Town of Essex
Street Tree Management Plan

Essex Town Center bike path. Photo credit: Sharon Kelley

Prepared by: Town of Essex Conservation and Trails Committee

TOWN OF Essex, Vermont

Adopted June 18, 2018

Acknowledgments

This street tree management plan was produced through collaboration between the Town of Essex's Planning Department, the Town of Essex Conservation and Trails Committee, and the Vermont Urban and Community Forestry Program of University of Vermont Extension (VT UCF).

The plan was created using data from a street tree inventory of the Town of Essex performed in July 2016. Elise Schadler, of VT UCF, provided many hours of consultation, organizational preparation, and implementation of the tree survey. Other VT UCF staff, as well as Chittenden County Forester Ethan Tapper and other staff of the Vermont Department of Forest, Parks, and Recreation, assisted the Town of Essex Community Development Department, the Conservation and Trails Committee, and volunteer members of the public to conduct the tree survey. Thank you to all who came out to inventory trees in Essex!

2016 Tree Inventory Volunteers. Photo credit: Elise Schadler, Vermont Urban and Community Forestry Program

In developing this management plan, Margaux Reckard, member of the Conservation and Trails Committee, researched and compiled the written report. Darren Schibler, Town Development Planner, and Greg Duggan, Deputy Town Manager, provided oversight, advice, and management recommendations. Ian Lyle, Essex Conservation and Trails Committee Intern for 2016, analyzed the street tree inventory data used in this plan. Meredith Whitney, of VT UCF, provided immensely helpful suggestions and support for the plan's invasive species management section. The Town of Essex Public Works Department provided input on current and future budgeting and operations.

Thanks also goes to members of the Essex Conservation and Trails Committee in their continued efforts to advise the Town of Essex to protect and conserve the town's natural, cultural, and historic resources: Eric McCarthy (Chair), Cristine Hammer (Vice Chair), Justin St. James (Clerk), Jaysen Dickinson, Hilary Jones, Andrew Mills, Dan Stein, and former members Heather Brochu, Ruth LeBlanc, Susan Kissel, Margaux Reckard, and Darren Schibler.

Contents

I. Introduction

A. Background Information

According to the International Society of Arboriculture ("Benefits of Trees," 2011), healthy urban forests provide a wide range of benefits to a community far beyond their aesthetic appeal, including:

- Improved air quality
- Improved Carbon sequestration from photosynthesis
- Improved stormwater mitigation as leaves and roots retain rainwater
- Reduced energy use and cost for cooling in warm weather
- Lower water use compared to irrigating sun-parched and windswept landscapes
- More urban wildlife habitat
- Higher property values
- Traffic calming and reduced crime

Without proper management, urban forests are susceptible to disease and pests, which can result in negative consequences, such as:

- Increased stormwater runoff due to loss of tree canopy and subsequent sediment and phosphorus erosion to waterways
- Increased cost for municipalities to remove and replace public trees
- Increased electric outages from dead trees falling on power lines, especially in rural areas

The Town Plan for the Town of Essex in 2016 recommended that the 2002 Street Tree Inventory be updated due to the threat of invasive tree pests to many of Essex's natural areas. The Conservation Committee (now a merged Conservation and Trails Committee as of July 2017) immediately started work on this goal, and widened its scope to also create a Street Tree Management Plan. This document summarizes that data, sets the policy for the maintenance of town-owned trees, and sets policy for responding to invasive tree pests.

B. Purpose and Authority

This plan covers trees in Town-owned rights-of-way, parks, and natural areas, but not Town forests, such as Indian Brook Park and the Mathieu Town Forest, which should have their own forest management plans. Trees on private lands are the responsibility of landowners, and trees within the State right-of-way are the responsibility of the Vermont Agency of Transportation (VTRANS). However, the Conservation and Trails Committee hopes to collaborate with the Parks and Recreation Department, the Public Works

Department, private landowners, and VTRANS to accomplish the goals of this management plan and provide technical, logistic, and financial support where possible.

Work within the Town right-of-way is governed by the right-of-way deed or easement; information on the extent and nature of these rights-of-way can be obtained from the land records and from the GIS Coordinator.

