible vegetation is removed if posing a hazard to safety, ecology, or rail operability; and

- Responsibility for removal and maintenance is assumed for vegetation within any newly identified areas requiring integrated management

In addition, it is recommended that removals or other control actions are not applied excessively or before a treatment threshold has been breached.

The intent of the integrated approach is to encourage a managed environment that is compatible with rail operations. In order to allow for the growth of a compatible plant community, treatment must be avoided unless the treatment threshold is exceeded. If controls are over-applied, this may compromise the health of compatible vegetation and IVM objectives.

5.3.3 IVM Step No. 3: Compiling Treatment Options

Goal

Develop a treatment method that meets the needs of ecological, economic, and stakeholder concerns.

Objectives

- Develop a treatment approach that will most effectively meet site-specific conditions and vegetation composition; and
- Develop a treatment approach that encourages the establishment of a compatible, self-sustaining vegetative cover which, over the long-term, becomes less dependent on treatments.

Once a decision has been made that treatment is required, the next step is to determine what treatment method, or combination of methods, should be used. Determining the appropriate action will depend on site-specific conditions and considerations.

The following section provides an overview of the treatments options that may be applied. It details the rationale, benefits, and limitations of the various treatment options, which include:

- Chemical;
- Mechanical; and
- Cultural treatments.

The information provided in this section should be regarded as a decision-making tool to determine what treatment option (or combination of options) will most effectively meet management needs and objectives given the circumstances.

5.3.3.1 Chemical Control Methods

Chemical treatment with herbicides is the primary vegetation control tool used by ROW owners and operators. When applied professionally, modern herbicides most effectively

control incompatible vegetation (BCRC, 2012) – particularly so if they are applied in combination with other methods or selectively, using advanced application technologies and appropriate timing.

Whereas other methods simply address the symptoms of overgrowth, herbicides treat the root cause. This is an important consideration to be made when weighing treatment options for areas of Metrolinx Lands where there is a zero to low tolerance for vegetation.

Chemical Treatment within Metrolinx Lands

Across Metrolinx Lands, herbicides/chemical controls may be used in response to threshold breaches and ad hoc events. They may also be required for:

- Vegetation control in areas where non-chemical methods are not feasible or practical due to accessibility issues to problematic vegetation;
- The control of the presence and re-growth of woody vegetation;
- The control of noxious weeds and invasive plants where mechanical methods are not effective, safe, or practical; and
- Instances where no feasible non-chemical control alternative is available.

For areas that are most sensitive to lateral and sub-track plant incursions, the plan also applies a strict, effective treatment strategy where chemical controls are to be the only method used to address incompatibility in “no growth zones”, i.e. Zones 1 and 2.

Herbicide Selection

Choosing which herbicide to apply in response to IVM needs is dependent on: time of year; stage of plant growth; site-specific considerations and sensitives; soil moisture before, during, and after application; precipitation (rain or snow); and temperatures of soil and air before treatment. It may also consider the use of the product with the least adverse non-target impacts available that will achieve the necessary control. Only chemicals approved (at the time of application) by the appropriate federal and provincial government shall be used.

While all factors will need to be considered for herbicide selection, time of year should be regarded as the most essential factor given the need to consider when certain active ingredients in herbicides are effective, or conversely, when they are rendered unusable due to cooler temperatures. Where chemicals are used, the timing window outlined in **Table 5** should be considered.

In addition to timing windows, details on the persistence and selectivity of active ingredients have also been listed in **Table 8**. Persistence, as defined in the context of IVM, refers to non-residual (controls that work at the time of treatment and remain active for only a short while thereafter) and residual (controls that remain effective where they are applied for some length of time). Generally, for areas like Zone 1 (which are operationally demanding) and areas such as those surrounding OSC poles (which are susceptible to risk), residual herbicides should be used to ensure long-lasting effectiveness.

Table 8: Herbicide Selection

Active Ingredient*	Persistence	Selectivity	Timing
20-25%Glyphosate (diluted in water)	Non-residual	Non-selective	August or September
10% Glyphosate	Non-residual	Non-selective	August
Triclopyr*	Non-residual	Selective	Summer or Winter
Picloram	Residual	Selective	Summer
Imazapyr	Residual	Non-Selective	Spring, Summer or Fall

* *The active ingredients provided have been determined based on their proven ability to treat vegetative species that are known to occur within Metrolinx* Lands*. While this Guideline does not strictly endorse the use of any one of these treatments, triclopyr is most recommended for use given its ability to be applied year-round and its proven ability to effectively manage a wider-range of vegetation.*

Non-selective herbicides are those which can address a broad range of vegetation; whereas selective herbicides are those that inhibit the growth of a target species while leaving other plants unaffected. Where noxious weeds and invasive species are a concern, a selective control is the best choice. Selective control should also be used where target vegetation is surrounded by compatible plants and, for that matter, be used in any instance where surrounding plants need to be protected. Within highly utilized and risk-prone areas, it is recommended that non-selective products be considered.

Limitations

While effective, the use of herbicides is associated with known environmental and social challenges. Despite their importance in maintaining a safe corridor, it is recommended that, to the extent possible, the extent of known impacts from herbicides be mitigated. This may be accomplished by utilizing precise application tools (discussed below), selecting appropriate herbicides, applying the appropriate ratio of active chemical ingredients, and following the operational information on herbicide use outlined below.

Operational Information

Personnel involved in the handling and application of herbicides must do so in accordance with Metrolinx protocols and policies and, at minimum, must adhere to the following:

1. Herbicides must be applied in accordance with the federal *Pest Control Products Act*, the *Ontario Pesticides Act*, and *Ontario Regulation 63/09* and in accordance will all label directions.
2. Prior to use, personnel are to ensure that they have the most current label consistent with the information detailed on the Pest Management Regulatory Agency search product label website: http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php.

3. All personnel applying chemicals shall have valid applicator's licenses. Copies of such licenses shall be provided to Metrolinx.

5.3.3.2 Mechanical and Manual Control Methods

Best applied in combination with herbicides, mechanical and manual methods can be used to damage or remove vegetation on site. They are regarded in ROW management as important tools for addressing imminently problematic vegetation – being one of the most effective methods at addressing issues where time and risk are major sensitives.

The mechanical methods outlined in this framework include chainsawing, weed trimming, mowing and brush cutting (refer to **Section 5.3.4.2**). Determining which of these controls should be used will be dependent on such factors as terrain, safety, and economic considerations/feasibility.

Mechanical Treatment

Given their ability to quickly respond to vegetative issues, this framework endorses the use of mechanical methods to address imminently hazardous or dangerous vegetation and are the preferred option for managing conifers. Mechanical methods may also be used in combination with other methods to control vegetation.

Limitations

When used in isolation from cultural or chemical approaches, mechanical treatments are limited in their ability to reduce the presence of incompatible vegetation over the long-term. Given that the reduction in incompatible vegetation is an important IVM objective, use of mechanical treatments in isolation from other methods is discouraged. Use of these treatments on their own may result in an increase in environmental damage, an increase risk to work safety, and a decrease in efficacy and cost-effectiveness.

5.3.3.3 Cultural Control Methods

Cultural controls involve the introduction of specific plants, ground covers, or mulches to control vegetation growth. They are used in ROW management as a means of creating a vegetative community compatible with the requirements of railway safety as well as the social and environmental values important to Metrolinx. They include such means of treatment as the retention of compatible vegetation, seeding, and use of mulch.

These treatment options represent an important non-chemical means of preventing the establishment of incompatible vegetation. Moreover, they are essential tools for:

- Providing an aesthetically pleasing rail corridor;
- Enhancing habitat;
- Preventing the loss of and promoting biodiversity;
- Establishing pollinator habitats and promoting pollinator species;
- Reducing the cost of vegetation management;

- Reducing the need of chemical control; and
- Helping to reduce the presence of tall growing vegetation by planting species that out-compete for light, space, and nutrients.

Cultural Treatment

Metrolinx Lands have the potential to provide habitats and functional connectivity for plants. Management practices that involve small-scale revegetation have been recommended to help increase these positive effects of railway corridors (Bordadegua, 2017) and other land types.

Cultural control methods are recommended in Zones 3, 4 and 5 (where located within the Metrolinx corridor). They offer a proactive means of treatment; for example, they can be used to prevent the establishment of invasive species. Cultural controls are most often used in combination with other methods and are typically implemented following chemical and mechanical treatment of incompatible species.

Limitations

While effective as a preventative measure, cultural controls should not be regarded as a reactive means of addressing immediately hazardous or problematic vegetation within the corridor. Where a breach of threshold demands a timely response, chemical or mechanical methods should be implemented. Cultural controls, however, are encouraged as a subsequent measure – whereby, as discussed above, seeding, etc. is used following a reactive treatment event.

5.3.3.4 The Mixed Method/Combined Approach

As noted, the effectiveness of each method is maximized when chemical, cultural, and mechanical treatments are used in combination. Thus, the framework endorses the use of a mixed-methods approach, whereby a combination of methods are used to address incompatible vegetation.

In action, the mixed method approach may appear as follows:

Example 1: For the removal of a hazard tree within Zone 4 of the Metrolinx ROW:

1. Mechanical controls would be used to remove an identified hazard tree as timely as possible.
2. Up to 30 days following mechanical treatment, chemical controls are used to treat the cut stump using the one of the herbicides recommended for use under the plan.
3. The area would then be subsequently seeded.

Example 2: For the large-scale removal of vegetation within Zone 3 of the Metrolinx ROW:

1. Where vegetation is being removed at a large-scale, e.g. prior to the construction of new rail, mechanical and chemical treatments will be used.
2. Following initial treatment, cleared ground will be seeded.
3. Mulch will then be applied to serve as a protective cover over disturbed soils.

The mixed method approach allows for the opportunity to create a control action which best:

- Maximizes cost-effectiveness;
- Creates a self-sustaining vegetative community;
- Improves worker safety;
- Reduces environmental and landscape alteration and damage
- Improves efficacy and cost-effectiveness;
- Promotes a healthier, more vibrant vegetative community within Metrolinx Lands; and
- Reduces the dependence on herbicides and chemical controls.

5.3.3.5 Selection Criteria

Determining which method, or combination of methods should be used of mechanical, chemical, or cultural control options hinges on a number of corridor considerations/ constraints:

- Vegetation cover and height relative to treatment thresholds;
- Site characteristics, including the proximity to a designated natural area or other feature requiring protection;
- Timing of treatment;
- Composition of vegetation present;
- Type and abundance of invasive, incompatible, and/or noxious species;
- The consequences of not treating;
- Potential impact to safety, site security, and biodiversity;
- Urgency of the problem;
- Public concerns;
- Cost effectiveness;
- Efficacy of previously implemented treatment options;
- The possibility of adverse impacts to surrounding land, workers, and bystanders; and
- Other factors which are generally used in IVM approaches to justify, evaluate, and determine method(s) chosen for the management of vegetation within ROWs and land management.

Table 9 and **Table 10** provide a summary of the zones for electrified corridors and non-electrified corridors, respectively, along with their respective treatment thresholds and suitable treatment options for each zone. While in some areas only one treatment method can be used, in others, the IVM manager will have to determine which option or a combination of options will most appropriately meet IVM objectives based on the selection criteria above.

Table 9: Integrated Vegetation Management Zones and Management Control Options for Electrified Corridors

Zone	Location/Description	Target Vegetation	Treatment Threshold	Control Options
Zone 1	Ballast area (which includes the main track, siding, back track and storage track)	No growth zone	3% cover	Chemical
Zone 1	2.9 m clearance from the track centerline to the Overhead Contact System (OCS)	No growth zone	3% cover	Chemical
Zone 2	2.5 m clearance from the Overhead Contact System (OCS) and electrified infrastructure	No growth zone	20% cover 0.5 m or less in height **OR** 10% cover 0.5 m to 1.4 m in height	Chemical **AND** Mechanical
Zone 3	1.6 m maintenance zone starting immediately adjacent to the Exclusion Zone infrastructure	Low growth zone comprised of non-woody vegetation.	10% cover 1.4 m or more in height	Chemical **AND** Mechanical **AND** Cultural
Zone 4	5.5 m area (between 7 and 12.5 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Medium growth zone comprised of shrubs and non-woody species that grow up to 4 m high when mature.	N/A	Chemical **AND** Mechanical **AND** Cultural

Zone	Location/Description	Target Vegetation	Treatment Threshold	Control Options
Zone 5	3.5 m area (between 12.5 and 16 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Tall growth zone comprised of trees, shrubs, and non-woody species that grow up to 8 m high when mature.	N/A	Chemical **AND** Mechanical **AND** Cultural
All	Invasive species	Minimize presence	Species-specific	Chemical **AND** Mechanical **AND** Cultural
All	Hazard tree(s)	Minimize presence	0% tolerance level	Mechanical
All	Hazardous vegetation	Minimize presence	0% tolerance level	Chemical **AND** Mechanical **AND** Cultural

Table 10: Integrated Vegetation Management Zones and Management Control Options for Non-Electrified Corridors

Zone	Location/Description	Target Vegetation	Treatment Threshold	Control Options
Zone 1	Ballast area (which includes the main track, siding, back track and storage track)	No growth zone	3% cover	Chemical
Zone 1	2.9 m clearance from the track centerline	No growth zone	3% cover	Chemical

Zone	Location/Description	Target Vegetation	Treatment Threshold	Control Options
Zone 2	1.6 m maintenance zone starting immediately adjacent to the Exclusion Zone infrastructure	Low growth zone comprised of non-woody vegetation.	10% cover 1.4 m or more in height	Chemical **AND** Mechanical **AND** Cultural
Non-Electrified Zone 3	5.5 m area (between 4.5 and 10 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Medium growth zone comprised of shrubs and non-woody species that grow up to 4 m high when mature.	N/A	Chemical **AND** Mechanical **AND** Cultural
Non-Electrified Zone 4	3.5 m area (between 10 and 13.5 m from the track centerline) outside of the vegetation clearance zone where treatment is not required but future plantings should be limited.	Tall growth zone comprised of trees, shrubs, and non-woody species that grow up to 8 m high when mature.	N/A	Chemical **AND** Mechanical **AND** Cultural
All	Invasive species	Minimize presence	Species-specific	Chemical **AND** Mechanical **AND** Cultural
All	Hazard tree(s)	Minimize presence	0% tolerance level	Mechanical
All	Hazardous vegetation	Minimize presence	0% tolerance level	Chemical **AND** Mechanical **AND** Cultural

5.3.4 IVM Step No. 4: Site-Specific Implementation of Treatments

Goal

Apply a control action that is tailored to varying site conditions, needs, and sensitivities. The selected option should aim to represent a balance between meeting IVM targets/objectives while considering indirect and direct impacts to the environment and society, as well as cost.

Objectives

- Adhere to the selection criteria/decision-making process to determine which potential control type and method (pruning, mowing, foliar chemical application, seeding, etc.) best addresses management constraints, i.e. site conditions, environmental sensitivities, timing windows etc.

Once a control option has been determined, the next step will be to decide on the application approach to be used to apply the chemical, mechanical and/or cultural treatment(s). Each method of control comes with a host of application options in terms of the techniques and technologies that can be used for application. Determining which approach to take hinges on a variety of species-specific and site-specific sensitives, constraints, and conditions that will need to be accounted for.

What is essentially a continuation of IVM Step No.3, this section details the application techniques and technologies that may be used to apply treatments. It provides a summary of the benefits and limitations of application options and gives recommendations on which approach should be taken. The summary that is below presented represents the decision-making process to be followed to ensure that the most suitable, cost-effective, and environmentally compatible treatment approach is applied within Metrolinx Lands.

5.3.4.1 Chemical Techniques and Application Technologies

The advancement in herbicide application techniques and technologies has allowed IVM professionals to apply chemicals more precisely and efficiently resulting in a dramatic reduction in the volume of herbicide needed to treat incompatible species. Given its importance in improving application, the most precise treatment approach to use to reduce the volume of herbicide used should be implemented. The following provides details on the various treatment approaches which can be used to efficiently apply herbicide within Metrolinx Lands under various conditions.

Foliar and Stem Applications

Foliar and stem applications involve the use of a manually operated pressurized backpack sprayer, or a handgun that is used to apply active chemical ingredients. Unlike other chemical technologies, foliar and stem applications can be used at any time of the year and are therefore an important option to consider. Within Metrolinx Lands, this form of application should be used:

- To target vegetation that is actively growing;
- For the treatment of deciduous vegetation by foliar or basal bark/stem applications (to prevent re-sprouting); and
- To target vegetation within Zone 3.

Given its disadvantage of being susceptible to drift (unless specialized equipment is used during ideal low-wind conditions), caution must be exercised if:

- Application is needed in an environmentally sensitive area; or
- If a targeted species is around desirable plants and habitats.

Wick/Wipe-On Applications

Wick/Wipe-on applications involve the use of a wick soaked with herbicide solution that is wiped or dragged over the foliage of the target vegetation. Within Metrolinx Lands, this form of application should be used:

- Where cut stumps have re-sprouted;
- For treating small patches of vegetation within Zone 3;
- In environmentally sensitive areas where there is a need to minimize drift; and
- In areas where target vegetation is located in areas of compatible vegetation.

Treating vegetation using this application is neither time-efficient nor cost-effective given that it is highly labor-intensive. It should therefore only be used to treat small areas or small number individual plants.

Soil Applications

Soil applications use a manually-operated backpack sprayer, power hose, nozzle, or boom sprayer to apply herbicide to soil. They provide season-long (residual) control of all vegetation, which is an important consideration for ensuring that no growth areas (e.g. the ballast) are free of vegetation for an extended period of time. Within Metrolinx Lands, this form of application should be used:

- For the application of non-selective herbicides within the ballast and Zone 1;
- As a form of pre-emergent weed control; and
- To prevent seed germination of some broadleaf vegetation, annual, and perennial grasses.

Caution must be exercised with this treatment if:

- Used within areas subject to heavy rainfall or snow as they may be washed or move off-site; or
- Being applied within environmentally sensitive areas (including areas with a high-water table).

This section will also detail the active ingredients that should not be used in combination with soil applications.

Cut Surface

The cut stump method is often applied in lands/ROW management following the mechanical removal of trees. Within Metrolinx Lands, this form of application should be used shortly following the removal of:

- Hazard trees;
- Invasive woody species; and
- Any incompatible tree within Metrolinx Lands.

Following the felling of trees, stumps will need to be treated using the cut stump method – which can be carried out throughout the growing and dormant season. Cut stump application involves the application of chemical herbicide sprayed or manually applied onto freshly cut stumps. Herbicides applied in this manner rely on the downward movement of the active ingredient to the root system and are most effective when the treatment is applied to the cambium – located where the bark and wood meet, usually referred to as the first ring inside the tree. It is important to cover this area of the stump with herbicide to ensure effective translocation or penetration of the active ingredient.

