Emerald Ash Borer (EAB)
Management Action Plan

City of Cambridge, Ontario — May 20, 2015

Prepared for:

City of Cambridge
Attn: Brian Geerts - Manager of Forestry and Horticulture
Dickson Centre
30 Parkhill Road W.
Cambridge, ON N1R 5W8

Prepared by:

Urban Forest Innovations Inc.
1248 Minnewaska Trail
Mississauga, ON L5G 3S

URBAN FOREST INNOVATIONS INC

Contents

Introduction

Emerald ash borer (EAB) is a non-native insect tree pest, and it threatens to completely eliminate ash trees from the urban, rural and natural forests in Cambridge. Even with effective planning, implementation of control measures, and replanting efforts, the city's forested landscapes will be drastically changed by the ongoing invasion of this beetle; no amount of effort can fully prevent or control EAB.

However, through the implementation of specific actions outlined in this Action Plan, the City will be better prepared to take effective efforts to minimize the risks, loss of benefits, and costs associated with EAB infestation.

This document presents an Action Plan for the management of emerald ash borer and ash trees in the City of Cambridge, Ontario.

Background

Emerald Ash Borer

Emerald ash borer (EAB) (*Agrilus planipennis* Fairmaire) is a highly-destructive, non-native insect tree pest. It feeds exclusively on and kills ash (genus *Fraxinus*) trees in urban, suburban and natural forests alike. Through larval feeding action, the borer kills virtually every ash tree it infests, and has the potential to kill billions of ash trees across North America. The process of larval feeding produces serpentine galleries that disrupt nutrient flow in the affected tree's phloem, usually resulting in tree death within 1-3 years after initial attack.

EAB infestation is currently ongoing across southern Ontario. The insect has been present in the City of Cambridge for several years, and ash trees across the city are succumbing to EAB's disastrous effects.

EAB biology and ecology

A true beetle, emerald ash borer (EAB) (*Agrilus planipennis* Fairmaire) is a member of the order *Coleoptera*, family *Buprestidae*. Adult beetles are metallic blue-green, narrow, hairless, and elongate. The average size of an adult beetle is 7.5 to 13.5 mm in length and 4 mm wide. Females lay up to 300 eggs from May to mid-July in crevasses and under the bark of ash (genus *Fraxinus*) trees, and eggs turn a yellow-brown color prior to hatching. Eggs hatch in approximately 20 days. EAB larvae are between 26 and 32 mm long, and are a creamy white color. The larval body is flat and broad shaped; posterior ends of some segments are bell-shaped. Larvae burrow into the bark after hatching and consume the host ash tree's cambium and phloem tissues, effectively girdling the affected tree and causing rapid decline and mortality. Larvae feed aggressively before overwintering in the host tree. Pupation begins in late

April, and adults emerge in early spring to late summer, living for about one month, during which they breed. The borer's life cycle is one year in southern Michigan, but may be up to two years in colder regions, including Ontario.

EAB hosts, dispersal methods and range

Over the past several decades, ash (genus *Fraxinus*) has become a popular street and landscape tree due to the species' large mature size, fast growth, relatively strong insect and disease resistance, and tolerance for urban conditions. Ash served as a particularly suitable replacement for the once-ubiquitous white elms (*Ulmus americana*) killed by Dutch Elm Disease (*Ophiostoma novo-ulmi*) since the 1960s. Although there are indications of varying degrees of EAB susceptibility between ash species, no species is completely resistant and it is estimated that virtually all untreated ash trees will succumb to the beetle, resulting in the loss of an estimated 7.5-10 billion ash trees across North America. EAB is indiscriminate in affecting urban, suburban and natural forest landscapes. Aside from municipalities, the hardwood forest industry and woodlot owners face significant economic losses, as green (*Fraxinus pennsylvanica*) and white ash (*F. americana*) are important species used in the manufacture of products such as cabinetry and sporting goods.

The first North American EAB infestations were reported in Detroit, Michigan and Windsor, Ontario in 2002. EAB most likely arrived in North America in infested wood packing material, shipped from its native range in Asia, in the 1990s. As of April 1, 2015, EAB has been found as far south as Arkansas, as far north as Thunder Bay, as far west as Colorado, and as far east as New England and Quebec's Eastern Townships.