C. Partners and Funding

This street tree inventory for the Town of Essex was accomplished through collaboration between Vermont Urban and Community Forestry Program ("VT UCF"), the Essex Conservation and Trails Committee ("CTC"), the Essex Public Works Department ("EPW"), and many volunteers, among others.

Essex Conservation and Trails Committee

The mission of the Committee is to inventory and study the natural, historic, educational, cultural, scientific, architectural, or archaeological resources of the town in which the public has an interest; and to preserve, develop and maintain a multi-use trail, sidewalk, and greenway system in the Town of Essex that will link residential neighborhoods to natural areas, schools, parks, businesses, recreational facilities, community centers, and neighboring towns. The Committee also advises the Selectboard and Planning Commission on matters relating to the public understanding of local natural resources and conservation needs, development applications and acquisition of lands involving the above resources.

The Committee does not have a budget or general funding, but its volunteer members dedicated their time and expertise to the street tree inventory and management plan. Volunteers from the Town of Essex also dedicated their time to collecting data for the 2002 and 2016 public tree inventories, and Essex High School STEM Academy student Ian Lyle processed and summarized the data presented in the "Results" section of this document.

Vermont Urban and Community Forestry Program

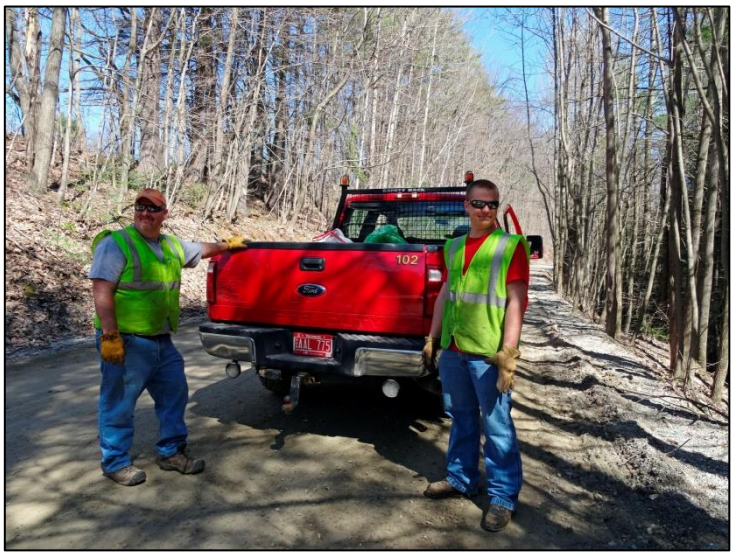
A division of the Department of Forest, Parks, and Recreation, the Vermont Urban and Community Forestry Program's mission is to lead citizens, businesses, and governments in understanding the value of urban and community forests and to promote civic responsibility for and participation in the stewardship of these resources for this and future generations. The program has helped 27 communities in Vermont perform street tree inventories through the Care of the Urban Forest Project. The Care of the Urban Forest Project was a multi-year effort funded by the USDA Forest Service; the goal of the project was to strategically support 20 Vermont communities in moving their municipal tree programs forward through a three-pronged approach: 1) conducting a street tree inventory, 2) developing a strategic action plan or urban forest management plan, and 3)

providing an in-house technical tree care training for Public Works and Parks Departments, as well as citizen volunteers.

VT UCF contributed funding to this project in the form of staff time, which included pre-project planning, mapping technical assistance, and data collection. The program also provided tools to perform data collection, including iPads, measuring tapes, and DBH tapes.

Town of Essex Public Works Department

The Public Works Department is responsible for overseeing Town infrastructure services and planning, which includes water, sewer, stormwater, traffic, roads, and Town-owned trees. The latter responsibility, which includes maintenance and planting of trees in the public right-of-way, is managed specifically by the Essex Tree Warden.



Essex Public Works crew members on Green-Up Day. Photo by Sheri Larsen.