In addition to these considerations, to optimize cut stump treatment, the following actions must be exercised:

- Herbicide must cover the entire cut stump and should pool on the surface of the stump;
- During applications, attention should be paid to covering the cambium of the stump;
- Exposed roots should also be sprayed/treated with herbicide;
- Herbicide must be applied as soon as possible to the freshly cut stump, up to a maximum of 20 days before regrowth; and
- The appropriate herbicide must be applied according to the target species, intended use and restrictions of the intended herbicide, as well as the correct timing window/season.

To maximize effectiveness, it is also recommended that colorants or dyes be added to the herbicide to help identify treated stumps and ensure adequate coverage. If a colorant or dye is used, it must be compatible with the carrier used.

5.3.4.2 Mechanical Techniques

For mechanical application options, recommended methods include pruning, mowing, bushing, and chainsawing. In order to minimize soil disturbance during tree removal, trees should be cut above the soil and grubbing should be avoided.

Pruning

Within Metrolinx Lands, pruning should be used to address vegetation (namely branches) encroaching into Zone 1, 2 or 3 and in cases where complete tree removal is not required.

The frequency of trimming will be based on the assessment of conditions collected during monitoring events. Pruning can be labour intensive (and thus costly), which should be considered in the decision to implement.

Pruning must also be undertaken by an arborist with knowledge and experience in proper arboricultural techniques. This will ensure the treatment is successful and does not lead to damage of a tree.

Chainsawing

Within Metrolinx Lands, chainsawing may be implemented:

- For the removal of hazard trees that pose a risk of falling within Metrolinx Lands.
- For the removal of trees that have breached the treatment threshold or that have been deemed necessary for removal due to proximity to the 7 m vegetation clearance zone;
- For the removal of trees necessary for new construction; or
- For the removal of trees in environmental sensitive areas.

Mowing

Mowing involves the cutting of vegetation using track-mounted or wheel heavy-duty flail or rotary cutters. Within Metrolinx Lands, mowing may be used:

- For the removal of incompatible vegetation less than 20 cm in diameter within Zones 1-3 within the Metrolinx ROW;
- To maintain requirements where alternative methods have proven ineffective, or in areas with high densities of conifers;
- In circumstances where removal is required immediately; or
- For the removal of vegetation in areas where it is desirable for Metrolinx Lands to be left aesthetically pleasing, e.g., adjacent to public parks.

Caution must be exercised with this treatment in the following circumstances:

- If mowing is to take place within the bird nesting season (April 1 to August 31). It is recommended that this form of treatment only be used once the nesting season has ended to avoid disruption of habitat; or
- Where treatment is needed in areas with considerable pollinator habitat and compatible species. Late summer mowing in particular is problematic if done on a large scale has it comes with the consequence of destroying plants that provide

food (i.e., nectar, pollen, foliage, and seeds) for insects and birds, as well as killing pollinator larvae on host plants, such as milkweed.

5.3.4.3 Cultural Techniques

Cultural methods include retaining existing low ground cover, as well as seeding, mulching and planting. Determining which of these methods should be applied will be largely dependent on location and site-specific conditions. Within Zone 3, the retention of existing low ground cover, mulching and seeding are recommended. Where suitable, planting of native trees and shrubs within Zones 4 and 5 may be undertaken.

Retaining Existing Low Ground Cover

To the greatest extent possible, existing, compatible ground cover should remain undisturbed. Retaining existing compatible vegetation will benefit IVM as it will help prevent the establishment of incompatible species resulting in a reduced need for the implementation of mechanical and chemical controls.

Seeding

Seeding within Zone 3 will inhibit weed establishment and promote the establishment of a native plant community and natural regeneration.

Seeding typically includes application of a nurse crop as well as a seed mix with a high percentage of grass and legume species. The nurse crop will provide fast, temporary cover while the seed mix becomes established, helping to suppress weeds before disappearing from the established vegetation community. Virginia Wild Rye (*Elymus virginicus*), Canada Wild Rye (*Elymus canadensis*), Common Oat (*Avena sativa*) and Buckwheat (*Fagopyrum esculetnum*) can all be used as a nurse crop. Annual Rye (*Lolium multiflorum*) is not recommended for use, as it can inhibit the growth of other species (Conservation Halton, 2017; CVC, 2013). Nurse crops should be applied at a rate of 22 kg/ha; however, the application method must be considered and rates adjusted as appropriate.

The recommended seed mixes include species that will be compatible with the long-term objectives of IVM within Metrolinx Lands. Site-specific recommendations are provided based on the existing site conditions, particularly moisture level and sun exposure, within (e.g. cultural meadow or meadow marsh community) and immediately adjacent (e.g. meadow or wooded) to Zone 3.

In partnership with Ontario Seed Company (OSC), Credit Valley Conservation (CVC) has developed a number of seed mixes suitable for restoration projects within the Credit River watershed (CVC, 2014). These seed mixes were designed to be used in a variety of soil and moisture conditions. The study area falls within the jurisdiction of multiple conservation authority jurisdictions; however, each conservation authority does not have jurisdiction-specific lists. As such, the recommended seed mixes include those developed by OSC/CVC as well as others develop exclusively by OSC. All species included in the recommended seed mixes are listed as suitable species for seed mixes for the TRCA jurisdiction per TRCA's Seed Mix Guidelines (TRCA July 2004). Seed mixes should be

applied at the specified rate of 22-25 kg/ha (adjusted as necessary to suit application method).

The recommended seed mix for areas within Zone 3 have been determined based on existing site conditions. **Table** 11 provides a summary of suitable seed mixes based on the pre-disturbance ELC. **Appendix K** contains a list of species in each mix.

Table 11: Seed Mix Recommendations

Existing Community	Seed Mix
Shallow Marsh (MAS)	CVC 2 – Naturalized Wetland Mixture
Meadow Marsh (MAM)	CVC 4 – Wet Meadow Mixture
Cultural Meadow (CUM)*	CVC 7 – Upland Native Meadow Mixture
Wooded (CUW, FO, SW)	OSC Woodland Seed Mix 8275

** May also be referred to as ME, MEM, MEG, and MEF (per the 2008 ELC)*

Seeding application methods include dry seeding, wet broadcast seeding, hydroseeding and Terraseeding™. The most appropriate application method will be based on site conditions such as soil, hydrology, and slope, as well as logistical issues such as access and equipment. In general, Terraseeding™ is recommended where feasible. Seeds that require cold stratification for successful germination should be pre-stratified or seeded in fall. Where dry seeding or wet broadcast seeding are implemented, the soil should be rolled after seeding or the seed should be otherwise pressed into the soil to ensure there is good contact at the seed/soil interface. **Table 12** provides a summary of seeding methods.

Table 12: Methods to Apply Seed within Zone 3

Method	Description
Dry Seeding	Dry seeding methods that may be used within the rail corridor include hand broadcast, motor-driven cyclones, and air blowers. Hand broadcast seeding involves use of a rotary type “belly grinder” seeder, which is estimated to allow seeding at a rate of 1 ha per hour depending on walking speed, cranking speed and spill rate. For the purposes of this IVM framework, hand broadcast seeding will allow accurate application of seed within Zone 3’s narrow 1.6 m width. Application using motor-driven cyclones involves a seeder mounted on equipment. This method may reduce application costs by increasing speed of application but comes with the challenge of mounting on rail equipment which creates access and timing restrictions. Air blowers can be used to blow seed up to 10 m (coated seed is recommended for improved ballistics). This method has been shown to allow approximately 2-5 km of roadside to be seeded per hour.

Method	Description
Wet Broadcasting	Wet broadcast seeding mixes seed with water prior to application. With wet seeding, the seed is carried farther when sprayed and can cover a larger surface area per unit time. It allows better control of seed dispersal and can accelerate germination.
Hydroseeding	Hydroseeding is a common post-construction measure to restore disturbed areas that involves a wet slurry of seeds, fertilizer, soil binding agent (tackifier), and mulch. Soil binders or tackifiers are added to stick the seed to the soil during germination and can provided the added benefit of erosion protection by holding soil particles in place (Forest Practices Code of British Columbia, 1997). Soil binders may not be needed in the slurry for flat areas or gentle slopes and can be reduced when using a wood fibre mulch. When hydroseeding, the OSC recommends that the application rate be increased by 50 to 75%. Ground-based hydroseeding within the corridor may be completed using hi-rail-mounted equipment consisting of a mixing tank with mechanical or hydraulic agitation and a volume pump. The equipment can reach a distance of 50 m.
Terraseeding™	Terraseeding™ involves injecting the seed into a growing medium that can be selected/specified to match the site soil and application requirements. Because the medium has gone through a composting process, Terraseeding™ is unlikely to introduce invasive or weedy species to the site. Application depth varies depending on the site, with typical application being 1-10 cm. Uneven soil surfaces can be leveled with the appropriate depth of medium.

Mulching

Woody material (e.g., branches, stems, leaves) cut as part of IVM activities has the potential to be used as mulch within Metrolinx Lands. Over time, mulch slowly decomposes and provides nutrients to plants and soil and organic materials to the soil that improves soil aeration and structure, nutrient holding capacity, and moisture retention (GOERT, 2012). The repurposing of mulch has the potential to provide a number of benefits; for example, it can:

- Serve as a protective cover over disturbed soils by reducing erosion;
- Prevent soil from forming a crust;
- Improve soil structure, texture, and porosity;
- Provide nutrients to plants;
- Conserve soil moisture;
- Moderate soil temperatures; and

- Improve native plant establishment in urban and disturbed environments.

Despite these benefits, caution must be exercised with this treatment. Mulch shall not be applied within Zones 1 or 2. Material to be used as mulch can be applied:

- A minimum of 3 m from any active rail; and
- A minimum of 30 m from any watercourses and drainage systems (Network Rail, 2018).

The application of mulch should be considered as part of ongoing monitoring to ensure that it is not being used by rodents and/or insects for cover nor lending to the establishment of incompatible plant species (e.g. from fragments in the mulch). Use of chips cut from invasive tree species, such as Tree of Heaven (*Ailanthus altissima*), is not recommended to be spread in areas where the species are not present as the chips might include viable seed or other material that may lead to plant growth (GOERT, 2012). It should be noted, however, that where invasive tree species already exist on Metrolinx Lands, and seeds are already present in the soil seed-bank, little benefit will be gained by attempting to separate the chips from these species from already infested areas.

Within Metrolinx Lands, mulch should be applied according to the desired outcome of the area of application. Where mulch is being applied for the purpose of inhibiting plant growth, a thicker layer is appropriate. Where mulch is being applied for the purpose of protecting seeded areas, a thin layer 1 to 4 cm in depth should be applied, leaving some areas bare. A thin, scattered application will allow growth and establishment of compatible plants. Leaving some areas free of mulch provides the added benefit of retaining ground nesting habitat for bees and other pollinators (GOERT, 2012).

Mulch is best applied during the spring, after the soil has begun to dry, or in the fall when the soil is no longer dry from the summer. However, for efficiency, mulch should generally be applied during and immediately following tree removals, when tree waste will be chipped in place and spread to nearby areas as needed.

Planting

For electrified corridors, planting may take place within Zones 4 and 5. For non-electrified corridors, planting may take place within non-electrified Zone 3 and non-electrified Zone 4. Where planting is deemed appropriate it is recommended that vegetation be composed of species that will not exceed 4 m in height at maturity (within Zone 4 and non-electrified Zone 3) or 8 m in height (within Zone 5 and non-electrified Zone 4). A list of recommended species is provided in **Appendix L**.

5.3.4.4 Selection Criteria and Best Practices

In determining which treatment application method to use for chemical, mechanical or cultural treatment, the following should be considered:

- Location and size of the area requiring treatment;

- Site conditions including slope and aspect, drainage, soil type;
- Existing vegetation – species, composition, and density;
- Previous treatment (and successes and failures);
- Proximity to designated natural areas or other features requiring protection;
- Adjacent land uses (e.g. residential); and
- Adjacent vegetation.

Environmentally sensitive areas, including designated natural areas, exist within and adjacent to the Metrolinx Lands. Thus, IVM treatments will be required within and adjacent to these areas. In order to protect environmentally sensitive areas, avoidance and mitigation measures shall be incorporated into all IVM implementation activities to the greatest extent possible. The following provides information intended to prioritize avoidance and mitigation of impacts to environmentally sensitive areas. It also provides avoidance and mitigation measures that are expected to protect wildlife within Metrolinx Lands.

Site-Specific Treatment – Protection of Environmentally Sensitive Areas

Prior to treatment application, the boundaries of the treatment area shall be delineated in the field to confirm treatment area boundaries and protection of environmentally sensitive areas or other features requiring protection.

Throughout implementation, IVM treatments will be required within and/or adjacent to environmentally sensitive areas within and/or adjacent to Metrolinx Lands. In order to protect these areas from the impacts of treatment, avoidance and mitigation measures shall be incorporated into all IVM implementation activities. Best Management Practices provide information meant to inform avoidance and mitigation of impacts to designated natural areas.

At the time of writing, within natural areas, the application of chemical, cultural, or mechanical treatments is fairly unregulated from a legislative perspective. However, where caution should be applied is within the context of parks and protected areas where, prior to the use of chemical methods, municipalities, Ontario Parks, Parks Canada, and conservation authorities will need to be notified.

Protecting Wildlife

Wildlife such as burrowing mammals should be provided with adequate escape routes from the work area (if contained). This can include small spaces beneath a fence, or natural gaps caused by uneven terrain. If intentionally created, these escape routes should direct wildlife to the next available habitat surrounding any given work site. Once clearing operations have been completed, any wildlife escape routes should be closed off to reduce the risk of wildlife returning to the site.

Site Management

All personnel involved with IVM treatment and other related activities should be briefed about wildlife protection measures at the outset of the project in order to ensure site management measures are understood and properly implemented. The briefing should include an overview of the mitigation measures in place on site, as well as general instructions on the steps to follow if wildlife is encountered during routine daily work. It should also include information on any species at risk that may be present, and instruction on what to do if a species at risk is seen within the project site. It is recommended that a laminated handout summarizing key information on wildlife protection be present on site at all times for reference by personnel. The handout should include information such as general provisions on encounters and handling, species at risk identification and protocol and well as contact information for MNRF, MECP, wildlife rehabilitators and or project biologist(s). Although on-site activities generally discourage wildlife from entering the work area during the day, they may be drawn to the site at night or on weekends, especially if sources of food, water or shelter are present. Therefore, the site should be managed in a way which eliminates the potential for attracting wildlife (e.g. garbage removal, proper site drainage, containment of excess materials and stockpiles of vegetation, etc.).

While all personnel need to be aware of the wildlife protection measures, one or more people should be specifically tasked with 1) ensuring that mitigation measures are properly implemented by regular inspections and 2) monitoring to ensure proper function and integrity (e.g. site containment, habitat compensation, work site cleanliness, etc.). It is recommended that a full-time on-site project biologist be retained in order to properly manage wildlife conflicts as well as mitigation measures on a daily basis. The qualified biologist retained should responsible for the creation of an Environmental Management Plan (EMP), which shall outline the protocol, guidelines and mitigations to follow during vegetation clearing/construction in order to reduce impacts to wildlife as effectively as possible.

5.3.5 IVM Step No. 5: Adaptive Management and Monitoring

Goal

Allow for ongoing improvement to the IVM based on learned experiences and meet new objectives and conditions.

Objectives

- Monitor and evaluate the success of the program.
- Adjust and revise IVM to allow for ongoing improvements based on field observations and learned experiences.

In the final step of IVM, post-treatment monitoring will be undertaken to evaluate the success of implemented treatments. This monitoring and evaluation will work to inform adaptive management needs, providing guidance for future work. This adaptive

management approach allows ongoing improvement to the IVM based on learned experiences. It also allows IVM to be revised as needed to meet new objectives and conditions. The following section details the methodology of the monitoring and management approach that will be followed at this stage. It also outlines a framework for ongoing documenting and reporting.

5.3.5.1 Bi-Annual Monitoring - Post-Treatment

Methodology and Frequency

As outlined in IVM Step No. 1, the bi-annual monitoring program involves a post-treatment monitoring event. The intent is to provide information on the efficacy of management efforts. Post-treatment monitoring should be undertaken when the effects of treatment are anticipated to be evident – which can range between one (1) to six (6) weeks depending on what control method(s) was used. These visual investigations must be carried out by qualified specialists. The method of undertaking post-treatment monitoring may involve field and high-rail vehicle or train surveys or other suitable approaches identified by Metrolinx. For example, where more general information is required to evaluate efficacy of treatments, remote sensing (Landsat 8) may enable treated areas to be monitored roughly twice monthly at a lower cost. Use of remote sensing would require some level of ground-truthing.

Where chemical and/or mechanical treatments have been applied, monitoring shall be undertaken to capture the following:

- Plant species composition, distribution, and density;
- The presence/persistence of the targeted unwanted vegetative species;
- The presence/persistence of dead, dying, imminently hazardous, and potentially hazardous trees (e.g. leaning trees);
- Residual access problems to Metrolinx Lands caused by the presence of unwanted species;
- Residual vegetation encroachments;
- The location of trees or brush compromising site security and creating safety issues for employees (tripping, slipping, or health hazards);
- Percentage of target plants alive/dead following treatment; and
- Any evident environmental impacts from treatment.

Where cultural methods have been used, the following outlines the data that should be captured as part of these evaluations:

- Plant species composition, distribution, and density;
- The presence/persistence of the targeted unwanted vegetative species;
- The presence of compatible species;

- General effectives of the treatment and evidence of the establishment of a more compatible plant community; and
- Presence and abundance of pollinator plants.

Generally, for evaluating treatments, be it cultural, chemical, or mechanical, information/ findings gathered from monitoring will be used to determine:

- The state of the target vegetation;
- Efficacy of treatment;
- Need for additional control;
- The success in meeting IVM objectives; and
- Adverse effects that may be the result of treatment.

The data that are captured as part of post-treatment monitoring will be compared against findings from that year's pre-treatment monitoring event and established thresholds. Evaluating treatment effectiveness consists of undertaking inspections on a regular basis, recording results, and comparing progress year-by-year. The following criteria are relied upon within this IVM as appropriate measures of success:

- An increase in compatible species;
- A decrease in incompatible species;
- A decrease in vegetation issues identified as part of monitoring, incidental observations or as identified by a concerned adjacent property owner; and
- A decrease in service disruptions and/or operational challenges attributed to vegetation.

5.3.5.2 Adaptive Management

Successful IVM plans are consistently implemented over a series of years and annually adjusted as necessary based on field observations. Post-treatment evaluation results will determine what adjustments are needed, if any, to better meet safety needs, program compliance, and IVM objectives for the following year. If it is clear that more effective treatment is needed, this should trigger an investigation into what different control method or application technology can be used in the future. For areas like Zone 1 or ballast areas where control options are limited, changes in herbicide active ingredients and application frequencies (for example, to limit plants from developing herbicide resistance) can and should be considered.