The beetle is capable of dispersal up to several kilometers, although an opportunistic preference is shown for nearby hosts. Research (McCullough *et al.* 2004) suggests that adult beetles are unlikely to disperse more than 3 kilometres, although mated females have been noted to disperse up to 10 km (Taylor *et al.* 2005). Moreover, the spread of EAB has been accelerated by the inadvertent human transportation of beetle-infested wood, particularly firewood and nursery stock, prompting Ministerial Orders under the Plant Protection Act, 1990 to prohibit the transportation of infested or potentially-infested wood materials. EAB infestation is now assumed to be widespread in much of Southern Ontario, particularly in urban areas, and it continues to spread at a rapid rate into uninfected areas. Continued spread will lead to ongoing massive tree mortality in natural forest stands and urban forests.

EAB signs and symptoms

Conclusive identification of EAB infestation requires the presence of one or more positive signs or symptoms. Signs are physical indicators of the presence of EAB, while symptoms are a display of the tree's reaction to such infestation.

Externally-visible signs of EAB infestation include irregular notches on host tree foliage, caused by immature beetle feeding, as well as tell-tale "D-shaped" beetle exit holes, 3.5 mm to 4.1 mm in size, found on the bark. Presence of any of the life stages of EAB (larvae, pupae or adults) are also a clear sign, as is bark damage caused by woodpecker or squirrel feeding upon larvae. Within the host tree, flat, wide and serpentine 'S-shaped" galleries, often filled with fine brownish frass, are clear signs of EAB larval feeding. Galleries are typically 9 to 16 cm long (up to 30 cm) and increase in width from the beginning to the end. Galleries can occur along the entire bole and in branches that are at least 2.5 cm in diameter. Callus tissue may be produced by the tree in response to larval feeding and may cause vertical bark cracks to occur over a gallery.

Symptoms of EAB infestation, particularly in later stages, may include top-down crown thinning and dieback, foliar chlorosis, heavy epicormic shoot development, and dying or dead trees (particularly with bark sloughing off).

By the time signs and symptoms develop, an infested tree is usually in serious decline and may die shortly afterwards. Trees typically die within 1-3 years of infestation, depending upon local and individual tree pest pressure.

Infestation dynamics

Research and experience suggest that widespread ash tree mortality begins approximately 6-7 years following initial infestation (the 'tipping point'), and escalates in a nearly exponential fashion until near complete ash tree mortality within 15 years across the entire infested area. Complete mortality may occur much more rapidly among populations of street trees or in individual wooded areas. It is anticipated that EAB populations will drastically decline following the initial infestation, as the available food source is nearly depleted. The beetle is unlikely to disappear, however, as recovering ash in natural forest stands will continue to provide a limited food source to this much smaller population.

EAB in Ontario

EAB was first reported in Ontario in 2002. Despite extensive monitoring and control efforts, including the creation of a 10 km-wide 'ash-free zone' in Essex Country in an attempt to stop the spread of the beetle, EAB has since spread throughout much of the province. The current emerald ash borer Regulated Area (see Existing Regulations section, below) in the Province encompasses all of Southern Ontario. Much of southern Quebec is also regulated. Movement of ash wood and wood products out of the Regulated Area is prohibited, while movement within its boundaries is permitted. The large and contiguous extent of the Regulated Area suggests that efforts to contain the spread of EAB are no longer considered effective.

EAB and ash trees in Cambridge

A comprehensive street tree inventory conducted in summer 2014 found 4,095 ash street trees in Cambridge, representing approximately 7% of the City's street tree population of 55,000. Basic statistics regarding the species composition and health of the ash street tree population are shown in Tables 1 and 2, below.

Table 1: Species composition, Cambridge street ash trees (2014).

Species	#	%
Ash Species (*Fraxinus sp.*)	1437	35%
Green Ash (*Fraxinus pennsylvanica*)	2238	55%
European Ash (*Fraxinus excelsior*)	111	3%
Black Ash (*Fraxinus nigra*)	27	1%
White Ash (*Fraxinus americana*)	282	7%
	4095	

Table 2: Health (based on Canopy Vitality attribute), Cambridge street ash trees (2014).

Canopy Vitality	#	%
Poor	856	21%
Fair	1435	35%
Good	1804	44%

EAB was first positively identified in Cambridge in August 2010. Since infestation is typically positively identified several years following the first likely appearance of EAB in a given area, it is possible that the city is already some 6 to 9 years into the infestation phase. This is corroborated by the findings of the street tree inventory, which identified approximately 20% of ash street trees as being in poor health (i.e., canopy vitality). According to the generalized ash mortality curve (Figure 1) (from Zwack, 2010), mortality of approximately 20% of the ash tree population could be expected in Year 8 of the infestation. By comparison, only 2% of the non-ash street tree population was identified as being in poor health. These findings show that ash street trees are disproportionately unhealthy, and suggest ongoing EAB infestation among the City's ash street trees. It is likely that significant ash mortality will begin in the near term, necessitating immediate action by the City.