The Public Works operating budget for Fiscal Year End 2019 includes $13,950for the ongoing maintenance of Town-owned trees and landscaping around public buildings and road islands; of this, $2,500 is dedicated for new plants, and the remainder is dedicated for dead tree removal. Labor for this work is paid out of the Public Works Salaries account. When necessary, tree maintenance work is contracted out.

Town of Essex Capital Budget

The Town's Capital Projects budget includes a "Natural Resource Management" account, which is projected to have a balance of $15,014 as of June 30, 2018. These funds were originally intended for completion and implementation of a street tree inventory and management plan. None of those capital funds have been used to date, and could therefore be dedicated to implementation. See sections III ("Management Recommendations") and IV ("Invasive Tree Pest Management") for detailed information on funding implementation.

The massive windstorm of October 30, 2017 resulted in significant tree damage and may require funds from this account, though the Town may receive some reimbursement for these costs from the Federal Emergency Management Agency (FEMA). Furthermore, the current level of funding is not sufficient to undertake comprehensive re-planting of Town-owned trees if invasive insects become epidemic, and further funding should be dedicated

to invasive tree pest management. See sections III ("Management Recommendations") and IV ("Invasive Tree Pest Management") for details on implementation and cost analysis.

Other Partners

In addition to those listed above, the Essex Conservation and Trails Committee worked with the following organizations to prepare the Street Tree Management Plan:

- Village of Essex Junction Tree Advisory Committee
- Town of Essex Planning Commission
- Town of Essex Parks and Recreation Department
- The University of Vermont

D. Street Tree Management Goals

This Street Tree Management Plan for the Town of Essex outlines the Town's objectives and the actions it will take to meet the current or anticipated needs of its urban and community forests. The goals and actions of this management plan take into consideration the objectives and strategies of the Village of Essex Junction Urban Forest Management Plan, adopted in January 2016, as well as the 2016 Essex Town Plan. See Appendix A for more details on timeline, lead party or parties responsible for implementation, and potential partners and funding sources for each action.

Goal 1: Pursue Tree City USA designation.

Action A. Establish an urban forest management budget of at least $2 per capita funded through tax and/or non-tax revenues.

Action B. Designate a citizen board to oversee urban tree care.

Action C. Adopt a Tree Care Ordinance using the standards of the Arbor Day Foundation and the Vermont Urban and Community Forestry Program.

Action D. Proclaim and observe Arbor Day through celebrations and activities.

Goal 2: Continue to monitor the health of public trees in Essex.

Action A. Keep the town's public tree data current by performing periodic tree inventories.

Action B. Perform a rural areas survey so that invasive species prevention, monitoring, and treatment are not limited to urban trees.

Goal 3: Improve and maintain the health of the urban forest in Essex.

Action A. Increase species diversity among street trees by replacing some trees and planting new trees where space allows.

Action B. Ensure Site Plan and Landscaping guidelines in the Zoning and Subdivision Regulations take into account urban forest health and aim to prevent the spread of invasive pests.

Action C. Monitor the health of individual street trees, especially larger specimens, and prune and treat trees as needed.

Action D. Replace street trees that are dead and dying.

Action E. Identify sites for new street trees, especially in the Town Center area and Susie Wilson corridor.

Action F. Invest in new street trees, especially in the Town Center area and Susie Wilson corridor.

Goal 4: Prevent or mitigate impacts of invasive tree pests on public trees in Essex.

Action A. Monitor public trees for signs of invasive pests.

Action B. Maintain up-to-date forest management plans (including a section on invasive pests) for Town-owned forests, including Indian Brook Park, Mathieu Town Forest, and Saxon Hill Forest.

Action C. Provide public training and outreach on identifying signs of invasive pests.

Action D. Create an invasive pest response plan and associated budget that is revisited and refined each fiscal year.

Action E. Maintain a list of certified arborists and pesticide applicators for treatment and/or removal of infested trees.