As the program progresses and maintenance becomes less demanding, alternative methods will be explored as part of adaptive management. For example, there may be opportunities to integrate vegetation monitoring into other ongoing monitoring of the ROW (e.g. for track maintenance). Similarly, alternative methods, such as video recording/monitoring from trains or drones, or remote sensing can be explored as options in future years and/or the frequency of monitoring may need to be re-evaluated as Metrolinx Lands is successfully managed and maintenance becomes less demanding.

5.3.5.3 Reporting

Reporting will consist of maintaining an up-to-date GIS database, annual reports as well as a five-year review of the IVM framework.

GIS Database

Maintaining up-to-date information on Metrolinx Lands through the use of a GIS database will enable IVM managers to:

- Forecast work;
- Decide where to focus actions;
- Prioritize work flows;
- Allocate budget;
- Minimize inefficiencies;
- Track interactions with residents;
- Apply data to create long-term work strategies to meet operational goals;
- Ensure proactive work orders are issued; and
- Ensure rapid response to events that may compromise the integrity of the electrical and rail infrastructure.

The GIS database should include at minimum:

- Centreline data consistent with the current status of Metrolinx Lands or with work planned for the upcoming year so that IVM can be adjusted as necessary to plan for new work;
- IVM zones and associated information including management objectives, treatment thresholds, recommended control options and compatible plant species;
- Metrolinx Lands and ROW limits.
- Adjacent property information such as Property Identification Number (PIN);
- Designated Natural Areas and protection requirements;
- Ecological land classification (ELC) information;
- Tree data (location, species, size, tree protection zone, existing or removed etc.);
- Information on implemented IVM treatment within a delineated area (e.g. date of seeding, seed mix used, application method); and
- Information on planned IVM treatment within a delineated area (e.g. schedule for herbicide application, type of herbicide, application method).

Annual Reporting

An annual report following post-treatment evaluation will be finalized by December 31 of that year and will include (at minimum):

- Name and contact information of the person(s) who conducted the pre-treatment monitoring;
- The results of pre-treatment monitoring;
- Plans for treatment implementation;
- Name and contact information of the person(s) who conducted the treatment applications;
- Documentation of all areas treated including:
  - Pre-treatment condition;
  - Location (including size);
  - Treatment option(s) applied (including details e.g. active substance and dosage for chemical treatment);
  - Application method(s); and
  - Date of treatment application.
- Name and contact information of the person(s) who conducted the post-treatment monitoring;
- The results of post-treatment monitoring;
- An evaluation of the efficacy of applied treatments and methods;
- Identification of any and all issues including but not limited to:
  - Adverse impacts of treatment(s); and
  - Complaints.
- A record of consultation issues, landowner agreements, contracts;
- Recommendations for adjustments to the IVM program for the following year;
- Cost estimates for the following year's implementation of IVM;
- Photographs; and
- Field notes.

Five-Year Review

A five-year review of the IVM framework is recommended to ensure up-to-date information on the following components in included:

- Legislation;
- Best management practices; and
- Technological advances.

The five-year review should incorporate any changes based on lessons learned and adaptive management implemented. This will include an assessment of the cost and results over time.

6 REFERENCES

British Columbia Rail Company

BCR Port Subdivision Ltd. Draft #1 Integrated Vegetation Management Plan 2008 – 2013
Available at: https://www.bcrco.com/IVMPLAN2007.pdf

Canadian Pacific Rail

Canadian Pacific Rail 2015 Integrated Vegetation Management Plan

Available at: https://www.cpr.ca/en/community-site/Documents/CP-IVMP-2015-BC.pdf

Government of South Australia

Vegetation Removal Policy Standard Operating Procedure under the Native Vegetation Act 1991

Available at:
https://www.dpti.sa.gov.au/__data/assets/pdf_file/0008/35657/DOCS_AND_FILES-1965602-v36-Environment_-_Technical_Standards_-_Vegetation_-_Vegetation_Removal_Policy.pdf

Rail Electrification – Department Planning, Transport and Infrastructure

Available at:
https://www.dpti.sa.gov.au/__data/assets/pdf_file/0003/98400/Electrification_singlepages_new_Low_Res.pdf

Rail Revitalization – Department Planning, Transport and Infrastructure

Available at: https://www.dpti.sa.gov.au/__data/assets/pdf_file/0019/112717/rr-vegetation_management_fact_sheet.pdfhttps://www.dpti.sa.gov.au/__data/assets/pdf_file/0003/98400/Electrification_singlepages_new_Low_Res.pdf

Hydro One

Hydro One Vegetation Management Study 2016

Available at: http://publicsde.regie-energie.qc.ca/projets/414/DocPrj/R-4011-2017-C-OC-0007-Preuve-Dec-2017_11_13.pdf

Vermont Rail System

Integrated Vegetation Management Plan for Vermont Rail System for Railroad Rights-of-Way in the State of Vermont (April 2006 – December 2011)

Available at: https://outside.vermont.gov/agency/agriculture/vpac/Other%20VPAC%20Documents/Railroad_Alternative_Vegetation_Management/Integrated_Vegetation_Management_Plan___FINAL1%20041806.pdf)

Other

Ministry of the Solicitor General, 2019. Consider Fire Safety when Storing Wood Chips

Available at: https://www.mcscs.jus.gov.on.ca/english/FireMarshal/FireServiceResources/messenger/OFM_Mr_2014-01_A4.html

Network Rail, 2018. Lineside vegetation manual. Available at: https://cdn.networkrail.co.uk/wp-content/uploads/2018/05/Lineside-Vegetation-Management-Documentation.pdf

Nowak, Christopher A. and Ballard, B.D. 2005. A framework for applying integrated vegetation management on rights-of-way. International Society of Arboriculture. Available at: http://www.rowstewardship.org/resource_pdfs/ivm_framework.pdf

Hahn, Jerold T. 1984. Tree volume and biomass equations for the Lake States. Research Paper NC-250. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station. Available at: https://www.fs.usda.gov/treesearch/pubs/10037

APPENDIX A

Arborist Data Collection Recommendations

Arborist Data Collection Recommendations

Field Surveys

Data will be collected by field crews using a submeter GPS unit and digital forms to enable data to be recorded consistently and uploaded in digital GIS format.

Inventories will include (at minimum) all trees 10 cm diameter at breast height (DBH) or greater, whose canopies or Tree Protection Zones (TPZ) extend into the study area (except for finer branches, less than 1 cm diameter). In determining which trees to include in an inventory, consideration must also be given to applicable by-law requirements and the nature of the proposed work. Diameter at breast height is measured 1.4 m from the ground according to International Society of Arboriculture (ISA) standards.

Characteristics documented during the inventory will include:

- Species;
- Diameter at breast height;
- Height;
- Crown extension into corridor;
- Overall health/condition;
- Evidence of pests or disease;
- Physical defects, including lean and direction of lean;
- Tree canopy growing within/immediately adjacent overhead wires, power lines, or light fixtures, or were growing within a fence or other structure; and,
- Straight, branchless trunk without defects with the potential to be a higher value tree.

A full list of characteristics and defects that will be documented and codes used for the tree data are provided below. The basic assessment techniques will include visual examination of above ground parts of each tree. Trees are not be probed, cored, or dissected. Excavation for detailed root crown inspection will not be conducted as part of tree inventory work.

In cases where the ability of the field crews to perform a full visual assessment is limited (i.e. when trees were not as accessible visually or physically because they are located on top of retaining walls, behind existing noise walls, or behind fences etc.), the visible parts of the tree will be used to estimate the assessment characteristics. Where direct access to a tree is not possible (e.g. for safety reasons, or due to being located outside of the Metrolinx ROW), the tree location will be determined either: through the use of a laser rangefinder in the field; or, as a desktop exercise with the use of high resolution aerial imagery.

Species and Condition

Based on the assessment characteristics, each tree will be given a condition rating of Excellent, Good, Fair, Poor, or Dead, as defined below:

1	Excellent:	No apparent health problems; good structural form
2	Good:	Minor problems with health and/or structural form
3	Fair:	More serious problems with health and/or structural form
4	Poor:	Major problems with health and structural form
≥5	Dead:	Currently dead; includes trees that have epicormic growths from the base (except for Butternut, where they will be assigned a condition rating of 4 where there is epicormic growth)

Any dead trees will be further classified into four (4) categories to indicate the level of decay, which will assist removal contractors in identifying them:

5	Very Recently Dead:	No canopy, bark intact, branches intact; includes trees that have minor epicormic growth from the base (except for Butternuts, as noted above)
6	Recently Dead:	Recently dead, bark peeling, only large branches intact
7	Older Dead Tree:	90% of bark lost, few branch stubs, broken top
8	Very Old Dead Tree:	Advanced decay, no branches, parts of the stem have rotted away

The tree height will be recorded using the following height categories:

A: 1-2 m
B: 3-5 m
C: 6-8 m
D: 9-12 m
E: 13-16 m
F: >16 m

DBH

The DBH will be recorded to the nearest centimeter. On multi-stemmed trees, the number of stems ≥10 cm DBH will be recorded. To determine the calculated DBH (DBH CALC) for multi-stemmed trees, the following calculation will be used:

DBH CALC = SQRT(dbh^2/number of stems)*number of stems

e.g. a multi-stemmed tree with 3 stems and the DBH of the largest stem was 15 cm: DBH CALC = SQRT($(15cm)^2$/3)*3 = 25.98 cm

Where the DBH CALC on multi-stemmed trees exceeded 100 cm and where the number of stems exceeded three (3), the calculated DBH will be adjusted to account for a potential

overestimate of the calculated DBH. To determine the calculated DBH (DBH CALC) for multi-stemmed trees where the original calculation returned a value over 100 cm DBH or where there was more than 3 stems, the following calculation will be used:

> DBH CALC = SQRT(dbh^2/number of stems)*(number of stems – (number of stems*0.2)).

This accounts for the fact that as DBH and age increase, or as trees have more than a few stems, trees invest less energy into expanding the radial distance of their roots. Roots radial distance from the tree generally follows a logarithmic curve with number of stems, age, and increased size.

Tree Canopy and Tree Protection Zones

Tree canopy will be documented to the nearest meter to allow for the determination of where pruning of the canopy may be required.

Tree Protection Zone (TPZ) will be based on the City of Toronto's *Tree Protection Policy and Specifications for Construction Near Trees* (**Table 1**). In addition to trees with canopy extensions into the study area, trees with TPZs that extends into the study area will be inventoried. The TPZ is a zone within which impacts due to soil compaction, equipment operation, excavation and filling are to be avoided as the loss, disturbance, or damage to any roots in this zone will adversely affect the tree's long-term health and structural stability. As root damage in this zone may not directly kill the tree, but secondary stresses usually kills the tree, sometimes months or years later, protection of this area to compaction during tree removals is vital.

Table 13: Recommended Minimum Protection Distances[2]

Trunk Diameter (DBH) (1)	Minimum Protection Distances Required (Tree Protection Zones) for Trees
< 10 cm	1.2 m
10 – 30 cm	1.8 m
31 – 40 cm	2.4 m
41 – 50 cm	3.0 m
51 – 60 cm	3.6 m
61 – 70 cm	4.2 m
71 – 80 cm	4.8 m

[2] Tree Protection Zones vary by municipality. For example, the Town of Richmond Hill's Minimum Protection Distances are greater by 0.6 m for trees less than 40 cm. The Town of Newmarket states that Tree Protection Barrier must be at least 2 m around the circumference of the trunk, or to the tree dripline (whichever is greater). The Region of York's specifications states that tree protection fencing should be installed at the dripline (edge of crown) or edge of the construction zone, whichever is furthest from the tree. The recommendations provided in the Table 13 are standard arborist guidelines.

Trunk Diameter (DBH) (1)	Minimum Protection Distances Required (Tree Protection Zones) for Trees
81 – 90 cm	5.4 m
91 – 100 cm	6.0 m
> 100 cm	6 cm Protection for Each 1 cm Diameter

Lean and Tree Health

The lean of trees will be recorded to allow for the recognition of trees that might be rooted in one location, but the trunk and canopy were leaning into or out of the study area, thus potentially requiring pruning or removal. Leaning trees are often also at a higher risk of failing (falling over), and removals of leaning trees may require extra caution. Additionally, trees that are growing into overhead wires, power lines, or light fixtures, or are growing within a fence or other structure will be documented, as their removal or pruning will be more complicated and may require additional safety measures.

Where defects are apparent, they will be documented and used to determine the condition rating of each tree, as defects on otherwise healthy trees may make them prone to future issues. The term “defects” is used to include damage and structural issues, both of which may result from natural events, natural growth patterns, or human activities.

Naturally caused defects, such as co-dominant stems with included bark where bark is growing in the crack between two or more branches, tend to prohibit the growth of fibrous tissue which connects and strengthens the branch union. Fungal growths within defects typically indicate advanced wood decay, which is often a serious defect. All of these conditions may be exacerbated by a lean in the tree or by an unbalanced crown.

Defects can also be caused by human activities and include torn bark or large pruning wounds. These defects can increase susceptibility to decay and dieback which is characterized by death of the young shoots and can spread to the larger branches. The decay and dieback may in turn cause structural weakness, loss of limbs, or even death. Other human caused defects can include trees that have been topped (when the main leader is cut off in an attempt to reduce the height or is broken off), over-pruned (when more than 1/3 of the tree’s crown is removed), or branches that have been torn off flush to the trunk or left with a long stub. Each of these defects may also lead to future decay, structural weakness, or death.

A tree’s response to defects typically take many months to years to become apparent. Over time, vigorous healthy trees will compartmentalize wounds and grow compensation wood, which can partly or mostly offset damages. Thus, trees will be inspected for signs of callus tissue (a sign that the tree is able to compartmentalize wounds) and assessed accordingly. Some defects are critical and some species are more susceptible to certain types of defects than others. If possible, trees should be monitored for their response to defects, to ensure that timely corrective action is undertaken where possible.

Boundary Trees and Tree Ownership

A boundary tree is defined as a tree whose trunk is growing across one or more property lines. Based on the *Forestry Act, RSO 1990, c. F.*26, tree ownership is determined by where it is rooted, and by the location of the trunk below the first branches. If the tree parts above the ground up to the first branches overlaps more than one property, it is jointly owned by both property owners, and may not be removed without permission from both owners.

The ownership of each tree within the study area will documented within the GIS platform using Teranet information. The Arborist Report will include mapping of each tree inventoried, documenting the property owner (e.g. private, municipal, provincial, or federal, including PIN). Where ownership cannot be determined as part of the tree inventory, a surveyor licensed in the province of Ontario will determine the ownership (following Metrolinx approval), or the potential owners will be consulted by Metrolinx to verify ownership.

Hazard Trees and Risk

A hazard tree can generally be defined as a tree with structural defects likely to cause the failure of all or part of the tree. Risk is related to the chance that the tree could potentially strike a target if left untreated.

To determine hazard trees and risk, trees will assessed on the likelihood of failure during normal weather conditions during the first 12 months following the date of assessment. If more than one serious defect is noted on the tree's main stem, the tree may be assessed to pose a very high risk of failure.

The falling distance of the tree will be estimated to be one (1) times the height of the tree category's highest dimension (e.g. for height category D, the striking distance will be estimated as 12 x 1 = 12 m). Note that a tree may shatter when striking, thus debris from a fallen tree may spread up to 1.5 x the height of the tree (e.g. for height category D, the striking distance is estimated as 12 x 1.5 = 18 m).

The terms that are used are defined below:

Improbable	The tree or branch is not likely to fail during normal weather conditions and may not fail in many sever weather conditions within a specified time frame. For simplicity, this includes trees with a condition rating of 1 or 2.
Possible	Failure could occur, but it is unlikely during normal weather conditions within a specified time frame. This includes trees with a condition rating of 3.
Probable	Failure may be expected under normal weather conditions within a specified time frame. This includes trees with a condition rating of 4.
Imminent	Failure has started or is most likely to occur in the near future, even if there is no significant wind or increased load. This includes trees with a condition rating of 4 or ≥5.

Trees requiring immediate attention on an urgent basis will be given a rating of HIGH Risk due to the following characteristics:

Have serious defects (are in poor condition with lean towards the corridor, or dead condition) and likelihood of failure is imminent or probable; and,

The rail line or electrification infrastructure is within the potential fall zone.

Trees requiring attention on a short-term basis, within the next 12 months, will be given a rating of MODERATE Risk due to the following characteristics:

Have serious defects (any of the following: are in poor condition, or dead, or have a lean towards the corridor) and likelihood of failure is possible; and,

The rail line or electrification infrastructure is within to the fall zone.

Trees requiring future monitoring following 12 months or due to abnormal weather conditions will be given a rating of LOW Risk and include trees with the following characteristics:

Have moderate defects (fair condition) and likelihood of failure is improbable; and,

The rail line or electrification infrastructure is within the fall zone.

The potential hazard assessment ratings provided above are based on normal conditions and not on unusual or extreme conditions.

Tree Characteristics Codes and Descriptions

1. Symptoms & Location (location on tree only if not obvious, like dieback always being in crown (e.g. Re-F, D2, S1-T…)
    - Br: Leaf Browning
    - Ca: Cavity/Cavities - indicate height of highest cavity in metres from ground after tree location as additional descriptor – e.g. Ca-T-10; to be included as applicable on trees with condition ratings 2 through 8
    - Ch: Chlorosis
    - D1: Dieback 5-15%
    - D2: Dieback 16-30%
    - D3: Dieback 31-60%
    - D4: Dieback > 60%
    - Ep: Epicormic Growth
    - Ga: Galls
    - Bu: Burls
    - Po: Powdery Mildew
    - Re: Bark Removed
    - S1: Scar over 5-15% main limb
    - S2: Scar over 16-30% main limb

- S3: Scar over >30% main limb
- Sp: Spotted Leaves
- Ta: Tar Spot
- Ye: Yellow Leaves
- Optional location criteria for symptoms:
  - F: Root Flare
  - R: Roots
  - T: Trunk
  - C: Crown

2. Cause (if obvious)
   - DED: Dutch Elm Disease
   - EQI: Equipment
   - EAB: Emerald Ash Borer
   - FUN: Fungal Damage
   - GIR: Girdling
   - INS: Insect Damage
   - MOT: Motor Vehicle Accident
   - NAT: Natural, Other
   - ROD: Rodent
   - STO: Storm
   - PRU: Pruning
   - VIN: Vines
3. Structural Issues (may include more than one)
   - FRO: Frost Cracks
   - INC: Included Bark
   - LIO: Lion's Tail
   - NOL: No Leader
   - NRG: No Response Growth around scars or cavities
   - BRO: Broken or severely cracked leader or main branches
   - OVE: Overpruned
   - STR: Stress Cracks
   - UNB: Unbalanced Crown
   - BUL: Bulging root plate
4. Lean - L-E,W,N,S: Lean, direction AND into corridor –-> YES/NO
5. Treatments and Special Conditions (may include more than one)
   - W: High Voltage Wires, Power Lines, Light fixtures within crown

- F: Growing within a fence or other structure (e.g. sidewalk, shed, electrical box, fire hydrant, etc.)
- G: Grate
- C: Hard Surface (Asphalt, concrete, etc.)
- M: Overmulched
- P: Planter
- H: Planted High
- L: Planted Low or fill over roots
- S: Structural Support
- T: Staked
- G: Tree Guard/Collar
- Other: blank for adding text

6. Potential Higher Value Tree: have a straight trunk (a minimum of 3 m long) with no large branches (branches greater than 5 cm diameter), no visible defects, and have a minimum DBH of 15 cm
7. Was the location and size estimated - yes or no

GIS Analysis

The data must be submitted in a precisely consistent format for proper integration and analysis in the GIS platform. The codes and numbers above must be used, as well as consistent names for tree species. All data must be submitted with a Global ID, time-stamps from the time of inventory, and company name (or also surveyor names). The data formatting, such as headers and order of data, must be consistent with the standards provided, preferably following existing standards within Metrolinx to avoid reformatting.