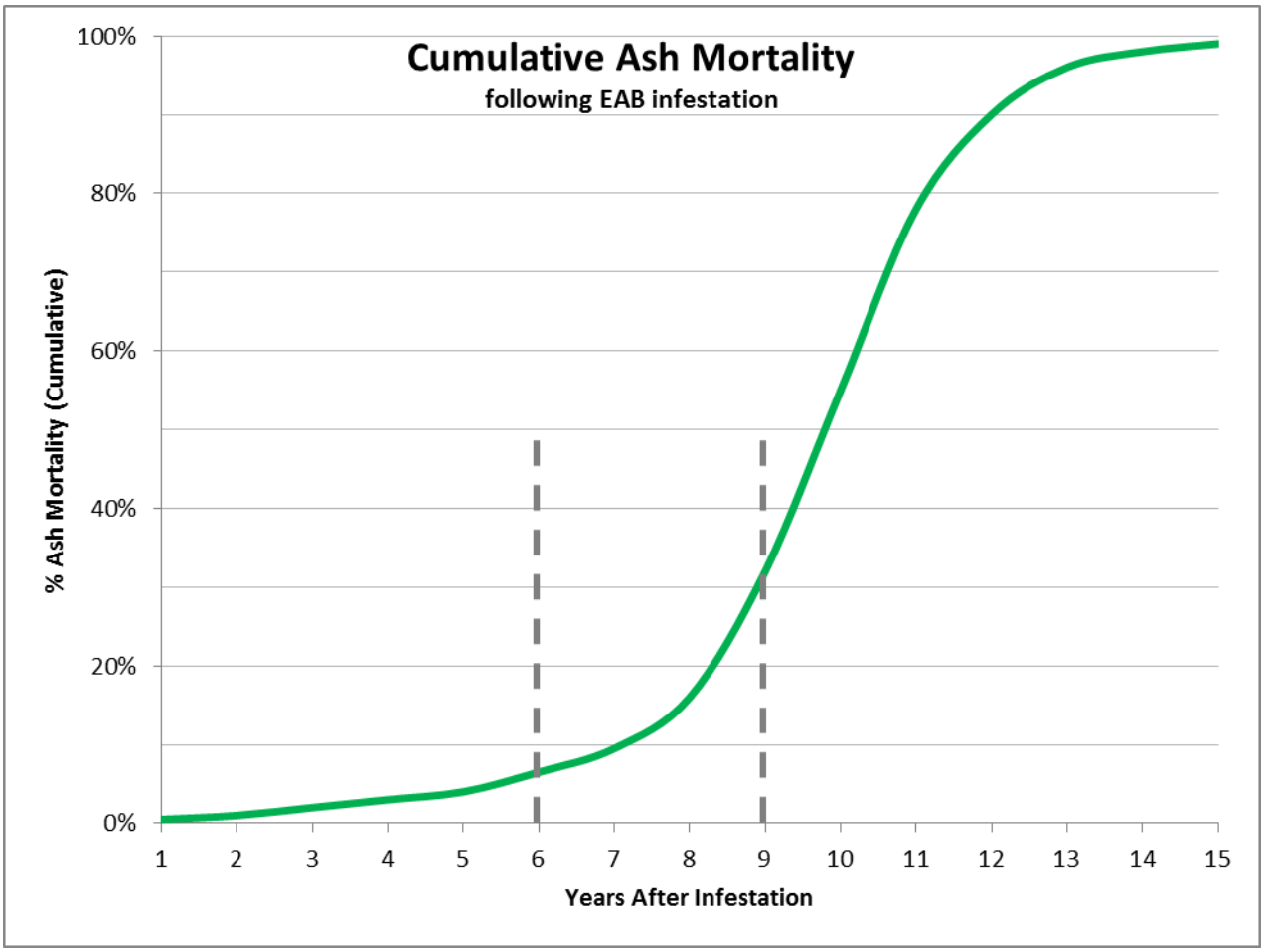

Figure 1: Generalized EAB/ash mortality curve (from Zwack, 2010). Area between dashed grey lines shows likely position on the mortality curve of EAB infestation in Cambridge.