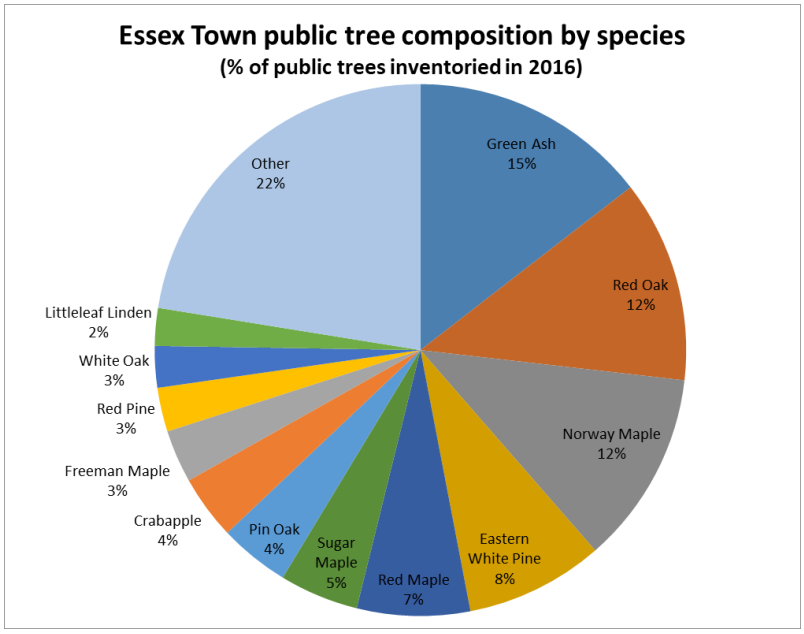
II. Street Tree Inventory Results

In July 2016, the Essex Conservation and Trails Committees, with tremendous assistance from the VT Urban and Community Forestry Program and community volunteers, completed an update to the 2002 Street Tree Inventory and also captured streets and neighborhood parks that were missed or not yet built at that time. This included a total of 1,309 trees managed by the Town of Essex, both in the public right-of-way of 145 streets (44 miles of street) as well as in four urban parks. The results of this inventory are presented below, and represent only the trees surveyed in 2016, and not all trees in Essex.

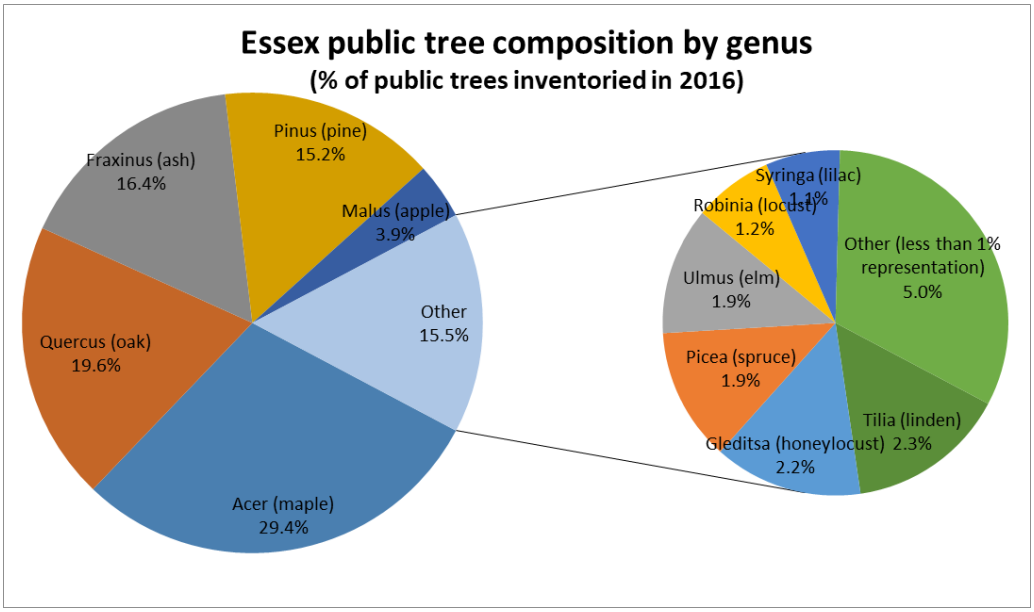
In this inventory, a GPS and street address location were recorded for each tree, along with the species, diameter, and overall health of the tree. All data are summarized here and are also available to the public via the VT Agency of Natural Resources Atlas (hosted at http://anr.vermont.gov/maps/nr-atlas). The Conservation and Trails Committee hopes to collaborate with VT UCF and the Public Works Department to continue updating the inventory for maintenance purposes, either on a rolling basis as new public trees are planted, or through periodic inventory updates.