The species names presented in the table below were used for previous data-gathering and contain species typically encountered in and adjacent to the Metrolinx corridors. Where additional species are inventoried, names must be consistent between surveyors to ensure analysis can be carried out.

To develop the list of species indicated to be Invasive, invasive trees should include those that are listed as priority invasives (categories 1-3) by the City of Toronto, York Region, the Toronto Region Conservation Authority (TRCA), the Lake Simcoe Region Conservation Authority (LSRCA), Credit Valley Conservation (CVC), Central Lake Ontario Conservation Authority (CLOCA), Conservation Halton (CH), and Ontario's Invading Species Awareness Program (OISAP). Common pests and diseases that may be found within the project area and the tree species that are typically affected should be designated as Pest & Disease Prone. Those that were designated as invasive and pest and disease prone during the 2019 tree surveys are provided in the table below.

Significant trees include those species identified by Toronto and Region Conservation Authority in 2019 as being regionally rare (rank L1, L2, or L3, with L1 being the most rare). These trees include those identified as rare by the Credit Valley Conservation Authority

in 2011. Other local Conservation Authorities do not provide lists of rare species. All types of regionally significant trees and woody shrubs that may grow to have a DBH of 10cm and greater are listed in the table below.

Higher Value Trees include defined as those trees that were identified in the field as having potential characteristics to be higher value (see above under Tree Characteristics Codes and Descriptions), and filtered for species that were provided in the Initial Business Case (White Ash was not included due to the restrictions on movement of ash logs).

Table 14: Species Names (Scientific and Common), Invasive, Pest or Disease Prone, Regional Status, and Higher Value Species

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Abies balsamea	Balsam Fir		L3		
Abies concolor	White Fir				
Abies species	Fir species				
Acanthopanax sieboldianus	Fiveleaf Aralia				
Acer campestre	Hedge Maple				
Acer x *Freemanii*	Freeman Maple	P & D Prone	L3		
Acer ginnala	Amur Maple				
Acer griseum	Paperbark Maple				
Acer negundo	Manitoba Maple	Invasive			
Acer platanoides	Norway Maple	Invasive			
Acer pseudoplatanus	Sycamore Maple	Invasive			
Acer rubrum	Red Maple	P & D Prone			Medium Value
Acer saccharum	Sugar Maple	P & D Prone			High Value
Acer saccharinum	Silver Maple	P & D Prone			
Acer tartaricum	Amur Maple	Invasive			
Aesculus hippocastanum	European Horsechestnut	Invasive			

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Aesculus species	Horsechesnut/Buckeye species				
Ailanthus altissima	Tree-of-Heaven	Invasive			
Alnus glutinosa	Black Alder	Invasive			
Alnus incana ssp. rugosa	Speckled Alder		L3		
Alnus rhombifolia	White Alder				
Amelanchier alnifolia	Saskatoon Berry			Rare	
Amelanchier amabilis	Large-flowered Serviceberry		L3		
Amelanchier species	Serviceberry				
Amelancheir spicata	Running Serviceberry		L2		
Amelancheir stolonifera	Running Serviceberry			Rare	
Aralia spinosa	Devil's Walking Stick				
Betula alleghaniensis	Yellow Birch				Medium Value
Betula nigra	River Birch				
Betula papyrifera	White Birch				Medium Value
Betula pendula	European Birch	Invasive			
Betula populifolia	Gray Birch				
Betula species	Birch				
Caragana arborescens	Siberian Peashrub				
Carpinus carolinana	Blue Beech, Musclewood				

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Carya cordiformis	Bitternut Hickory				Low Value
Carya glabra	Pignut Hickory				Low Value
Carya ovata	Shagbark Hickory		L3		Low Value
Catalpa speciosa	Northern Catalpa				
Celtis occidentalis	Hackberry				
Cercidiphyllum japonicum	Katsura tree				
Cercis canadensis	Eastern Redbud				
Chamaecyparis nootkatensis	Nootka Cypress				
Cladrastis kentukea	Yellowwood				
Cornus alternifolia	Alternate-leaved Dogwood				
Cornus species	Dogwood species				
Corylus colurna	Turkish Hazelnut				
Crataegus monogyna	Common Hawthorn	Invasive			
Crataegus species	Hawthorn				
Elaeagnus angustifolia	Russian Olive	Invasive			
Elaeagnus umbellata	Autumn Olive	Invasive			
Euonymus atropurpureus	Burning Bush		L2		

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Euonymus europaeus	European Spindle-tree	Invasive			
Fagus grandifolia	American Beech	P & D Prone			Low Value
Fagus sylvatica	European Beech				Low Value
Fraxinus americana	White Ash	P & D Prone			
Fraxinus excelsior	European Ash				
Fraxinus nigra	Black Ash	P & D Prone			
Fraxinus pennsylvanica	Green Ash	P & D Prone			
Fraxinus species	Ash	P & D Prone			
Ginkgo biloba	Ginkgo/Maidenhair Tree				
Gleditsia triacanthos	Honey Locust				
Gymnocladus dioicus	Kentucky Coffee Tree				
Juglans cinerea	Butternut		L3		Low Value
Juglans nigra	Black Walnut				High Value
Juglans x bixbyi	Heartnut/Hybrid Butternut				
Juniperus species	Juniper				
Juniperus virginiana	Eastern Red-cedar				
Larix decidua	European Larch				
Larix laricina	Tamarack		L3		
Larix species	Larch				

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Liriodendron tulipifera	Tulip Tree				High Value
Lonicera species	Bush Honeysuckle	Invasive			
Magnolia species	Magnolia species				
Malus pumila	Common Apple				
Malus species	Crabapple				
Metasequoia glytostroboides	Dawn Redwood				
Morus alba	White Mulberry	Invasive			
Morus species	Mulberry				
Morus rubra	Red Mulberry				
Ostrya virginana	Ironwood				Low Value
Phellodendron amurense	Amur Corktree				
Picea abies	Norway Spruce				
Picea glauca	White Spruce		L3		Medium Value
Picea mariana	Black Spruce		L2	Rare	
Picea omorika	Serbian Spruce				
Picea pungens	Colorado Blue Spruce				
Picea species	Spruce				
Pinus banksiana	Jack Pine				
Pinus mugo	Mugo Pine				
Pinus nigra	Austrian Pine				
Pinus resinosa	Red Pine		L2	Rare	Medium Value
Pinus rigida	Pitch Pine				

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Pinus strobus	Eastern White Pine				Medium Value
Pinus sylvestris	Scots Pine	Invasive			
Pinus species	Pine				
Platanus x *acerifolia*	London Plane				
Platanus occidentalis	Sycamore		L1	Rare	
Populus alba	European White Poplar	Invasive			Low Value
Populus balsamifera	Balsam Poplar				Low Value
Populus x *candensis*	Canadian Poplar				Low Value
Populus deltoides	Eastern Cottonwood				Low Value
Populus grandidentata	Big-tooth Aspen				Low Value
Populus nigra	Lombardy Poplar				Low Value
Populus tremula	European Aspen				Low Value
Populus tremuloides	Trembling Aspen				Low Value
Populus species	Poplar				Low Value
Prunus avium	Sweet Cherry				
Prunus domesticus	Plum				
Prunus species	Cherry				
Prunus malaheb	Perfumed Cherry				
Prunus padus	Bird Cherry				

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Prunus serotina	Black Cherry				High Value
Prunus virginiana	Chokecherry				
Pseudotsuga menziesii	Douglas Fir				
Pyrus species	Pear				
Quercus alba	White Oak	P & D Prone	L2		High Value
Quercus macrocarpa	Bur Oak	P & D Prone			
Quercus species	Oak				
Quercus muehlenbergii	Chinquapin Oak	P & D Prone			
Quercus robur	European White Oak	P & D Prone			
Quercus rubra	Red Oak	P & D Prone			High Value
Quercus velutina	Black Oak	P & D Prone	L2	Rare	
Rhamnus cathartica	Common Buckthorn	Invasive			
Rhamnus frangula	Glossy Buckthorn	Invasive			
Rhus typhina	Staghorn Sumac				
Robinia pseudoacacia	Black Locust	Invasive			
Salix alba	White Willow (weeping)	Invasive			
Salix caprea	Goat Willow				
Salix fragilis	Crack Willow	Invasive			
Salix species	Willow species				
Salix nigra	Black Willow				
Salix x rubens	Basket Willow	Invasive			

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Sambucus racemosa	European Red Elder				
Sassafras albidum	Sassafras		L4	Rare	
Sorbus americana	American Mountain Ash			Rare	
Sorbus aucuparia	European Mountain Ash				
Sorbus decora	Showy Mountain Ash				
Syringa reticulata	Silk Lilac				
Syringa vulgaris	Common Lilac				
Syringa species	Lilac species				
Taxodium distichum	Bald Cypress				
Taxus species	Taxus species				
Thuja occidentalis	Eastern White Cedar				Low Value
Tilia americana	Basswood				High Value
Tilia cordata	Littleleaf Linden				
Tsuga canadensis	Eastern Hemlock	P & D Prone			Low Value
Ulmus americana	White Elm	P & D Prone			
Ulmus glabra	Scotch Elm				Low Value
Ulmus pumila	Siberian Elm	Invasive			Low Value
Ulmus rubra	Slippery Elm	P & D Prone	L3		Low Value
Ulmus thomasii	Rock Elm	P & D Prone	L3	Rare	Low Value

Scientific Name	Common Name	Invasive, Pest or Disease Prone	TRCA Status	CVC Status	Higher Value Species
Ulmus species	Elm	P & D Prone			Low Value
Unknown species	Unknown species				
Viburnum opulus	Guelder-rose				
Vitis riparia	Wild grape				

For consistency, the following abbreviations were applied based on the applicable bylaw.

Table 15: Tree Bylaw Codes

Bylaw Abbreviation	Municipality	Bylaw Name
YORK-Wood	Region of York	*Forest Conservation Bylaw, Bill No. 70, Bylaw No. 2013-68*
YORK-Stre	Region of York	*Street Tree and Forest Preservation Guidelines (2016)*
SIMC-Wood	County of Simcoe	*The Forest Conservation Bylaw #5635*
DURH-Wood	Region of Durham	*The Regional Tree By-law*
N/A	Region of Peel	None
HALT-Wood	Region of Halton	*Halton Region Tree Bylaw 121-05*
BARR-Priv	City of Barrie	*Tree Preservation Bylaw 2014-1150*
BARR-Muni	City of Barrie	*Public Tree Bylaw 2014-116*
BRAM-Park	City of Brampton	*Park Lands By-law 161-83*
BRAM-Priv	City of Brampton	*Tree Preservation Bylaw 317-2012*
BRAM-Wood	City of Brampton	*Woodlot Conservation Bylaw 316-212*
BURL-Muni	City of Burlington	*Public Tree Bylaw 068-2013*
MISS-Priv	City of Mississauga	*Private Tree Protection Bylaw 0254-2012*
MISS-Muni	City of Mississauga	*Encroachment Bylaw 57-04*
PICK-Envi	City of Pickering	*Tree Protection Bylaw Number 6108/03*
TORO-Priv	City of Toronto	*Private Tree Bylaw (Article III of Chapter 813)*

Bylaw Abbreviation	Municipality	Bylaw Name
TORO-Ravi	City of Toronto	*Ravine and Natural Feature Protection Bylaw (Municipal Code, Chapter 658)*
TORO-Stre	City of Toronto	*City Street Tree Bylaw (Article II of Chapter 813)*
TORO-Park	City of Toronto	*Parks By-Law. Article VII, Chapter 608*
VAUG-Muni	City of Vaughan	*Public Property Tree Protection Bylaw 95-2005*
VAUG-Priv	City of Vaughan	*Private Property Tree Protection Bylaw 185-2007*
AURO-Priv	Town of Aurora	*Private Tree Protection Bylaw Number 5850-16*
MARK-All	Town of Markham	*Tree Preservation Bylaw (2008-96)*
NEWM-Muni	Town of Newmarket	*Public Tree Protection Bylaw 2017-59*
NEWM-Wood	Town of Newmarket	*Woodlot Bylaw 2007-71*
OAKV-Muni	Town of Oakville	*Bylaw 2009-025*
OAKV-Park	Town of Oakville	*Bylaw 2013-013*
OAKV-Priv	Town of Oakville	*Private Tree Protection Bylaw 2017-038*
WHIT-Wood	Town of Whitby	*Tree Protection Bylaw No. 4640-00*
WHST-Muni	Town of Whitchurch-Stouffville	*Bylaw Number 2017-017-RE*

APPENDIX B

Tree Bylaw Compensation Summary

Table 16: Tree Bylaw Compensation Requirements

Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
Halton	Tree Bylaw 121-05 (HALT-Wood)	No compensation required.
Burlington	Public Tree Bylaw 68-2013 (BURL-Muni)	Where its removal is not required due to age, health or other reasons in accordance with sound arboriculture principles, the applicant shall plant Tree(s) with the total combined diameter being equal to or greater than that of the Tree(s) to be removed. Where any Tree located on Public Property is damaged to the degree that it must be replaced, the City Arborist may take whatever actions are required to obtain compensation for the City for the loss of the Tree. Compensation would be determined by city regulators during permit processing. Cash-in-lieu based on replacement costs calculated from diameter and $500 per 5 cm DBH replacement tree value using the Aggregate Caliper Formula. Minimum tree size to be compensated is 2 cm dbh. No compensation for dead or imminently hazardous trees or highly invasive tree species such as Tree of Heaven or Common Buckthorn.
	Private Tree Bylaw 43-2018 (BURL-Priv)	Cash in lieu of replacement value ($700/tree); 30 cm – 50 cm 1: 2 or $1,400; > 50 cm 1:3 or $2,100 **Only applies to Roseland geographical area. Not applicable.**
Oakville	Private Tree Protection Bylaw 2017-038 (OAKV-Priv)	1 tree for every 10 cm DBH of healthy tree removed (over 15 cm). $300 Security Deposit for each tree to be planted (refundable upon completion). The minimum tree replacement size is a 30-mm caliper (3 cm width) deciduous tree, or a 150-cm high coniferous tree in a five-gallon container, balled in burlap, or in a wire basket. ($585 standard cost per 60 mm or 5 cm DBH tree) Cash in lieu costs would be determined by city regulators during permit processing.

Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
	Public Tree Bylaw 2009-025 (OAKV-Muni)	Cash in lieu costs would be determined by city regulators during permit processing ($585 standard cost per 5 cm DBH tree). Compensation is based on the area of canopy cover to be removed for woodlands. One 5 cm DBH (60mm caliper) tree has an individual contribution of 1.2sq m.
	Site Alteration Bylaw 2003-021 (Appendix F Tree Protection Policies) (OAKV-Alte)	Same as Private.
	Parks Bylaw 2013-013 (OAKV-Park)	Private plus additional Cash in lieu costs would be determined by city regulators during permit processing ($585 standard cost per 5 cm DBH tree). Compensation is based on the area of canopy cover to be removed for woodlands. One 5 cm DBH (60mm caliper) tree has an individual contribution of 1.2sq m.
Peel	NA	
Mississauga	Private Tree Protection Bylaw 0254-12 (MISS-Priv)	1:1 ratio for <50 cm DBH 2:1 ratio for >50 cm DBH Cash-in-lieu: $574.50 per tree at 60mm caliper; none for dead or dying trees.
	Encroachment Bylaw 57-04 (MISS-Muni)	Cash in lieu costs would be determined by city regulators during permit processing.
	Parks Bylaw 186-05 (MISS-Park)	Cash in lieu costs would be determined by city regulators during permit processing. Repair and/or compensate for the damage to the satisfaction of the City at the expense of the permit holder; and/or provide any studies or documentation, as deemed appropriate by Parks staff, to determine the extent of the damage before repairing the damage. 3:1 ratio.

Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
Brampton	Tree Preservation Bylaw 317-2012 (BRAM-Priv)	3:1 ratio for >30 cm DBH Cash-in-Lieu: $500 per replacement tree
	Woodlot Conservation Bylaw 316-2012 (BRAM-Wood)	Cash-in-Lieu costs would be determined by city regulators during permit processing
	Park Lands Bylaw 161-83 (BRAM-Park)	Cash-in-Lieu costs would be determined by city regulators during permit processing
York	Forest Conservation Bylaw (BILL NO.70 BYLAW NO.2013-68) (YORK-Wood)	No compensation requirements applicable
	Street Tree and Forest Preservation Guidelines (2016) (YORK-Stre)	Number of replacement trees = DBH/replacement tree size * condition. Replacement tree value is $870.44 for 6 cm DBH tree. Compensation for 10 cm DBH or larger for naturally occurring trees, no minimum for planted trees.
Markham	Tree Preservation Bylaw 2008-96 (MARK-All)	2:1 for 20 cm - 40 cm 3:1 for 40 cm - 60cm 4:1 for 60 cm - 80 cm 5:1 for >80 cm Cash-In-Lieu: $300 for non-construction, $600 for construction
Vaughan	Public and Private Tree Protection Bylaw 052-2018 (VAUG-Priv & VAUG-Muni)	20cm – 30cm 1:1 31cm – 40cm 2:1 41cm – 50cm 3:1 Over 50cm 4:1 Cash-In-Lieu: $550 per tree at ratios above. + $127 for each tree >=20 cm DBH (no fee if tree is Ash and dying or dead from EAB) for Type 2 permit +142 for each tree >=20 cm DBH (no fee if tree is Ash and dying or dead from EAB) for Type 3 permit

Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
Aurora	Private Tree Protection Bylaw 5850-16 (AURO-Priv)	Compensation based on tree size and condition. i.e. a 30cm DBH tree with Good condition rating to be replaced with five 6cm DBH trees (or six 5cm DBH trees) with adjustment for tree condition (1x replacement tree for Good/Excellent, 0.6x Fair, 0.2x poor or almost dead).Cash-in-Lieu based on compensation ratio x installed cost of tree (nursery cost x 2.5) x condition rating x species rating (see ISA chart),
King	Bylaw CL-2014-14 is under development	Not Applicable at this time.
Whitchurch Stouffville	Bylaw Number 2017-017-RE (WHST-Muni)	Any tree from 3 to 20cm DBH is a charge of $1490.00. This will include the purchase and installation of a 40mm tree and also include 3 years of care and maintenance of the tree. Care and maintenance includes, watering, fertilization and an initial 3rd year prune for structure, planting shock or damage through planting. Any tree over 20cm DBH will have to be appraised through the recognized ISA “Trunk Formula Method”. These will be initiated once the application report for intent is received. Report must be done by an ISA Certified Arborist.
East Gwillimbury	No Bylaw	
Newmarket	Woodlot Bylaw 2007-71 (NEWM-Wood)	Cover the costs of any replacement trees, and the maintenance of the replacement trees for up to two years. If the replacement is not physically possible on site, the commissioner may require that replacement trees be planted at another suitable location or require that payment for each replacement tree not replanted on the property. Cash-in-Lieu costs would be determined by city regulators during permit processing.

Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
	Tree Preservation, Protection, Replacement and Enhancement Policy (2005) (NEWM-Priv)	Cash-in-Lieu costs shall be calculated based on the “Guide for Plant Appraisal” 9th (or latest) edition established by the International Society of Arboriculture, or other recognized appraisal guide or method.
	Public Tree Protection Bylaw 2017-59 (NEWM-Muni)	All trees over 20 cm, if not preserved, will require compensation in the form of planting or cash-in-lieu paid to the Town. If trees are going to be transplanted on site the compensation could be reduced, using depreciate aggregate cm method (DAM) to calculate number of trees need for replacement. Tree value for trees on public lands: 200% of the Actual Cost + 15% Admin. Fee + HST Where applicable, cost of Town’s contractor to remove each tree: minimum $750.00 plus HST or Actual Cost + 15% Admin. Cost of Town’s contractor to remove each stump: minimum $250.00 plus HST or Actual Cost + 15% Admin.
Toronto	City Street Tree Bylaw (Article II of Chapter 813) (TORO-Stre)	3:1 ratio for trees of any size No compensation for dead or imminently hazardous trees. Cash-In-Lieu: $583 per replacement tree required
	Private Tree Bylaw (Article III of Chapter 813) (TORO-Priv)	3:1 compensation ratio for trees over 30cm DBH except dead or imminently hazardous trees. Cash-In-Lieu: $583 per replacement tree required.
	Ravine and Natural Feature Protection Bylaw. Chapter 658 (TORO-Ravi)	3:1 ratio for trees over 10 cm DBH. 1:1 ratio for trees under 10 cm or those in poor condition. 1:1 ratio for injuries to trees of any size. 1:5m ratio for hedges removed. No compensation for dead or imminently hazardous trees. Cash-In-Lieu: $583 per replacement tree required

Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
	Parks Bylaw. Article VII, Chapter 608 (TORO-Park)	3:1 ratio for trees of any size. No compensation for dead or imminently hazardous trees. Cash-In-Lieu: $583 per replacement tree required.
Durham	Regional Tree Bylaw No. 31-2012 (DURH-Wood)	Region of Durham Tree Bylaw 31-2012 has no provisions for cash-in-lieu payments.
Uxbridge	No Bylaw	
Pickering	Tree Protection Bylaw No. 6108/03 PICK-Envi	• 15-29 cm DBH at a compensation ratio of 1:1 • 30-49 cm DBH at a compensation ratio of 2:1 • 50-74 cm DBH at a compensation ratio of 3:1 • >75 cm DBH or greater at a compensation ratio of 4:1 Cash-In-Lieu: $500 per required tree to a limit of $7,500 for industrial land/commercial developments or $3,000 per residential dwelling.
Whitby	Tree Protection Bylaw 4640-00 (WHIT-Wood)	Cash-in-Lieu costs would be determined by city regulators during permit processing. The CTLA Method was applied. Applied to trees 5 cm or larger.
Oshawa	Bylaw 78-2008 (OSHA-Muni)	Study area does not overlap with Oshawa municipal lands. **Not applicable**.
Simcoe County	Forest Conservation Bylaw 5635 (SIMC-Wood)	Bylaw is not applicable where a project has received approval from the lower tier municipality.
Bradford West Gwillimbury	No Bylaw	Not Applicable
Innisfil	No Bylaw	Not Applicable
Barrie	Tree Preservation Bylaw 2014-1150 (BARR-Wood)	Each tree must be appraised individually by recording the tree species, size, location and evaluating its current condition. Refer to the City of

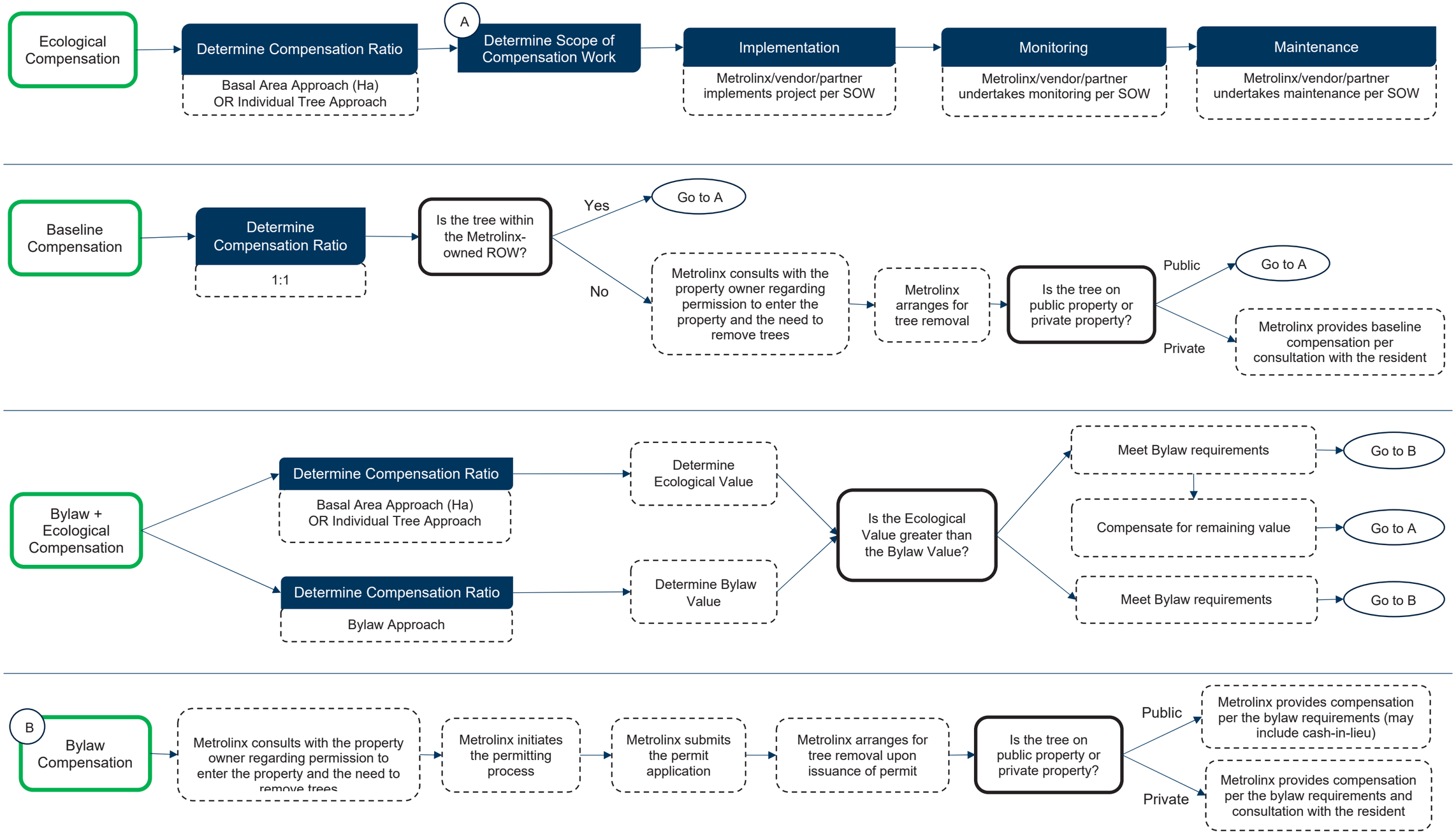
Municipality	Bylaw Name (Abbreviation in Data)	Compensation Requirements
	Public Tree Bylaw 2014-116 (BARR-Muni)	Barrie Tree Protection Manual for details. Section 7.1 **Current Tree Value** = [the Greater of its Current Base Value (1) OR Total value per unit growth (2)] X [Species values index] X [location value Index] X [Health Value Index] X [Current tree Ht for Conifers or DBH (cm) for Deciduous]. (1) Note: Current Base Value is set at $500.00 for deciduous trees and $400 for conifers, based on the cost of planting a standard nursery stock tree (including purchase, delivery, installation, warranty, and administration). Note that indexes are provided in the Tree Protection Manual. (2) Note: Tree Value per Unit Growth = $160.00 per metre Height for coniferous trees and $100.00 per centimeter DBH for deciduous trees. Applicable for trees ≥5 cm DBH if landscape trees, to trees ≥10 cm DBH for all others.

*Note that the bylaws are subject to change and the information presented in this summary should be verified in the municipality's bylaws directly.

APPENDIX C

Compensation Implementation Flowchart

Compensation Implementation Flowchart



APPENDIX D
General Principals of Implementing Ecological and Baseline Compensation

General Principals of Implementing Ecological and Baseline Compensation

Compensation through ecological restoration should involve, amongst others, the following key components:

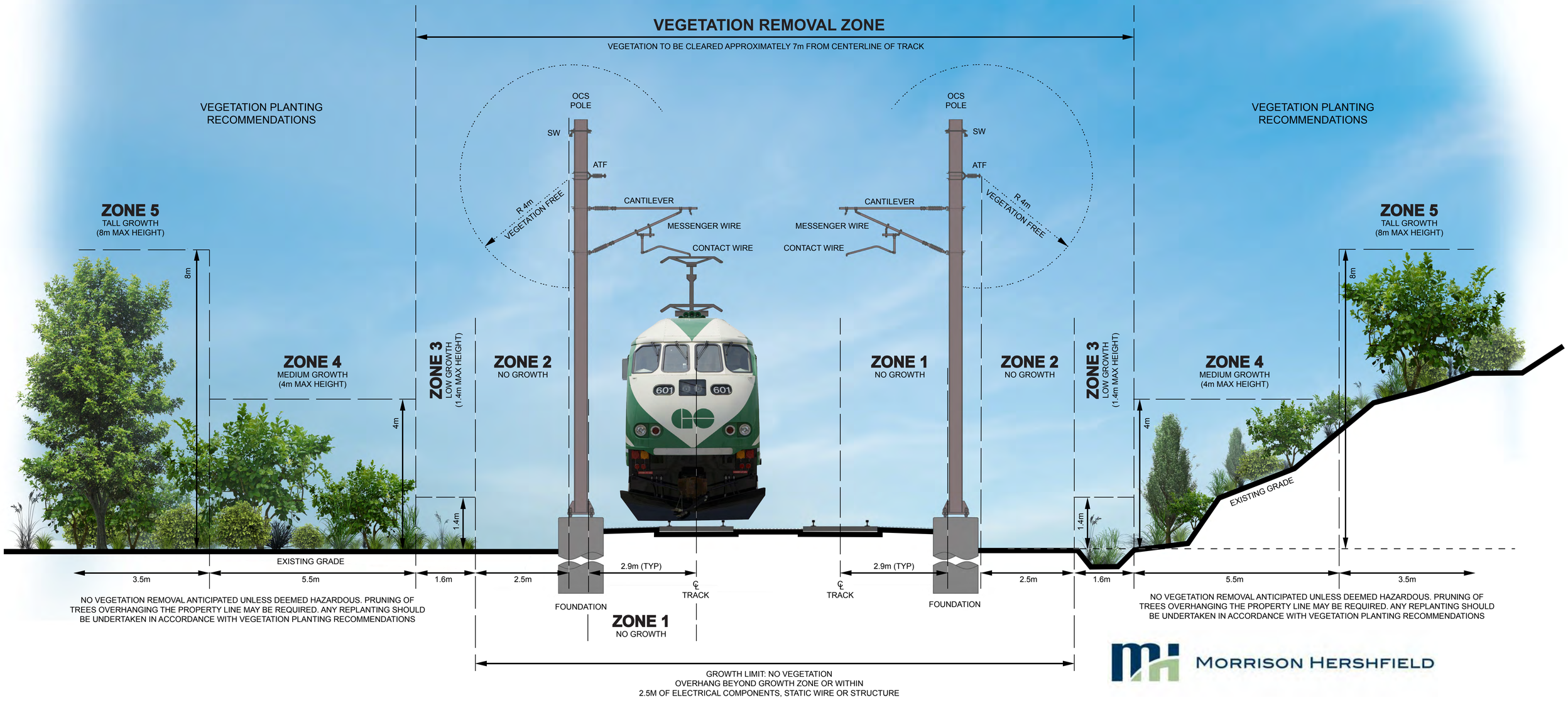
- Tree compensation will be provided through ecological restoration, such as the creation or enhancement of habitat through the planting of trees and shrubs;
- No funds will be diverted towards the acquisition of property;
- Whenever possible, compensation work should occur prior to or immediately following tree removals;
- Plant material will be native species with consideration for regional genetics (southern Ontario seed source or local seed source if applicable);
- A project-specific compensation implementation framework should be developed;
- Local partnerships are encouraged to leverage efficiencies and bolster regional restoration initiatives;

Factors to considered when identifying compensation work include but are not limited to:

- Project-Specific Requirements:
    - Ecosystem type to be restored;
    - Re-use of soil or woody material; and
    - Tree Relocation. Smaller trees with high probability of survival should be identified and moved prior to construction. Root pruning and seasonal requirements for survival to be evaluated as part of arborist report or tree inventory.
- Ecosystem Type:
    - Restoration based on site conditions (e.g. vegetation communities based on Ecological Land Classification (ELC), soil type, drainage, exposure and condition) of the restoration location.
- Considerations for planting location and siting:
    - Proximity to tree removals (preference is for plantings to be in same municipality and sub-watershed or watershed where feasible);
    - Contiguous to the natural system;
    - Land ownership and designation;
    - Land availability;
    - Ecosystem connectivity; and
    - Ecosystem configuration.
- Considerations for monitoring and maintenance:
    - They must be key to achieving goals;
    - They measure the success of compensation projects;
    - They must guide improvement of the overall compensation program over time;
    - A minimum of two years post-planting monitoring is recommended;
    - They must be the responsibility of those undertaking the restoration work; and
    - A minimum of 25% planting replacement cost should be built into project budgets.

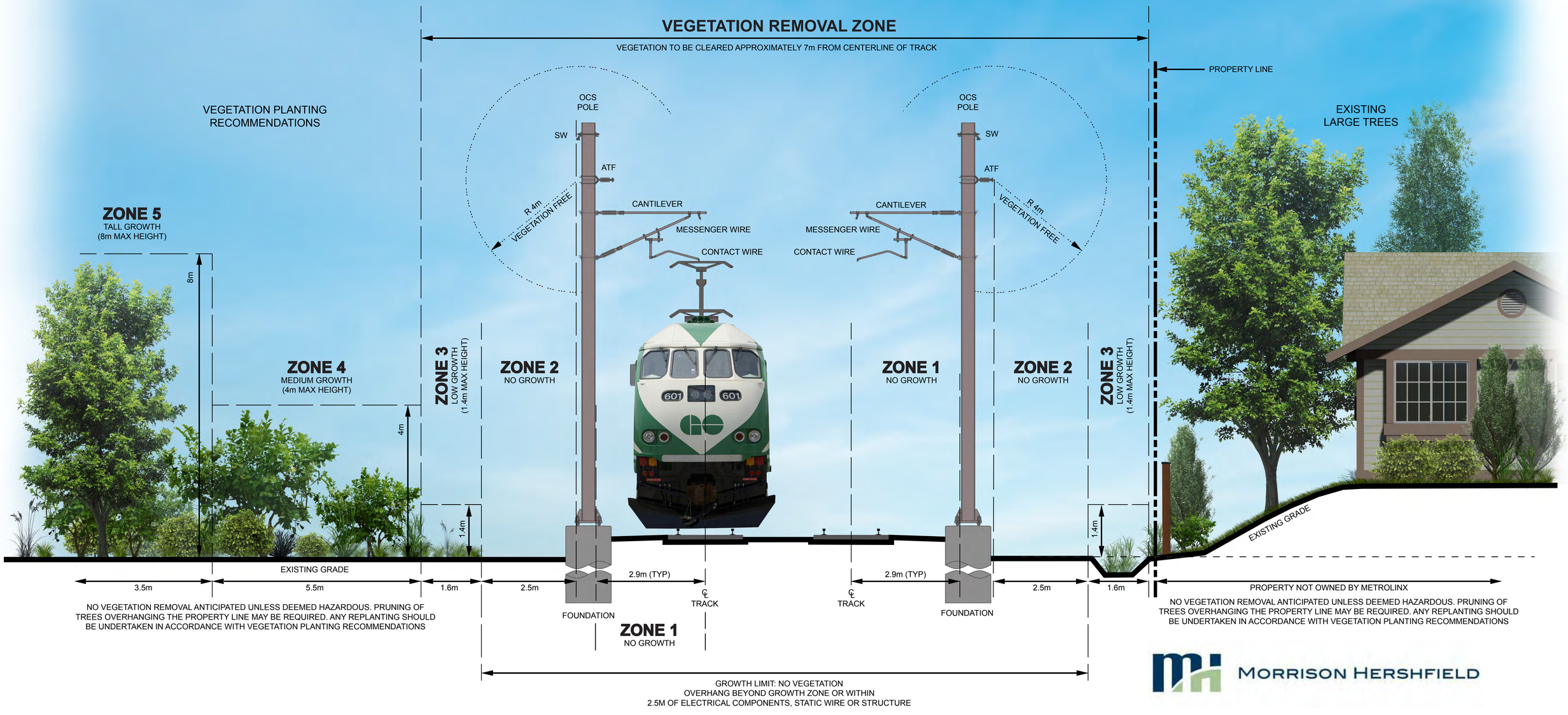
APPENDIX E
Illustrated Examples of IVM Zones