While the number of ash street trees is known, the total number of municipal and privately-owned ash trees across the city is unknown, as there is no inventory of ash trees in parks, cemeteries or other municipal lands, nor a comprehensive assessment of tree species composition in City-owned or private wooded areas. The City's Urban Forest Canopy Assessment (2013) found that ash is among the top 3 species in the City's Open Space lands. Based on a 'windshield survey'[1] sample, ash was estimated to account for 3.6% of the City's urban forest. However, the actual percentage may be significantly higher – studies in other Ontario communities suggest ash trees may account for up to 10% of the urban forest.

[1] A windshield survey is a basic observation of a large group or population, occasionally undertaken from within a vehicle. The intent of a windshield survey is to collect basic observations rather than detailed data or assessments.

EAB Management Action Plan

Management objectives

Emerald Ash Borer infestation requires an active management response by any affected jurisdiction. EAB-killed ash trees are known to become structurally compromised within a few years of mortality. This significantly increases the risk of component part or whole-tree failure, which may lead to property damage or personal injury in areas where ash trees are located in proximity to people and property. Therefore, at minimum, dead ash trees must be removed from public property.

There may be additional objectives, beyond risk reduction, associated with EAB management. These may include:

- To offset the loss of urban ash trees and their associated environmental, economic and social benefits;
- To restore the urban forest canopy following the loss of ash trees;
- To optimise and, as best as possible, reduce the required human and capital resource expenditures associated with ash tree and EAB management, and;
- To protect and retain selected significant ash trees along City streets, in parks and cemeteries, and on other City-owned properties.

Scope of management

The City of Cambridge will manage the emerald ash borer and ash trees on City-owned properties, including but not limited to the municipal road right-of-way, parks, cemeteries, sports facilities, administrative and public works buildings, and wooded areas on City-owned parcels.

Through implementation of its EAB management program, the City will work to inform the public about the threat of EAB, the importance of ash tree management, and the City's efforts to manage this pest. While the City will encourage private property owners and other residents to manage ash trees on their own properties, or properties under their care and control, the City will not actively manage such trees. Notwithstanding the above, the City may exercise its prerogative to ensure public safety and maintain property standards by managing or compelling property owners to manage privately-owned ash trees, particularly if such trees pose a risk to the public or to neighbouring private properties.

Components of an EAB management program

A comprehensive approach to managing EAB infestation and ash trees consists of several components. These include, but may not be limited to:

- **Tree inventory:** Understanding the ash tree resource, including individual tree and tree group locations, size, condition and risk potential, is critical to effective management. Knowledge of the ash tree inventory enables managers to plan and budget for management activities, prioritize actions, and carry out tasks in an efficient and effective manner. At minimum, the location and size of municipally-owned ash trees and ash tree groups should be known.

- **Infestation monitoring:** Various monitoring techniques may be used to gain knowledge about the extent and location of EAB infestation. Infestation monitoring may be useful in the early stages of the infestation, but its utility generally declines as the infestation becomes more widespread.

- **Tree and stump removal:** As described, tree removal is the minimum municipal obligation in any EAB-infested jurisdiction, in order to mitigate risk associated with EAB-killed ash trees. Ash tree removal may be undertaken on a proactive or reactive basis. Typically, stump grinding will accompany tree removal to prevent sprouting of EAB-susceptible trees and to make spaces available for re-planting.

- **Tree protection:** Selected high-value or otherwise significant ash trees may be protected through stem injection with one of several available insecticides.

- **Tree replacement:** Loss of ash trees will result in a significant reduction of urban forest benefits. As such, replacement of removed ash tree should be undertaken.

- **Wooded area management:** Ash trees located within wooded areas or along woodlot edges/trails are equally susceptible to EAB infestation and mortality. Trees in wooded areas with the potential to tip-out or otherwise pose risk to persons and property will need to be managed to minimize risk.

- **Wood waste management:** EAB management and associated tree removals will generate a substantial amount of wood waste, as most managed ash trees will be removed. There may be limited options for revenue generation, but wood waste management will likely result in increased costs.

- **Internal and public education and communication:** Communication and outreach are necessary to ensure internal and public awareness of and support for EAB management efforts, and to encourage management of ash trees on private property in the city.

Tree inventory

An understanding of the existing ash tree resource, including attributes such as location, species, size, condition and non-EAB related management requirements (i.e., arboricultural requirements) is fundamental to the development and implementation of an effective management program. At minimum, location, size and condition of municipally-owned ash trees should be known. Ash tree inventory findings will enable a comprehensive understanding of the City's potential risk exposure and the municipal obligation in terms of risk management. A comprehensive inventory will also improve planning, budget setting, and prioritization of activities such as tree removal and injection treatments, and enable the identification of areas for specialized management focus, if any.