A. Tree Species and Genus Composition

Green ash (*Fraxinus pennsylvanica*) was the most common species, making up 15% of all the trees inventoried, validating concerns over susceptibility of the Town's street trees to invasive pests such as emerald ash borer (*Agrilus planipennis*). Emerald ash borer was found in Vermont in the winter of 2018. Another invasive pest, the Asian longhorn beetle, targets the most common genus, maples (genus *Acer*) – comprised of both natives such as red maple (*Acer rubrum*) and sugar maple (*Acer saccharum*) as well as the non-native and invasive Norway maple (*Acer platanoides*).

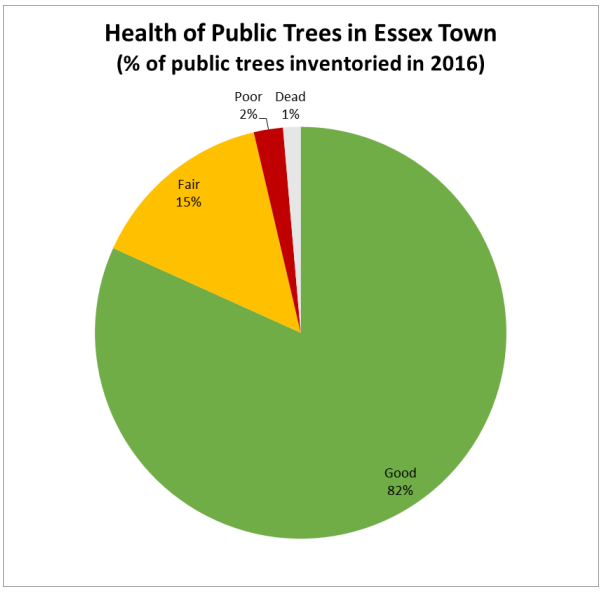


While the overall diversity of street trees in Essex is relatively well-balanced, future plantings should be selected to reduce dominance of any species or genus; take into consideration current and future (climate-changed) site conditions; and avoid species with known pest susceptibilities.



B. Tree Health and Structure

Volunteers rated the overall health of each tree inventoried into one of four categories: "good," "fair," "poor," and "dead." A vast majority of trees surveyed were found to be in good condition, and only a few were poor or dead. Most of those in fair condition have suffered limb or trunk damage and may need to be removed or replaced eventually. Often this damage appears to have resulted from improper tree care or careless landscaping, such as lawnmower damage or volcano mulching, which occurs when mulch is piled too high around a tree.