VEGETATION REMOVAL ZONE GUIDELINES FOR ELECTRIFIED CORRIDORS



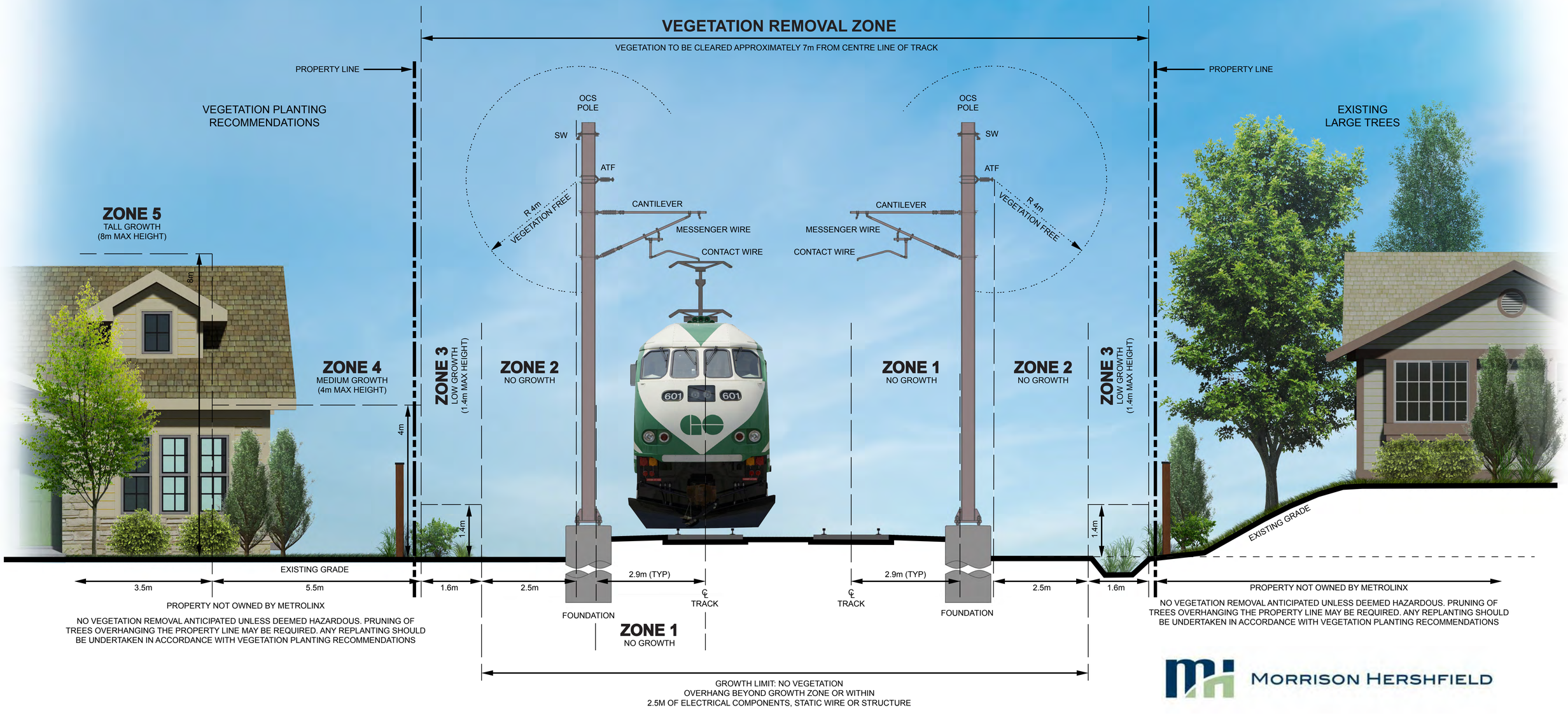
MORRISON HERSHFIELD

VEGETATION REMOVAL ZONE GUIDELINES FOR ELECTRIFIED CORRIDORS

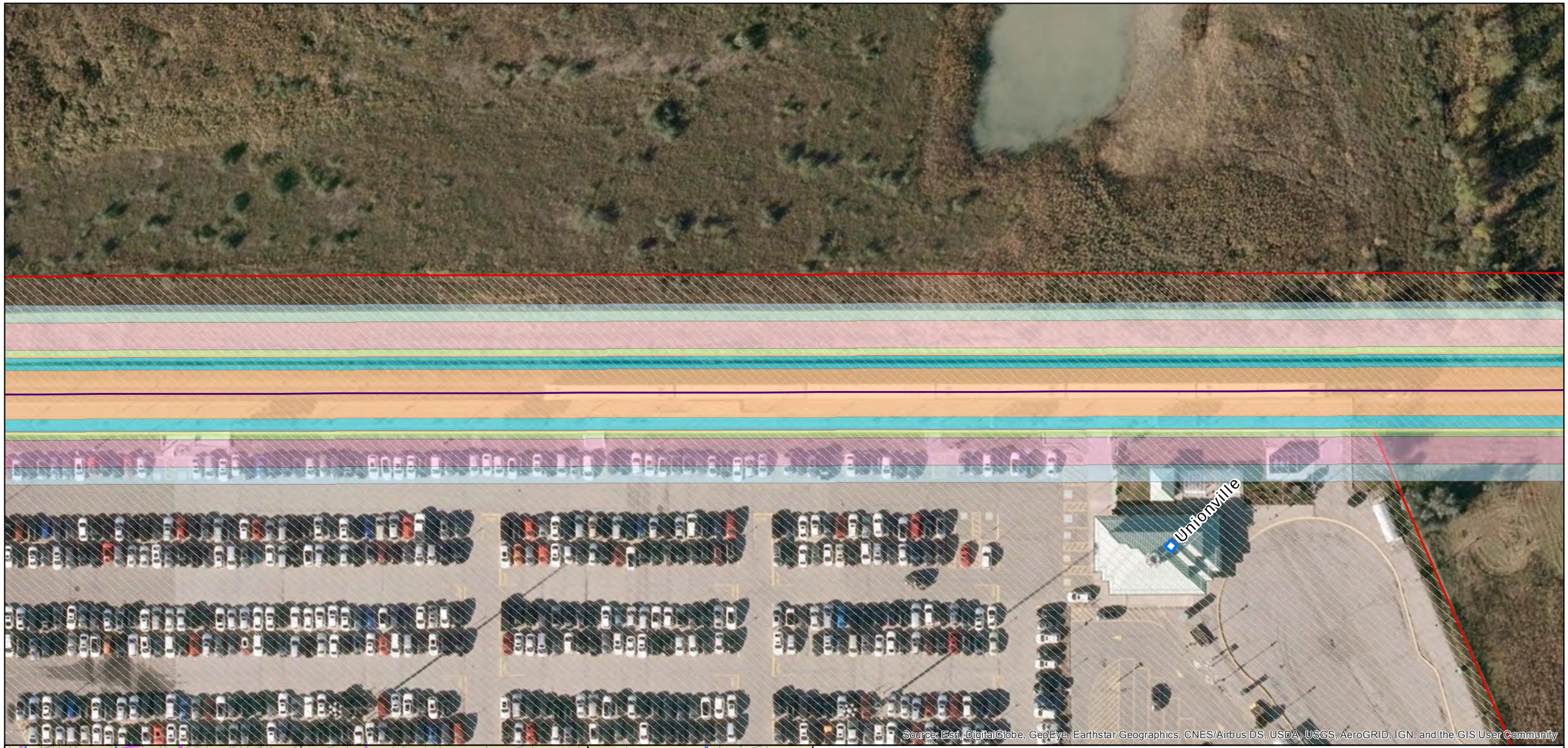


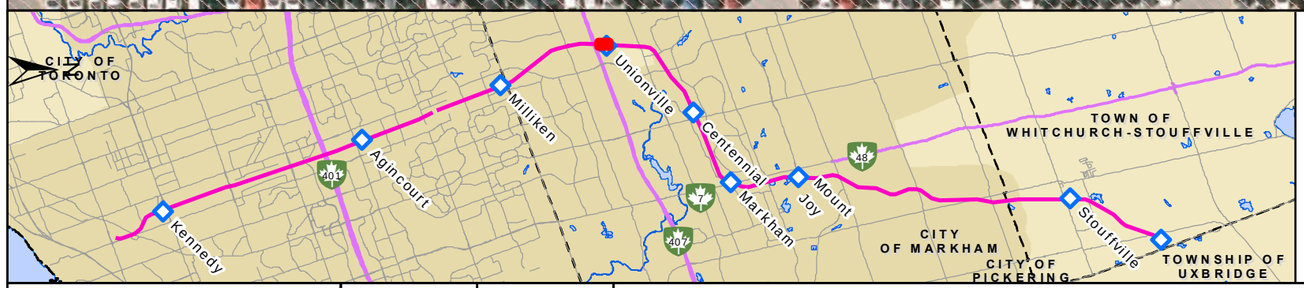
MORRISON HERSHFIELD

VEGETATION REMOVAL ZONE GUIDELINES FOR ELECTRIFIED CORRIDORS



MORRISON HERSHFIELD





Legend

Track Layout	Zone
Future Track Centreline	Zone 1
Track Centreline	Zone 2
Go Station Platforms	Zone 3
Metrolinx Properties	Zone 4
Other Property Owned	Zone 5

METROLINX

MORRISON HERSHFIELD

Drawn By: ES

Checked By: XX

0 5 10 15 20 25
Meters

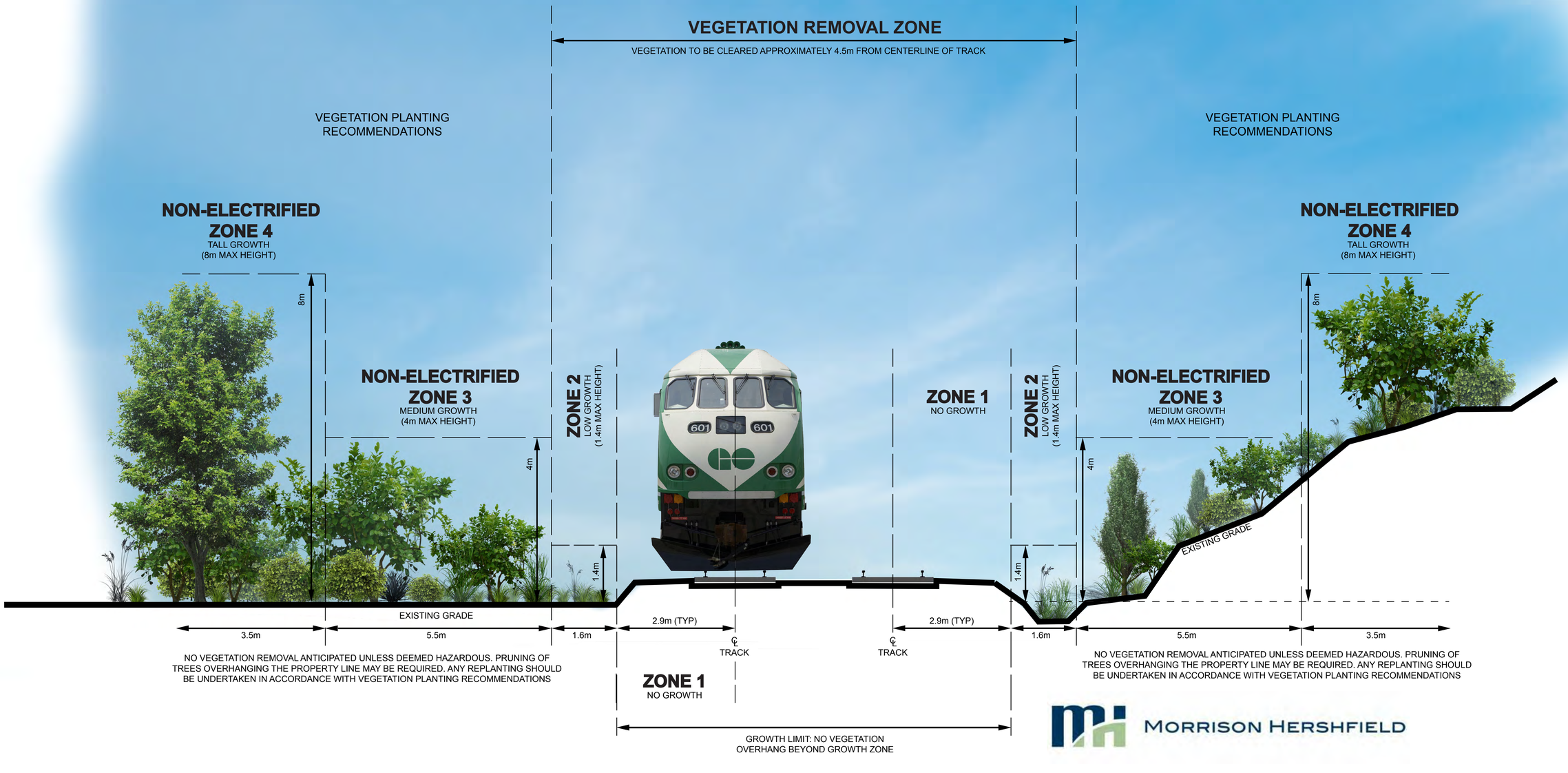
ISSUE

N

Integrated Vegetation Management for Electrified Corridors Program GO Rail Network