Ash trees located within road rights-of-way (urban and rural), parks, and other City-owned properties (e.g., cemeteries, sports facilities, administrative and public works buildings, etc.) should be inventoried. Currently, only ash trees within the City's road right-of-way are inventoried, with an inventory completed in summer 2014.

The total area of non-wooded park lands in Cambridge is approximately 270 ha, while the area of other non-wooded, non-park City-owned parcels is approximately 435 ha. It is anticipated that through further scope refinement it will be determined that only a relatively small proportion of these lands will require an ash tree inventory, and it will simply not be feasible to inventory all City-owned non-wooded properties. The inventory should focus on areas such as high-use parks, cemeteries, and public facilities. Vacant lands should be considered a lower priority for inventory.

It is recommended that the City budget approximately $28,000 for an inventory of ash trees in non-wooded park areas and other non-wooded City-owned properties and undertake inventory collection in 2015.[2]

Additionally, trees located within potential tip-out or striking distance of persons or property in proximity to or within City-owned wooded areas should be inventoried and appropriately managed (typically through removal). Inventory and management of wooded areas is described in greater detail in the *Wooded area management* section, below.

[2] Budget estimate is based on estimate of 8,000 ash trees at an inventory cost of $3.50/tree.

Infestation monitoring

Infestation monitoring involves surveillance actions to detect the presence of EAB infestation and delimit the approximate extent of the infested area(s).

Detection surveys are designed to gather qualitative (yes/no, presence/absence) data about the status of infestation. Detection usually relies on a combination of trapping (installation of baited traps in trees) and visual inspection. Detection surveys have limited utility for determining infestation 'hot spots' or determining the intensity or duration of infestation. Delimitation surveys aim to determine how far an EAB infestation has spread from a given point (usually a known infested area), and are useful in determining the intensity of infestation or pest population densities. Delimitation surveys are most useful for municipalities or other ash tree managers wishing to target specific areas for treatment, particularly in advance of widespread infestation.

Detection survey work was carried out as part of the 2014 street tree inventory. Based upon inventory findings, it is conclusively known that EAB infestation is present in Cambridge, and that ash street trees across the City are infested. While there appear to be infestation 'hot spots' in the northeast, east and southeast sections of the City, infested trees are found throughout the geographic area. Therefore, there is little further utility in undertaking detection or delimitation surveys in Cambridge; instead, management should focus on ash tree management through removal, protection and replacement.

One survey methodology which may still be useful in limited applications is branch sampling. This method, developed by the Canadian Forest Service (CFS) and described in detail online at: http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/32127.pdf can be used prior to undertaking stem injection to confirm absence or limited extent of infestation in a given tree, increasing the likelihood of successful protection.

Otherwise, no recommendations for infestation monitoring are provided due to its limited utility given the current known state of infestation and overall management direction.

Tree and stump removal

Given the near 100% ash tree mortality rate caused by EAB infestation, it is anticipated that a significant proportion of the City's actively managed ash trees will ultimately be removed. While there may be opportunities to preserve certain individual ash trees through stem injection of insecticides, most ash trees will either be removed proactively (before significant tree decline or mortality) or reactively (following tree mortality).

Ash trees must be removed promptly following mortality in order to minimize risk to people and property. Recent research and experience suggest that EAB-killed ash trees become structurally compromised and increasingly prone to whole-tree or component failure within 12 to 24 months following death. As such, proactive removal may reduce the number of trees which must be removed in future years, thereby spreading out the cost associated with timely tree removal and reducing the likelihood of significant work order backlogs for ash tree removal.

Conversely, reactive tree removal enables the ash tree resource to be maintained as long as possible, thereby potentially reducing the visual impact of EAB and ash tree management until trees are nearly dead or dead. However, such an approach is generally not recommended as it is virtually certain that all untreated trees will eventually become infested and will require removal. Waiting until trees are dead will result in a sharp increase in the number of required removals, thereby likely driving up service costs and preventing staff and contractors from fulfilling other urban forest maintenance duties.

A different approach will likely be needed for street and actively-maintained park areas, in comparison to wooded or natural areas. Street trees, and trees located within or in proximity to actively-maintained and frequently used park areas (e.g., sports fields, play areas, etc.) must be removed in a timely manner, preferably in advance of complete mortality. Trees in wooded areas but within potential tip-out distance into roadsides, parks or other potential 'targets' must be managed in a similar manner. Conversely, trees within woodland or natural area interiors should be allowed to fall naturally. Such areas may require temporary closure and access restrictions once trees begin to succumb to EAB in large numbers.