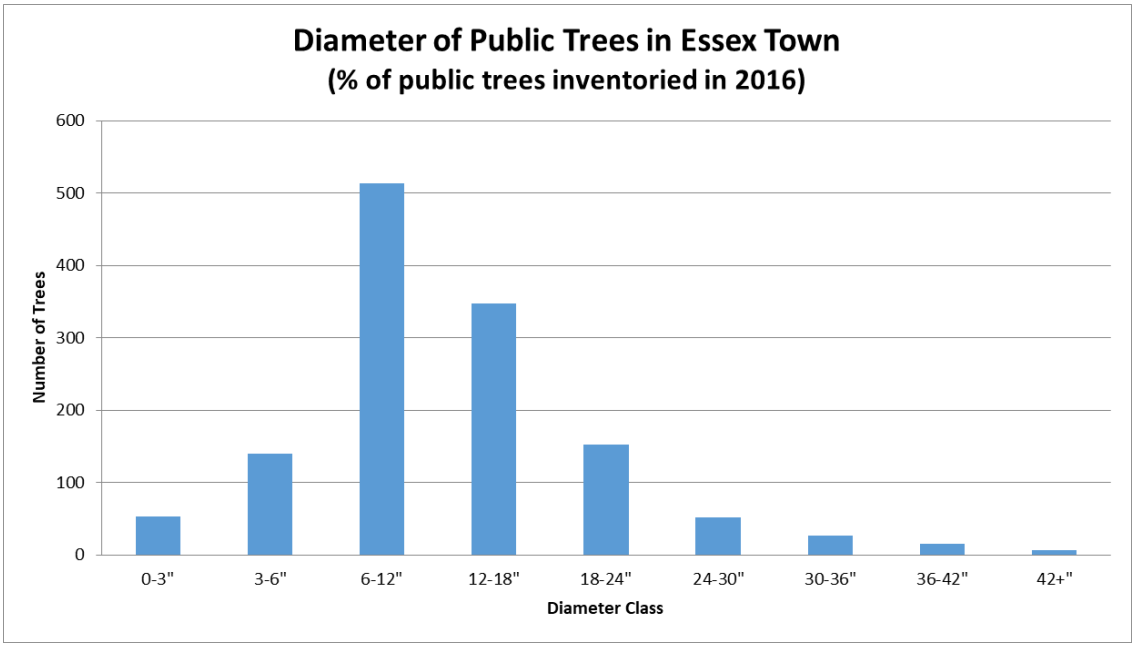
The size of trees was also measured using diameter at breast height (DBH) in inches, broken down into nine classes (0-3", 3-6", 6-12", 12-18", 18-24", 24-30", 30-36", 36-42", 42+"). The data show a normal distribution, slightly skewed toward smaller diameter trees. Over half the trees inventoried were between 6 and 18 inches, promising steady growth in the future of the urban forest.

III. Street Tree Management Recommendations

The Tree Warden, Conservation and Trails Committee, and Public Works Department should collaborate to preserve and monitor large trees; monitor and address problem trees; perform a rural areas survey to complement the street tree inventory; and explore potential sites and funding for new tree plantings.

A. Preserving and Monitoring Large Trees

A significant number of trees inventoried were quite large; these older, majestic specimens should be protected whenever possible and closely monitored for disease or damage. If large trees die or are removed, new trees should be planted in their place, and the Town should also continue to encourage the planting of young trees, and should seek out places where new trees can be planted. New plantings to replace dead trees, especially those affected by invasive insects, should be of diverse ages and species.



B. Street Tree Monitoring and Management

In the street tree survey, 79 trees were marked as needing monitoring by the Town; the Tree Warden should investigate each of these trees and consult with Public Works on next steps for the management of these trees. Any trees identified as dead should also be removed by Public Works or a contractor. The public can report problem trees through the "See-Click-Fix" app, which is already used for infrastructure problems.

Special attention should be given to areas of the town identified in the street tree survey as having dense plantings of pest-susceptible species. The following streets and greenspaces with concentrated plantings of ash, maple, and hemlock should be monitored:

Areas with high concentrations of ash

- Bluestem Road
- Cavendish Drive
- Cedar Street
- Dalton Drive
- Fox Run Road
- Raymond Drive
- Sand Hill Park
- Saybrook Road
- Weathersfield Bow Drive
- Willoughby Drive

Areas with high concentrations of maple

- Lilac Lane
- Bobolink Circle
- Thomas Lane
- Peacham Lane
- Bluestem Road
- Raymond Drive (neighborhood)
- New England Drive
- Fox Run Road
- Fort Ethan Allen Parade Grounds
- Foster Road Park
- Saxon Hollow Park
- Sand Hill Park

No hemlock trees were identified in the street tree survey, but are present in the town's forests and on private property. It is recommended that the Conservation and Trails Committee, Parks and Recreation Department, and the Tree Warden monitor hemlock trees in all Town forests, parks, and green spaces for signs of hemlock wooly adelgid (HWA) infestation. See section IV(C) for management recommendations for infested hemlock trees.