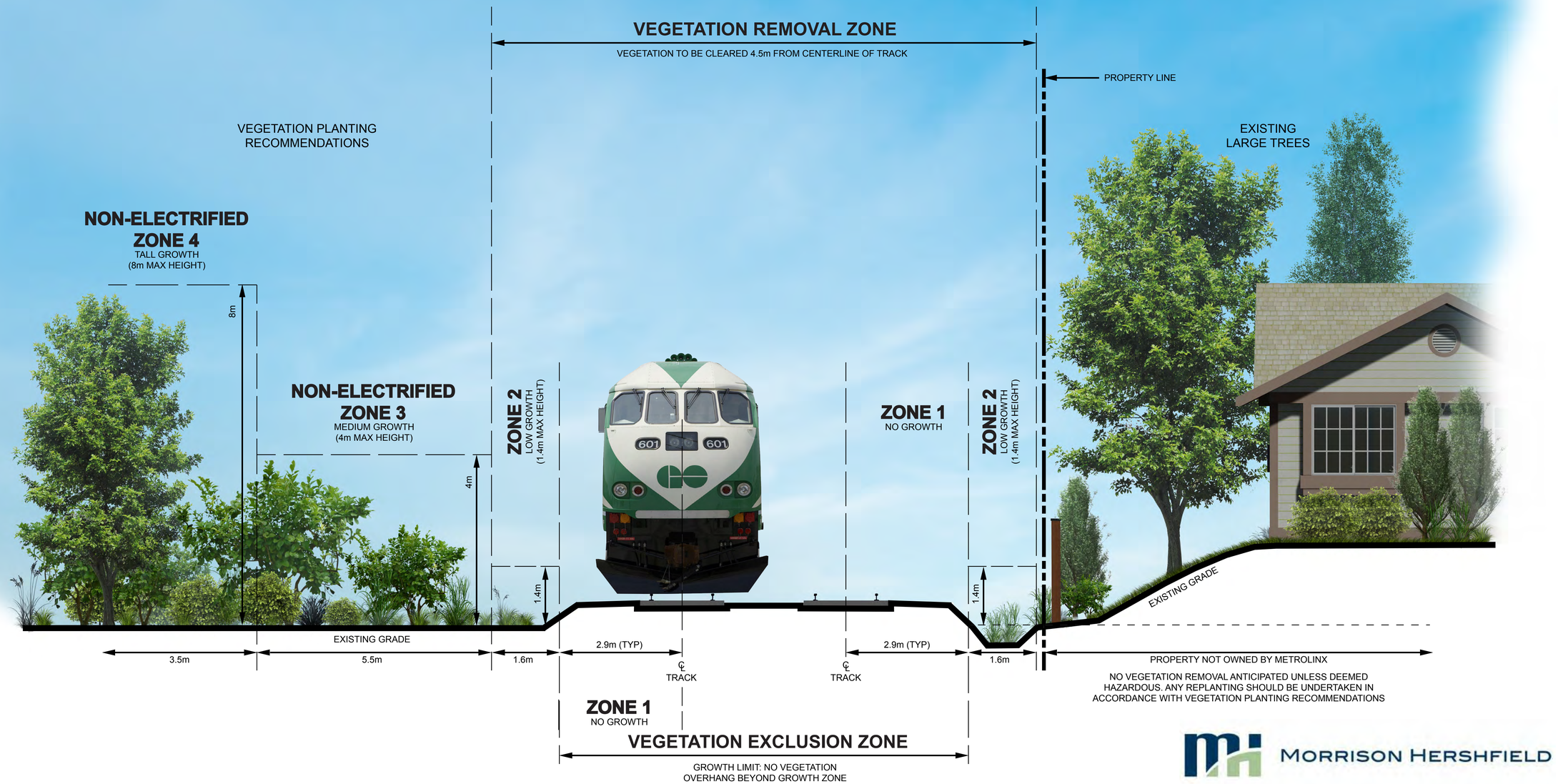
Figure 51

VEGETATION REMOVAL ZONE GUIDELINES FOR NON-ELECTRIFIED CORRIDORS



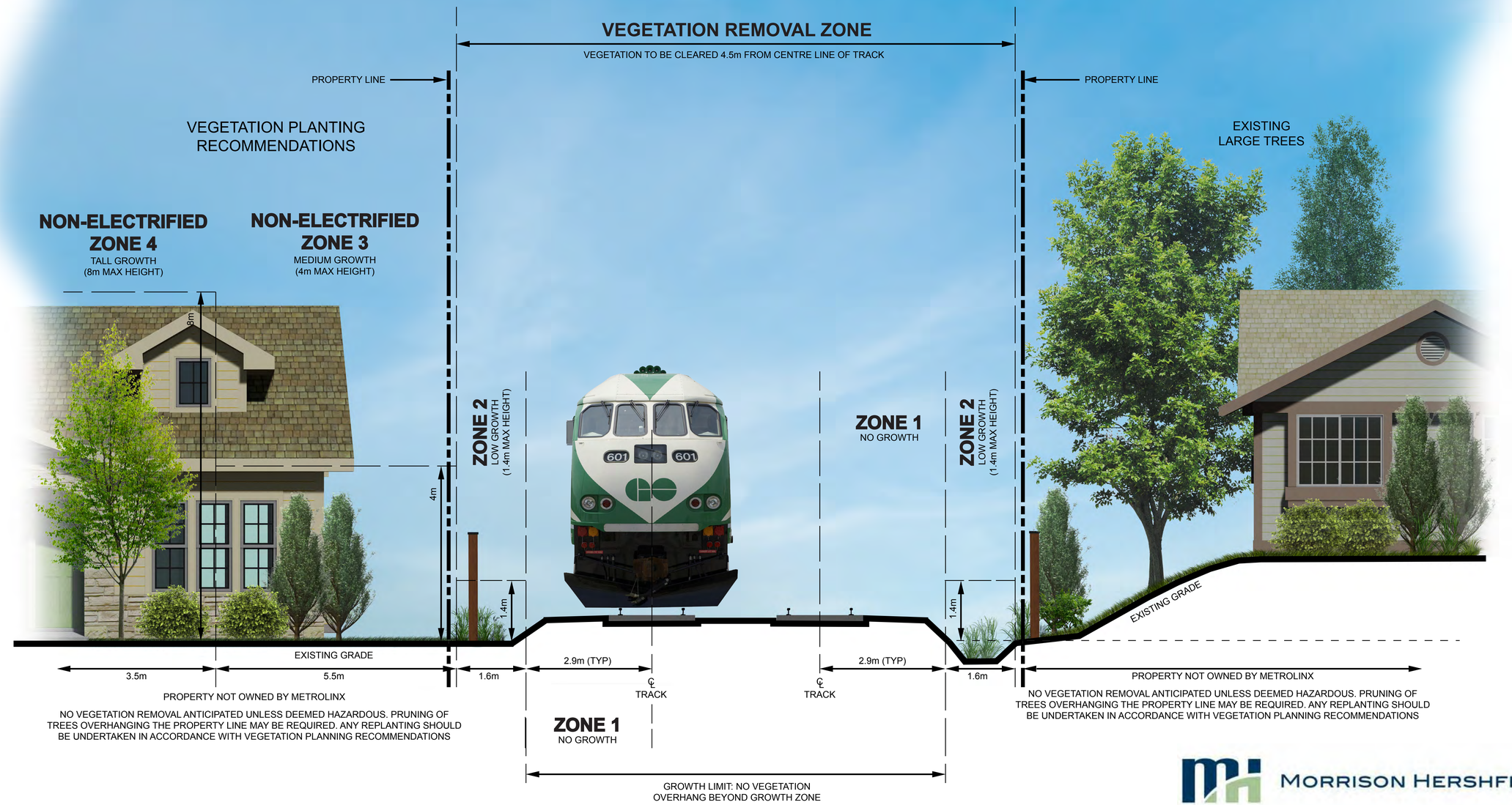
MORRISON HERSHFIELD

VEGETATION REMOVAL ZONE GUIDELINES FOR NON-ELECTRIFIED CORRIDORS

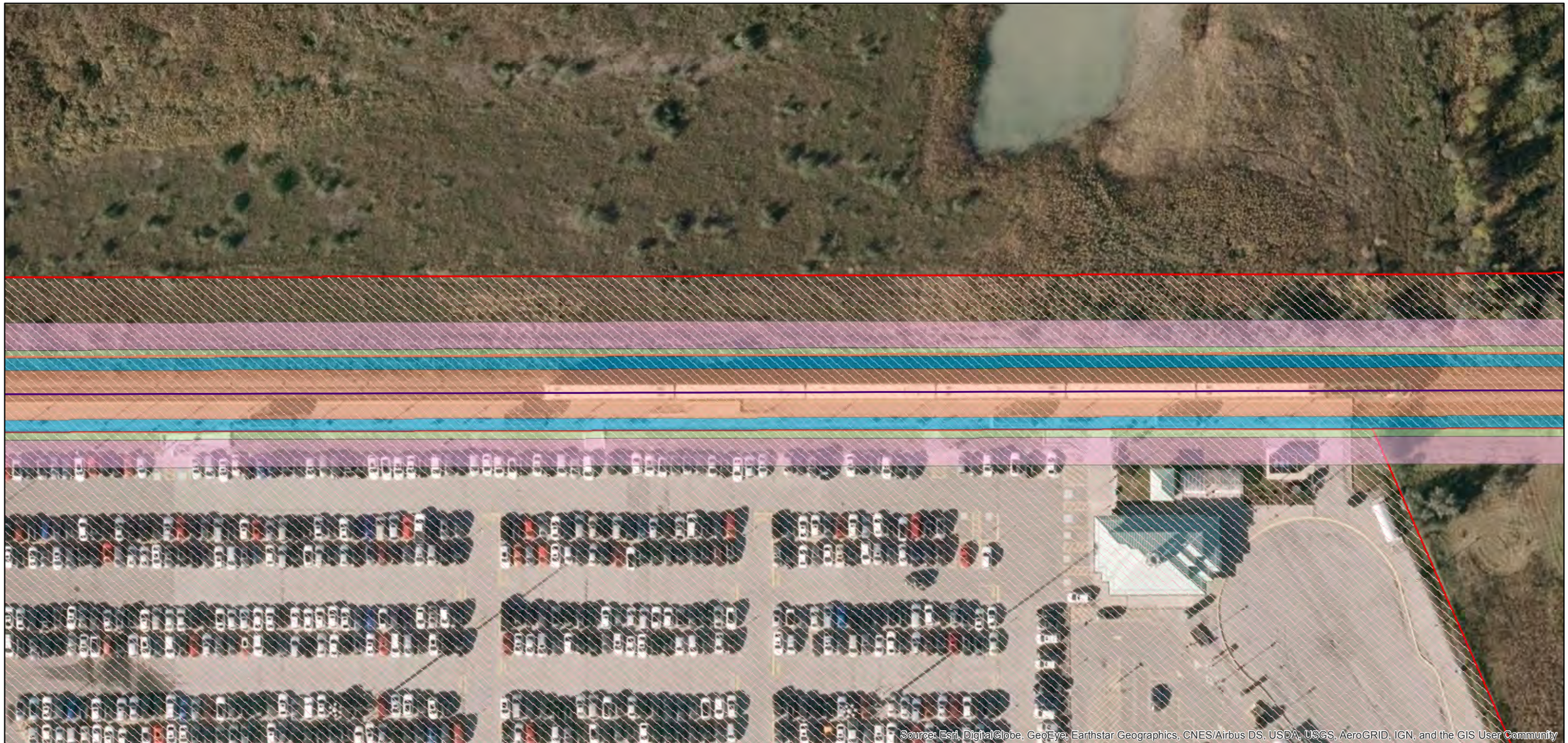


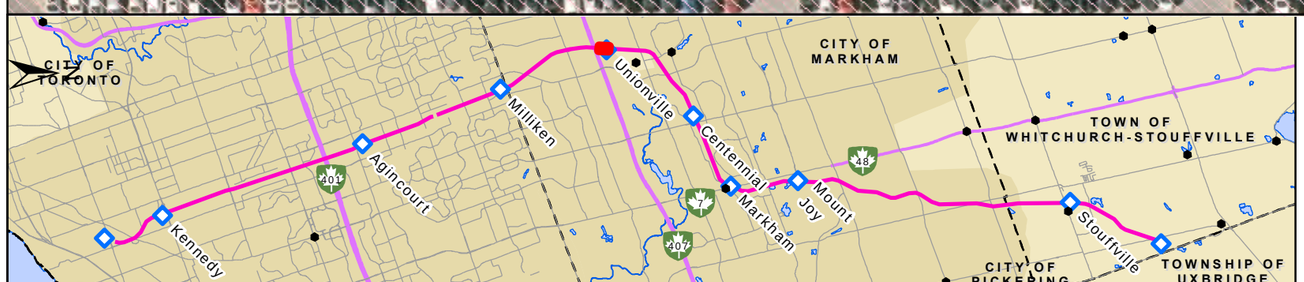
MORRISON HERSHFIELD

VEGETATION REMOVAL ZONE GUIDELINES FOR NON-ELECTRIFIED CORRIDORS



MORRISON HERSHFIELD





Legend

Track Layout	Zone
Future Track Centreline	Zone 1
Track Centreline	Zone 2
Go Station Platforms	Non-Electrified Zone 3
Metrolinx Properties	Non-Electrified Zone 4
Other Property Owned	

METROLINX

MORRISON HERSHFIELD

Drawn By: ES

Checked By: XX

0 5 10 15 20 25
Meters

ISSUE

N

Integrated Vegetation Management for Non-Electrified Corridors Program GO Rail Network

Figure 51

APPENDIX F

Integrated Vegetation Management Flowchart

INTEGRATED VEGETATION MANAGEMENT FLOWCHART

IVM Step No. 1: Understanding Pest and Ecosystem Dynamics

Develop and maintain a comprehensive understanding of the existing ecological conditions within the Metrolinx ROW.

- Undertake an inventory of vegetation conditions.
- Monitor plant community composition and structure.
- Monitor the presence of incompatible and compatible species within and adjacent to the Metrolinx ROW.

Use existing ecological conditions to inform management objectives and treatment thresholds

Evaluate existing ecological conditions against management objectives and treatment thresholds

1.1.3 *IVM Step No. 2:* Setting Management Objectives and Treatment Thresholds

Minimize the percentage of incompatible vegetation within the corridor to ensure that biodiversity and safety are upheld.

- Set treatment thresholds that aim to minimize and prevent the establishment of incompatible species.
- Enable required vegetation removal while retaining compatible vegetation.

Where incompatible vegetation is identified, proceed to IVM Step No. 3

1.1.4 *IVM Step No. 3:* Compiling Treatment Options

Develop a treatment method that meets the needs of ecological, economic, and stakeholder concerns.

- Develop a treatment approach that will most effectively meet site-specific conditions and vegetation composition.
- Develop a treatment approach that encourages the establishment of a compatible, self-sustaining vegetative cover which, over the long-term, becomes less dependent on treatments.

Once a control option has been determined, proceed to IVM Step No. 4.

IVM Step No. 4: Site-Specific Implementation of Treatments

Apply a control action that is tailored to varying site conditions, needs, and sensitivities. The selected option should aim to represent a balance between meeting IVM targets/objectives while considering indirect and direct impacts to the environment, society, and cost.

- Adhere to the selection criteria/decision-making process to determine which potential control type and technology (pruning, mowing, foliar chemical application, seeding, etc.) best addresses management constraints, i.e. site conditions, environmental sensitivities, timing windows etc.

Following implementation of treatments, proceed to IVM Step No. 5.

IVM Step No. 5: Adaptive Management and Monitoring

Allow for ongoing improvement to the IVM based on learned experiences and meet new objectives and conditions.

- Monitor and evaluate the success of the program.
- Adjust and revise IVM to allow for ongoing improvements based on field observations and learned experiences.

Carry revised approaches to IVM Step No. 1

APPENDIX G

Summary of Relevant Provincial and Federal Regulations for Invasive Species

Table 17: Summary of Federal and Provincial Acts Regarding the Management of Invasive Species

Act	Summary
Federal Plant Protection Act and Seeds Act	There are two major federal acts directly relating to invasive species: the *Plant Protection Act* (1990) and the *Seeds Act* (1985). The *Plant Protection Act* prohibits the import, movement, or growth of pests, things infested with pests, or biological obstacles to pest control which are injurious to plants. Its focuses are the agricultural and forestry sectors. The *Seeds Act* designates weed seeds and establishes standards for maximum weed seed content. Some examples of prohibited noxious weeds are Russian Knapweed (*Acroptilon repens*), Diffuse Knapweed (*Centaurea diffusa*), Leafy Spurge (*Euphorbia esula*), and Johnson Grass (*Sorghum halapense*). The *Seeds Act* has an agricultural focus Introductions of invasive insects, molluscs, plants, and viruses, fungi, and other diseases are regulated under the *Plant Protection Act* and may eventually spread from the project area into agricultural and forestry land use areas, and precautions must be taken.
Provincial Invasive Species Act	Invasive plant species are regulated federally by the *Plant Protection Act* (1990) and provincially by the *Invasive Species Act* (2015) and the *Weed Control Act* (1990). Most relevant to the management of invasive plants in the corridor is the *Ontario Invasive Species Act* (2015). The *Invasive Species Act* prohibits any activity that is likely to increase the threat of the invasive species to the natural environment in Ontario, and specifies circumstances in which an activity or act prohibited by the order or under this Act may be carried out. The *Act* refers to regulations which may designate an area of Ontario as an invasive species control area with respect to a significant threat invasive species. In these areas, regulations may specify measures to control the spread of the invasive species. While the *Act* primary focuses on the management of aquatic species, within the corridor, there are four restricted terrestrial plant species*:* Black dog-strangling vine (*Cynanchum louiseae*), Dog-strangling vine (*Cynanchum rossicum*), Japanese Knotweed (*Reynoutria japonica* var. *japonica*), and European Common Reed (*Phragmites australis* ssp. *australis*).
Provincial Weed Control Act	The *Weed Control Act* (1990) requires the destruction of noxious weeds, such as Common Barberry (*Berberis vulgaris*), Common Buckthorn (*Rhamnus cathartica*), Giant Hogweed (*Heracleum mantegazzianum*), and Canada Thistle (*Cirsium arvense*); this Act applies to agricultural and horticultural lands. While the project area is primarily zoned for infrastructure, agricultural and horticultural land-uses are present directly adjacent to the corridor, therefore appropriate measures must be taken to control and limit the spread of invasive species and pests found within the corridor. Introductions of invasive noxious weeds are regulated under the *Plant Protection Act* as they may eventually spread into agricultural and horticultural lands.

APPENDIX H

Treatment Methods for Provincially Restricted Invasive Species

Table 18: OISC Management Approach for Treating Provincially Restricted Invasive Species

Common Name	Application Method	Active Ingredient***	Timing & Application Details
Species Regulated Under the Provincial Invasive Species Act (2015)****			
European Common Reed (***Phragmites australis* ssp. *Australis*)**	Cutting (Mechanical)	N/A	• Cutting should *only* be undertaken in combination with chemical controls where the height of stands are causing visibility issues. • Where needed, cutting should take place: early July; prior to the application of herbicides; and in advance of seedhead formation.
	Foliar (Chemical)	Glyphosate (4.5 - 5% solution*) with 0.5 - 1% methylated seed oil.	• Best used if monoculture stands are dense or if the stand is in a natural environment. • Treat actively growing plants in late summer. Follow-up treatments may be needed and should take place at least 3 weeks following initial application.
		Imazapyr (2% solution**) with 0.5 - 1% methylated seed oil.	• Treat in late summer or early fall. • Should not be applied in natural environments.
	Wicking (Chemical)	Glyphosate (4.5 - 5% solution*) with 0.5 - 1% methylated seed oil.	• Best used to treat smaller stands, stands within environmentally sensitive areas, or stands mixed with compatible species. • Treat actively growing plants in late spring followed by a late summer/early fall application (no later than mid-September).

Common Name	Application Method	Active Ingredient***	Timing & Application Details
Dog-strangling Vine (pale swallowwort) (*Vincetoxicum rossicum*)	Foliar (Chemical)	Glyphosate (1.3% - 5% solution*)	• Best for large monocultures. • Treat from late May to seed pod development (late August/ early September). Subsequent applications in a growing year may be needed – for best results, treat 2 times per growing season (approx. 2 months apart) and repeat treatments for several years.
		Imazapyr (22% solution**)	• Best used to treat smaller, vigorously growing plants. • Apply in early May. Subsequent applications in a growing year may be needed.
	Wicking (Chemical)	Glyphosate (22% solution*)	• Best used to treat smaller stands, stands within environmentally sensitive areas, or stands mixed with compatible species. • Treat from mid-June to seed pod development (late August/ early September).
Japanese Knotweed *(Reynoutria japonica var. japonica)*	Foliar (Chemical)	Glyphosate (1.34% to 5% solution*)	• Best for large patches and re-sprouts. • Treat 2 per growing season: 1st application should take place when leaves are fully extended, from late May until end of June; 2nd application takes place mid-summer. A late summer application may also be needed for new growth.
		Aminopyralid (5% solution**)	• Best used to treat large patches and re-sprouts where glyphosate has proven to be ineffective after 3 years. • Treat 2 per growing season: 1st

Common Name	Application Method	Active Ingredient***	Timing & Application Details
			application should take place when leaves are fully extended, from late May until end of June; 2nd application takes place mid-summer. A late summer application may also be needed for new growth.

* Based on a product containing 540 g/l of chemical.

** Based on a product containing 240 g/l of chemical. Please read the label in full before use to ensure that these recommendations meet the requirements of the herbicide you have selected.