In addition to tree removal, stumps of all removed trees in actively-managed should be ground out to prevent sprouting and to make space available for replanting. Anecdotal evidence strongly suggests that stump sprouts are susceptible to EAB infestation after a few years, and require further management (i.e., removal).

Ash street tree removal

The majority of 4,095 inventoried ash street trees will be removed over the course of four years, beginning in 2015 and continuing until 2018. Each year's ash street tree removal criteria and figures are shown in Table 1, below. Figures shown are for the most aggressive removal approach, which limits the number of trees protected with stem injection to 22. More widespread injection will reduce the number of trees removed.

Table 1: Annual ash street tree removal data. Removal criteria based on 2014 assessments.

Year	Removal Criteria	Trees to be Removed	Estimated Removal and Stumping Cost
2015	• High risk trees • City-owned infested trees	1,104	$ 377,572
2016	• Moderate risk trees • Low risk trees with one or more Poor condition indicators • Shared ownership infested trees	972	$ 342,781
2017	• Low risk trees with one or more Fair condition indicators	911	$ 242,355
2018	• All remaining trees	1,108	$ 283,797
		4,095	$ 1,246,506

Park and other City-owned property ash tree removal

The number of ash trees to be removed from non-wooded parks and other non-wooded City-owned properties is currently unknown, and no reliable estimate of the number of trees in these areas is currently available. It is recommended that the City budget a minimum of $350,000 per year for at least 4 years for ash tree management in parks and other City-owned properties. This figure may need to be revised pending the findings of the recommended park and City-owned property ash tree inventory.

Tree protection

The use of stem-injectable insecticides is an available option for the retention of selected high-value street or park ash trees. Currently, the two most common and available insecticides for use against EAB in Canada are TreeAzin (azadirachtin 5%) and IMA-jet (imidacloprid 5%).

TreeAzin is a trunk-injectable insecticide derived from neem tree (*Azadirachta indica*) seeds. According to pesticide label instructions, TreeAzin is to be injected at a rate of 2 ml per cm DBH as a prophylactic (preventive) treatment, and 5 ml per cm DBH for infested trees or trees greater than 30 cm DBH. Any injections in Cambridge would likely need to be undertaken at the higher dosage rate. According to latest guidance provided by BioForest Technologies, annual injection or two rounds of injection every 3 years may be required to provide satisfactory control of EAB by preventing complete larval development, reducing female fecundity, and limiting egg viability.

IMA-jet is an imidicloprid-based insecticide, and has been available in Canada since 2014. According to pesticide label instruction, IMA-jet is to be injected at a rate of 1.6 ml to 3.2 ml per cm DBH, depending upon tree size and infestation rate. For optimal EAB management, annual injection of IMA-jet is recommended.

Street tree treatment

It is anticipated that the application of stem-injectable insecticide treatment will be limited to a select few significant ash trees in Cambridge. Three injection regimes have been modeled based upon the ash street tree inventory, as described in Table 2, below.

Table 2: Modeled ash treatment regimes.

Regime	Criteria for Injection	Street Trees Treated / Injectable DBH	Annual Cost[3]
Strict	• TI: G • CS: G • CV: G • RISK: Low • EAB_INFEST: F • DBH: 30+ • No outstanding arboricultural recommendations (except re-inspection) • No utility conflicts	22 / 857 cm	$ 3,857
Moderate	• TI: F or G • CS: G • CV: G • RISK: Low • EAB_INFEST: F • DBH: 25+ • No outstanding arboricultural recommendations (except re-inspection) • No utility conflicts	45 / 1472 cm	$ 6,624
Aggressive	• TI: F or G • CS: F or G • CV: G • RISK: Low • EAB_INFEST: F • DBH: 25+ • No outstanding arboricultural recommendations (except re-inspection) • No utility conflicts	184 / 6378 cm	$ 28,701

[3] Annual treatment cost based on assumed injection cost of $4.50/cm DBH.

Treatment of ash trees in parks and other City-owned properties

Additional costs may be incurred if treatment is to be extended to ash trees in parks or on other City-owned properties. Without inventory data and specific treatment criteria, the potential cost is currently unknown. A $6,000 annual contingency for treatment of ash on these lands is recommended.