*** Metrolinx is responsible for updating the potential list of active ingredients that are suitable and legal for the control of the invasive species, and the legal application methods according to the Pesticides Act & Ontario Regulation 63/09 and the Pest Control Products Act and regulations

**** Metrolinx will be responsible for adding/removing invasive species according to changes to provincial legislation.

APPENDIX I

Woody Invasive Species

Table 19: Woody Invasive Species

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Category 1 (Priority Species): Once Established, these Species have a Tendency to Dominate Sites Indefinitely. Their Removal should be Considered a Top Priority.									
Black (European) Alder	*Alnus glutinosa*				X		X	X	X
Amur Honeysuckle	*Lonicera maackii*	X	X			X	X	X	X
Autumn Olive	*Elaeagnus umbellata*						X	X	X
Non-Native Bush Honeysuckles	*Lonicera tatarica, Lonicera sp.*	X	X		X	X	X	X	X
Morrow's Honeysuckle	*Lonicera morrowii*	X				X	X	X	
Common (European) Buckthorn	*Rhamnus cathartica*	X	X	X	X	X	X	X	X
Glossy Buckthorn	*Frangula alnus*	X	X		X	X	X	X	X
Manitoba Maple	*Acer negundo*		X		X		X	X	X
Category 2 (Highly Invasive Species): Once Established, these Species have a Tendency to Dominate Certain Niches.									
Black Locust	*Robinia pseudo-acacia*						X	X	
Tree of Heaven	*Ailianthus altissima*				X		X	X	X
Norway Maple	*Acer platanoides*		X		X	X	X	X	X
Sycamore Maple	*Acer pseudoplatanus*						X	X	
Siberian Elm	*Ulma pumila*		X		X		X	X	X

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Multiflora Rose	*Rosa multiflora*						X	X	X
Category 3 (Moderately Invasive Species): Once Established, can be Locally Dominant.									
Burning Bush	*Euonymus alatus*	X	X			X	X		X
Common (English) Hawthorn	*Crataegus monogyna*						X		X
Crack Willow	*Salix fragilis*						X		X
European Spindle Tree	*Euonymus europaeus*						X		X
(European) White Poplar	*Populus alba*		X				X	X	
Horse-Chestnut	*Aesculus hippocastanum*						X		X
Hybrid Willow	*Salix* X *rubens*						X		X
Russian Olive	*Elaeagnus angustifolia*				X		X		X
Scots Pine	*Pinus sylvestris*						X		
Silver Birch	*Betula pendula*				X		X		X
White Mulberry	*Morus alba*				X		X	X	
White Willow	*Salix alba*				X		X		X

APPENDIX J

Non-Woody Invasive Species

1Table 20: Non-Woody Invasive Species

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Category 1 (Priority Species): Once Established, these Species have a Tendency to Dominate Sites Indefinitely. Their Removal should be Considered a Top Priority.									
Goutweed	*Aegopodium podagraria*	X						X	
Garlic Mustard	*Alliaria petiolata*	X	X	X				X	X
Common Mugwort	*Artemisia vulgaris*						X		
Oriental bittersweet	*Celastrus orbiculatus*							X	
Black swallow-wort	*Cynanchum nigrum*							X	
Pale swallow-wort	*Cynanchum rossicum*							X	
Rough manna grass	*Glyceria maxima*						X	X	
Giant hogweed	*Heracleum mantegazzianum*	X		X				X	
Dames rocket	*Hesperis matronalis*						X	X	X
Japanese honeysuckle	*Lonicera japonica*	X						X	X
Amur honeysuckle	*Lonicera maackii*	X						X	X
Morrow's honeysuckle	*Lonicera morrowi*	X						X	X
Tartarian honeysuckle	*Lonicera tatarica*	X						X	X
European fly honeysuckle	*Lonicera xylosteum*	X						X	
Purple loosestrife	*Lythrum salicaria*	X					X	X	

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Common reed	*Phragmites australis*	X	X		X	X	X	X	
Japanese knotweed	*Polygonum cuspidatum*	X	X	X			x	X	
Category 2 (Highly Invasive Species): Once Established, these Species have a Tendency to Dominate Certain Niches.									
Canada thistle	*Cirsium arvense*							X	
English ivy	*Hedera helix*	X						X	
Japanese Stillgrass	*Microsteqium vimineum*	X							
Eulalia	*Miscanthus sacchariflorus*	X						X	
Eulalia	*Miscanthus sinensis*	X						X	
Rosa multiflora	*Multiflora rose*							X	
Scilla	*Scilla siberica*						X	X	
Narrow-leaved cattail	*Typha angustifolia*							X	
Hybrid cattail	*Typha x glauca*							X	
Category 3 (Moderately Invasive Species): Once Established, can be Locally Dominant.									
Wild Chervil	*Anthriscus sylvestris*	X							
Creeping Bugleweed	*Ajuga reptans*						X		
Spring Savory	*Acinos arvensis*						X		
Velvet-leaf	*Abutilon theophrasti*							X	
Amur maple	*Acer ginnala*							X	
Mother-of-thyme	*Acinos arvensis*							X	
Creeping bugleweed	*Ajuga reptans*							X	

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Absinth sage	*Artemisia absinthum*							X	
Yellow rocket	*Barbarea vulgaris*							X	
Hoary-alyssum	*Berteroa incana*							X	
Flowering Rush	*Betula pendula*						X	X	
Smooth brome	*Bromus inermis*						X	X	X
Creeping bellflower	*Campanula rapunculoides*							X	
Nodding thistle	*Carduus nutans*							X	
Spotted knapweed	*Centaurea maculosa*	X						X	
Field bindweed	*Convolvulus arvensis*						X	X	
Lily-of-the-valley	*Convallaria majalis*						X	X	
Crown vetch	*Coronilla varia*							X	
Orchard grass	*Dactylis glomerata*						X	X	
Teasel	*Dipsacus sylvestris*							X	
Quack grass	*Elymus repens*						X	X	
Wintercreeper euonymus	*Euonymus fortunei*							X	
Cypress spurge	*Euphorbia cyparissias*							X	
Leafy spurge	*Euphorbia esula*						X	X	
Tall fescue	*Festuca arundinacea*						X	X	
White bedstraw	*Galium mollugo*							X	
Yellow bedstraw	*Galium verum*							X	

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Herb robert	*Geranium robertianum*							X	
Ground ivy	*Glechoma hederacea*						X	X	
Day lily	*Hemerocallis ssp.*							X	
Orange hawkweed	*Hieracium aurantiacum*						X	X	
Yellow hawkweed	*Hieracium caespitosum*						X	X	
Common hawkweed	*Hieracium lachenalii*						X	X	
Pale hawkweed	*Hieracium x floribundum*							X	
St. John's-Wort	*Hypericum perforatum*						X	X	
Yellow flag	*Iris pseudoacorus*	X					X	X	
Himalayan balsam	*Impatiens glandulifera*	X			X		X	X	X
Elecampane	*Inula helenium*						X	X	
Summer cypress	*Kochia scoparia*							X	
Butter-and-eggs	*Linaria vulgaris*							X	X
Perennial rye grass	*Lolium perenne*							X	
Bird-foot trefoil	*Lotus corniculatus*							X	
Bugleweed	*Lycopus europeaus*							X	
Hybrid honeysuckle	*Lonicera x bella*	X				X		X	X

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Creeping Jennie	*Lysimachia nummularia*							X	
Musk mallow	*Malva moschata*						X	X	
Black medic	*Medicago lupulina*						X	X	
Alfalfa	*Medicago sativa*						X	X	
Peppermint	*Mentha x piperita*						X	X	
True forget-me-not	*Myosotis scorpioides*						X	X	
Alfalfa	*Medicago sativa*						X	X	
Eulalia	*Miscanthus sacchariflorus*							X	
White sweet clover	*Melilotus alba*							X	
Yellow sweet clover	*Melilotus officinalis*							X	
Catnip	*Nepeta cataria*						X	X	
Wild marjoram	*Origanum vulgare*							X	
Japanese spurge	*Pachysandra terminalis*						X	X	
Wild parsnip	*Pastinaca sativa*	X						X	
Reed canary grass	*Phalaris arundinacea*						X	X	
Kentucky bluegrass	*Poa pratensis*							X	
Creeping buttercup	*Ranunculus repens*						X	X	
Sheep sorrel	*Rumex acetosella*						X	X	
Bouncing-bet	*Saponaria officinalis*							X	

Common Name	Scientific Name	OISAP	City of Toronto	York Region	TRCA	LSRCA	CH	CVC	CLOCA
Tansy	*Senecio jacobaea*						X	X	
Foxtail	*Setaria spp.*						X	X	
Tansy	*Tanacetum vulgare*						X	X	
Creeping thyme	*Thymus praecox*						X	X	
Rabbit-foot	*Trifolium arvense*							X	
Red clover	*Trifolium pratense*							X	
White clover	*Trifolium repens*							X	
Sweet coltsfoot	*Tussilago farfara*							X	
Guelder rose	*Viburnum opulus sp. opulus*							X	
European stinging-nettle	*Urtica dioica ssp. dioica*							X	X
Cow vetch	*Vicia cracca*							X	X
Common vetch	*Vicia sativa ssp. nigra*							X	
Slender vetch	Vicia tetrasperma							X	

APPENDIX K

Recommended Seed Mixes

Native Seeding

- The recommended native seed mixes for areas within Zone 3 have been determined based on existing site conditions and pre-disturbance Ecological Land Classification (ELC) community.
- Seed mixes may be customized to include additional species or percentages based on guidance from a qualified biologist or landscape architect with expertise in ecological restoration.
- Nurse crop consisting of fast-growing annual grasses should be added to the mix to establish quick vegetative cover at a rate of 22 kg/ha.
- Native seed mixes should be applied at the specified rate of 22-25 kg/ha.
- Native seed mix rates shall be adjusted as needed based on application method.
- Approved nurse crop and native seed mixes can be found in the TRCA Seed Mix Guideline V.2.0 (January 2022) found at the following link.

Seed Mix Recommendations	
Existing Community	**Seed Mix**
Shallow Marsh (MAS)	TRCA Frugal Wet Mix (TRCA-SW-1)
Meadow Marsh (MAM)	TRCA Wet Meadow Mix (TRCA-SW-6)
Cultural Meadow (CUM)*	TRCA Butterfly Meadow (TRCA-SD-6)
Woodland (CUW, FO, SW)	TRCA Swamp Mix (TRCA-SC-2)/TRCA Upland Slope Mix (TRCA-SD-3)
Cultural Meadow (CUM)* with heavy invasive pressure	TRCA Resilient Area Meadow Mix (TRCA-SD-4)
Woodland (CUW, FO, SW) with shade, slopes and/or compacted mixed soils	TRCA Difficult Site Mix (TRCA-SC-1)

**May also be referred to as ME, MEM, MEG, and MEF (from the 2008 ELC)*

Example seed mix that can be found in the TRCA Seed Mix Guideline (2022)

TRCA Difficult Site Mix (TRCA-SC-1) Shady, sloped, compacted, mixed soils mix		
Common Name	**Scientific Name**	**% of Mix**
Big bluestem	*Andropogon gerardii*	15%
Virginia wild rye	*Elymus virginicus*	15%
Little bluestem	*Schizachyrium scoparium*	15%
Silky Wild Rye*	*Elymus villosus*	15%
Riverbank rye	*Elymus riparius*	15%
Green coneflower*	*Rudbeckia laciniata*	2%
Showy tick-trefoil	*Desmodium canadense*	3%
Wild Columbine	*Aquilegia canadensis*	1%
Wild bergamot	*Monarda fistulosa*	3%
Golden Alexander	*Zizia aurea*	2%
Bee Balm*	*Monarda didyma*	1%
Great St.John's Wort*	*Hypericum ascyron*	1%
Yellow Hyssop*	*Agastache nepetoides*	1%
New Jersey Tea*	*Ceanothus americanus*	1%
Oxeye	*Heliopsis helianthoides*	2%
Evening primrose	*Oenothera biennis*	2%
Foxglove beardtongue	*Penstemon digitalis*	2%
Hairy beardtongue*	*Penstemon hirsutus*	1%
Virginia mountain mint*	*Pycnanthemum virginianum*	2%
White vervain*	*Verbena urticifolia*	1%
Minimum recommended ratio of 28.37 Kg/ha		

APPENDIX L

Recommended Tree and Shrub Species

Table 1: Tree and Shrub Planting List for Zones 4 and 5 and Non-Electrified Zones 3 and 4

Common Name	Scientific Name	Height (m)	Zone 4 and Non-Electrified Zone 3	Zone 5 and Non-Electrified Zone 4
Mountain Maple	*Acer spicatum*	3 - 5 m		✓
Striped Maple*	*Acer pensylvanicum*	Up to 10 m		✓
Speckled Alder	*Alnus incana*	4 - 8 m		✓
Green Alder	*Alnus viridus* ssp. *crispa*	Up to 3 m	✓	✓
Serviceberry*	*Amelanchier species*	3 – 9 m		✓
False Indigo Bush	*Amorpha fruticosa*	5 - 6 m		✓
Bearberry	*Arctostaphylos uva-ursi*	Less than 1 m	✓	✓
Black Chokeberry	*Aronia melanocarpa*	2 - 2.5 m	✓	✓
Blue-Beech	*Carpinus caroliniana*	Up to 8 m		✓
New Jersey-tea	*Ceanothus americanus*	Up to 3 m	✓	✓
Buttonbush	*Cephalanthus occidentalis*	Up to 6 m		✓
Eastern Redbud*	*Cercis canadensis*	Up to 10 m		✓
Sweet Fern	*Comptonia peregrina*	Up to 1 m	✓	✓
Alternate Leaved Dogwood	*Cornus alternifolia*	4 - 6 m		✓
Bunchberry	*Cornus canadensis*	Less than 1 m	✓	✓
Pale Dogwood or Silky Dogwood	*Cornus obliqua*	2 - 3 m	✓	✓
Gray Dogwood	*Cornus racemosa*	Up to 2.5 m	✓	✓
Round-leaved Dogwood	*Cornus rugosa*	Up to 3 m	✓	✓
Red Osier Dogwood	*Cornus sericea* (syn. *C. stolonifera)*	2 - 3 m	✓	✓
Beaked Hazelnut	*Corylus cornuta*	3 - 4 m	✓	✓
Cockspur Hawthorn*	*Crataegus crus-galli*	Up to 9 m		✓
Dotted Hawthorn	*Crataegus punctata*	Up to 8 m		✓
Bush Honeysuckle	*Diervilla lonicera*	Less than 1 m	✓	✓
Leatherwood	*Dirca palustris*	Up to 2 m	✓	✓
Trailing Arbutus	*Epigaea repens*	Less than 1 m	✓	✓

Common Name	Scientific Name	Height (m)	Zone 4 and Non-Electrified Zone 3	Zone 5 and Non-Electrified Zone 4
Running Strawberry Bush	*Euonymus obovatus*	Less than 1 m	✓	✓
Eastern Teaberry or Wintergreen	*Gaultheria procumbens*	Less than 1 m	✓	✓
Black Huckleberry	*Gaylussiacia baccata*	Up to 1 m	✓	✓
American Witch-hazel	*Hamamelis virginiana*	4.5 - 6 m		✓
Kalm's St. John's Wort	*Hypericum kalmianum*	Up to 1 m	✓	✓
Shrubby St. John's Wort	*Hypericum prolificum*	Up to 1.5 m	✓	✓
Black Holly or Common Winterberry	*Ilex verticillata*	3 - 6 m		✓
Common Juniper	*Juniperus communis*	Up to 1.5 m	✓	✓
Eastern Red Cedar*	*Juniperus virginiana*	10 m		✓
Spicebush	*Lindera benzoin*	Up to 3 m	✓	✓
Canada Fly Honeysuckle	*Lonicera canadensis*	Up to 1.5 m	✓	✓
Sweet Crab Apple*	*Malus coronaria*	7 - 9 m		✓
Partridge-berry	*Mitchella repens*	Less than 1 m	✓	✓
Sweet Gale	*Myrica gale*	Up to 1 m	✓	✓
Mountain Holly	*Nemopanthus mucronatus*	Up to 3 m	✓	✓
Ninebark	*Physocarpus opulifolius*	Up to 3 m	✓	✓
Shrubby Cinquefoil	*Potentilla fruticosa*	1 m	✓	✓
Hop Tree	*Ptelea trifoliata*	6 - 8 m		✓
Canada Plum*	*Prunus nigra*	Up to 10 m		✓
Sand Cherry	*Prunus pumila*	1 m	✓	✓
Chokecherry*	*Prunus virginiana*	6 - 9 m		✓
Fragrant Sumac	*Rhus aromatica*	Up to 1.5 m	✓	✓
Staghorn Sumac	*Rhus typhina*	3 - 6 m		✓
Wild Black Currant	*Ribes americanum*	1 m	✓	✓
Prickly Gooseberry	*Ribes cynosbati*	1 m	✓	✓
Smooth Gooseberry	*Ribes hirtellum*	1 m	✓	✓
Skunk Currant	*Ribes glandulosum*	1 m	✓	✓

Common Name	Scientific Name	Height (m)	Zone 4 and Non-Electrified Zone 3	Zone 5 and Non-Electrified Zone 4
Red Currant	*Ribes triste*	1 m	✓	✓
Prickly Wild Rose	*Rosa acicularis*	1 m	✓	✓
Smooth Rose	*Rosa blanda*	Up to 1.5 m	✓	✓
Swamp Rose	*Rosa palustris*	Up to 1.5 m	✓	✓
Prairie Rose	*Rosa setigera*	Up to 1.5 m	✓	✓
Allegheny Blackberry	*Rubus allegheniensis*	Up to 2 m	✓	✓
Wild Red Raspberry	*Rubus idaeus* ssp. *strigosus*	Up to 1.5 m	✓	✓
Black Raspberry	*Rubus occidentalis*	1 - 2 m	✓	✓
Purple-flowering Raspberry	*Rubus odoratus*	1 - 1.5 m	✓	✓
Dewberry	*Rubus pubescens*	Less than 1 m	✓	✓
Bebb's Willow	*Salix bebbiana*	1 - 6 m		✓
Sage-leaved or Hoary Willow	*Salix candida*	2 - 3 m	✓	✓
Pussy Willow	*Salix discolor*	2 - 6 m		✓
Heart-leaved Willow	*Salix eriocephala*	3 - 4 m	✓	✓
Sandbar Willow	*Salix exigua*	3 - 6 m		✓
Upland Willow	*Salix humilis*	1 - 3 m	✓	✓
Shining Willow	*Salix lucida*	3 - 6 m		✓
Slender Willow	*Salix petiolaris*	1 - 3 m	✓	✓
Common Elderberry	*Sambucus canadensis*	3 - 4 m	✓	✓
Red Elderberry	*Sambucus racemosa*	Up to 4 m	✓	✓
Black Elderberry	*Sambucus nigra*	Up to 2 m	✓	✓
Buffalo Berry	*Shepherdia canadensis*	Up to 2 m	✓	✓
American Mountain Ash*	*Sorbus americana*	Up to 10 m		✓
Showy Mountain Ash*	*Sorbus decora*	Up to 10 m		✓
Narrow-leaved Meadowsweet	*Spiraea alba*	1.5 - 2 m	✓	✓
Broad-leaved Meadowsweet	*Spiraea tomentosa*	1.5 m	✓	✓

Common Name	Scientific Name	Height (m)	Zone 4 and Non-Electrified Zone 3	Zone 5 and Non-Electrified Zone 4
American Bladdernut	*Staphylea trifolia*	3 - 5 m	✓	✓
Common Snowberry	*Symphoricarpos albus*	0.5 - 2 m	✓	✓
Canadian Yew	*Taxus canadensis*	Less than 2 m	✓	✓
Eastern White Cedar*	*Thuja occidentalis*	12 m		✓
Low Sweet Blueberry	*Vaccinium angustifolium*	Less than 2 m	✓	✓
Velvet-leaf Blueberry	*Vaccinium myrtilliodes*	Up to 1 m	✓	✓
One-leaved Bilberry	*Vaccinium ovalifolium*	Up to 1 m	✓	✓
Maple-leaved Viburnum	*Viburnum acerifolium*	Less than 2 m	✓	✓
Common Hobblebush	*Viburnum alnifolium*	Up to 2 m	✓	✓
Northern Wild Raisin	*Viburnum cassinoides*	Up to 1 m	✓	✓
Mooseberry	*Viburnum edule*	Less than 2 m	✓	✓
Nannyberry	*Viburnum lentago*	Up to 6 m		✓
Possumhaw	*Viburnum nudum*	3 - 4 m	✓	✓
Downy Arrow-wood	*Viburnum rafinesquianum*	Up to 1.5 m	✓	✓
Highbush Cranberry	*Viburnum trilobum*	3 - 4 m	✓	✓
Prickly Ash*	*Zanthoxylum americanum*	Up to 10 m		✓

* Indicates species that may exceed 8 m in height over time. Varieties should be carefully selected.