Resident-supported treatment

The City should consider implementing a resident-supported tree treatment program, whereby residents can apply for permission to inject City-owned trees in front of their properties that either do not meet City treatment program criteria or are not included in the treatment program for other reasons, and pay the cost of injection. Such programs have been implemented in the Town of Oakville and several American municipalities, with moderate resident uptake. Under such a program, it must be made clear that the City will not assume responsibility for the cost or results of injection treatment. The City should, however, assume responsibility for removal of ash trees which die if treatment fails or is suspended.

Tree replacement

EAB infestation will result in the loss of the majority of ash trees in Cambridge. Accompanying these losses will be the loss of a wide range of benefits, including air quality improvement, stormwater control, aesthetics and wildlife habitat, among many others. This loss of benefits may have significant adverse effects upon the City's residents. For example, recent research (Donovan *et al.*, 2013) found that widespread ash tree mortality is directly linked to increased human mortality due to a correlated increase in cardiovascular and lower respiratory tract-related illnesses.

As such, it will be important to replace dead and removed ash trees with new plantings of appropriate species, and to encourage and promote tree establishment across the City. It is recommended that, at minimum, a 1:1 removal to replacement ratio be maintained. A higher replacement ratio and replacement of removed park trees are preferred, but may be cost-prohibitive at the current time. Given that it may take upwards of 30 years for a newly-planted tree to begin providing substantial urban forest benefits, it is recommended that infill and underplanting (planting prior to tree removal) be undertaken.

Wooded area management

Ash trees in wooded areas (particularly along woodland edges adjacent to roadways, parks or properties and in proximity to formal trails) may require active management. Management will typically be restricted to tree removal, as injection is such areas is not considered feasible or sustainable.

It is not feasible or practical to inventory individual trees within or on the edge of woodlots for the purposes of management. Instead, a woodland ash tree inventory should collect basic data, such as tree size class distribution counts, within contiguous groups of ash trees (see Fig. 2). Such information will

inform tree removal contract tendering and budgeting, and inform an understanding of general risk exposure and management priorities.

Based on GIS analysis of City-owned wooded areas, it is estimated that the City is responsible for approximately 97 kilometres of perimeter of wooded park areas and 92 kilometres of perimeter of wooded non-park areas (i.e., wooded areas on City-owned property). A detailed analysis of wooded areas with potential targets in their proximity has not been undertaken.

Figure 2: Detail of group-based ash tree woodlot edge inventory. Colour-coding shows potential risk levels.

It is recommended that a 'windshield survey' of all City-owned wooded areas be undertaken to determine if: a) potential targets are present adjacent to or within the wooded area and b) if ash trees are present in the woodlot. The results of this survey can then inform the undertaking of a more detailed inventory of ash along wooded area edges and trails.

It is also recommended that the City budget approximately $6,500[4] for a desktop-based wooded area prioritization analysis (to identify City-owned wooded areas with potential targets) and a 'windshield survey' of ash presence at wooded area edges and along trails. The findings of this first phase of analysis

[4] Cost estimate is based on estimated 7 person-days of GIS analysis and field data collection.

will inform the scope of a more detailed inventory; a preliminary cost estimate for this inventory is approximately $25,000.[5] The analysis and inventory should be undertaken in 2015 or 2016.

Finally, the City will need to undertake removal of ash trees in high-risk areas such as wooded area edges and along primary formal trails. The extent of removals will be determined based upon the ash tree inventory. The City may need to budget approximately $200,000 per year for at least 3 years for ash tree removal, beginning in 2017 at the latest.

Internal and public education and communication

Education and communications are necessary to ensure internal (management and staff) and public support of EAB management, and to encourage private property owners to manage their ash trees.

Effective communications about EAB management in Cambridge will include discussion or description of:

- methods of identifying ash trees and EAB signs and symptoms;
- the threat of the emerald ash borer to municipal and private trees;
- ongoing updates about the status of the infestation and planned and proposed management activities;
- the responsibilities of residents to monitor and manage their own trees, and;
- external resources, including identification guides, management strategies, agencies and scientific publications.

Good communication may help encourage interagency, interdepartmental and public cooperation, such as information sharing or resident-supported tree injection, and may calm potential anxieties regarding the threat of EAB or possible solutions. Poor communication may erode support for the EAB management program, increase losses of trees and their associated benefits, and lead to a general misunderstanding or mistrust of the agencies involved.

A combination of communication and outreach tools will be necessary to reach the largest possible number of potentially affected individuals, businesses and organizations in Cambridge.

- **Internet:** As the internet is a primary source of information, a webpage (part of the City's website) dedicated to EAB-related information will be among the most effective means of public communication. The City does currently have a section on its Forestry webpage about EAB, but information is limited and, in some instances, incorrect (e.g., number of ash trees and extent of infestation). The page should be overhauled and updated. It should include answers to "Frequently Asked Questions (FAQs)", links to external resources, updates about the program, and other

[5] Cost is based on estimated 25 person-days of inventory collection. May vary significantly based upon findings of prioritization analysis and 'windshield' survey.

information described above. This webpage should be promoted on the City's main web portal through the "Latest News" highlight section and elsewhere on the website. The estimated cost of preparing improved web content for the EAB section of the Forestry web page is $1,000.

- **Paid advertising:** Additional communications should include occasional information updates through local media, including informational advertising as well as press releases to local news outlets such as the Cambridge Times and/or The Record. An annual budget of $1000 should be allocated for paid advertising.

- **Printed materials:** Printed materials, such as flyers and pamphlets can provide residents with a wide range of information about emerald ash borer and urban forest management in general. Printed materials can be readily distributed in conjunction with municipal tax and water invoices. An annual budget of $1,000 should be allocated for printed communications materials.

- **Internal awareness and engagement:** Roads and parks maintenance staff, and other staff who work with or around trees, should be taught to identify ash trees and the signs and symptoms of EAB infestation and dead or dying ash trees. They should be encouraged to report and record sightings of infestation or tree mortality, especially in parks or wooded areas where an inventory has not been conducted.

- **Public Information Centres (PICs) and other community forums:** The City should also be prepared to communicate with residents through Public Information Centres or other community forums, such as Earth Day or other environment-themed events. Forums or open houses allow citizens the opportunity to speak with City representatives directly, and express concerns or gather more information. Experience in other municipalities shows that resident delegations on both sides of the spectrum may be expected to attend such meetings; for example, residents opposed to the application of insecticides may need to be informed about the necessity of protecting ash trees using such methods, while others may need to be shown the high costs and impracticability of wide-scale injection. An annual budget of $1,000 should be allocated for public communications to cover the cost of facility rentals (if necessary), materials, etc. This does not include potential staff overtime (if necessary) for PICs or other events held outside of normal working hours.

Recommendations and Budget Implications

Table x: EAB management recommendations for Cambridge, 2015-2018.

Action	Timing	Estimated Resource Requirements			
Ash tree inventory		2015	2016	2017	2018
Undertake inventory of ash trees in non-wooded actively managed parks and other non-wooded City-owned properties.	Spring or early Summer 2015	$28,000			
Infestation monitoring					
No recommended actions for infestation monitoring.					
Ash tree and stump removal					
Undertake removal of ash street trees according to criteria and stump removal.	2015-2018	$378,000	$343,000	$242,000	$284,000
Undertake management of ash trees in parks and other City-owned properties.	2016-2018		$350,000	$350,000	$350,000
Ash tree protection					
Undertake injection treatment of selected ash street trees.[6]	2015 - ongoing	$3,900 – $ 28,000	$3,900 – $ 29,000	$4,000 – $ 30,000	$4,000 – $ 31,000
Undertake injection treatment of selected ash park/City property trees.[6,7]	2015 - ongoing	$6,000	$6,000	$6,000	$6,000
Consider implementation of resident-supported tree injection program.	2015	-	-	-	-
Tree replacement					
Undertake replacement planting at minimum 1:1 planting to removal ratio for street trees.	2015-2018	$552,000	$486,000	$455,500	$554,000
Wooded area management					
Undertake desktop analysis and windshield survey of all City-owned park and non-park wooded areas to identify target potential and ash presence/absence.	2015 or 2016	$6,500			
Undertake group-based inventory of ash trees in City-owned park and non-park wooded areas.	2016		$25,000		
Undertake management of ash trees in wooded areas.	2016-2018			$200,000	$200,000
Communications					
Update EAB section of Forestry webpage with current and expanded information.	2015	$1,000			
Undertake other communications as necessary.	2015 - ongoing	$3,000	$3,000	$3,000	$3,000
Total		$978,400 – $1,002,500	$1,216,900 – $1,242,000	$1,260,500 – $1,286,500	$1,401,000 – $1,428,000

[6] Cost varies depending upon selected treatment regime and criteria for injection.
[7] Commencement of injection in 2015 assumes completion of ash tree inventory in spring or early Summer 2015. Delay in treatment may result in reduced numbers of treatment-suitable trees.