A total of 11 mature eastern white pines were identified by the street tree survey in Foster Park, Sand Hill Park, and the Fort Ethan Allen Parade Grounds. They are also prevalent overstory trees in Indian Brook Park, Saxon Hill Forest, and Mathieu Town Forest. These should be monitored due to their susceptibility to white pine blister rust and the white pine weevil. Unfortunately, these threats are both well-established in the Northeast and eradication is unlikely, but certain silvicultural practices can limit their impact on trees within forests (Ostry, Laflamme, and Katovich). White pine is not recommended as a landscape or street tree, since open-grown pines are the most susceptible to the pine weevil, and are also prone to blowdown due to their top-heavy canopy. Any landscaped white pine infested with pine weevil or blister rust should be replaced with trees more suitable to the site.

Signs of white pine blister rust include: crown dieback; browning needles; stem and trunk lesions with oozing resin or rupturing blisters (UMass Extension). Signs of white pine weevil infestation include shiny droplets of resin at location of insect punctures crooked branches or trunk, especially over three feet. Trees located in direct sunlight are more susceptible to blister rust (Pennsylvania State University Dept. of Entomology).

C. Rural Areas Survey

It is recommended that the Conservation and Trails Committee perform a rural areas survey to better understand species diversity and susceptibility outside of developed areas of town. The CTC should collaborate with the Chittenden County Forester to determine where forest stands have been mapped, and which areas do not have data. Further, the Committee should collaborate with conservation commissions in neighboring municipalities to create a regional "neighborhood watch" for invasive insects.

D. Street Tree Plantings

To improve the resilience of the urban forest to invasive pests, the Town should find ways to ensure that the urban tree population maintains high diversity (the number of different tree types) as well as evenness (equal proportions of different tree types) over the entire population as well as within a given geographic area. In other words, no one species, genus, or family should be over-represented.

As a general rule of thumb, street tree populations should consist of no more than 10% of any one species, 20% of one genus, or 30% of any one family of trees (Simons and Johnson, 2008; Santamour, 1990). However, this is only a guideline and is subject to a number of different factors, including tree health, site conditions, changing threats and priorities, and financial and logistical constraints.

The neighborhoods identified in Section III(C) above would benefit from proactive removal and replacement of certain dominant trees, such as maple or ash, with under-represented trees and ideally those with no known pest susceptibilities. However, healthy mature trees should not be removed unless there is an imminent threat from an invasive tree pest that would make the tree hazardous or costly to remove, and pesticide treatment is not an option.

The Town should also promote a better urban canopy in areas that have currently little or none, such as the Town Center and Susie Wilson corridor, whether through public or private trees. One tool to accomplish this is to update the Site Plan and Landscape Guidelines, which the Planning Commission uses to review proposed developments, to align with the recommendations in this plan and resources recommended by VT UCF, such as the Vermont Tree Selection Guide.

IV. Invasive Tree Pest Management Plan

A. Background

Invasive tree pests and diseases have the potential to decimate urban forests because native trees have not developed a resistance to foreign parasites. The history of elm trees in urban landscapes provides a cautionary tale about invasive tree pests. Until the 1960s, Vermont's streets were lined with towering elms. But with the introduction of Dutch elm disease—caused by a fungus that is spread by elm bark beetles, both native to Asia—mature elms succumbed to the disease in vast numbers across the U.S. and Europe (USDA Forest Service, Northeastern Area State and Private Forestry). Today, healthy mature elms are uncommon, though research is under way to cultivate trees with resistance to the disease (UVM Tree Profiles).

Elm, along with maple, ash, hemlock, and other tree species that could be attacked by invasive pests, make up nearly two-thirds of the trees in Vermont's woodlands and urban forests. The 26.9 million trees in Vermont's urban and community forests—along streets and within public parks and woodlots, provide millions of dollars of environmental, social and economic benefits annually (Vermont Urban and Community Forestry).

Invasive pest outbreaks can reduce or eliminate many of the benefits of a healthy urban forest, listed in Section I(A) of this plan. Research shows that an overwhelming portion of the costs of invasive tree pests are borne by municipal governments and homeowners (Aukema et al., 2011). The impact of these pests on Vermont's urban forests will be devastating, and it is vital that the Town of Essex, Vermont's second largest municipality, prepare a management plan in advance of these pests.

B. Invasive Tree Pest Information and Identification

Currently, there are three invasive insects that pose the greatest threat to Vermont's trees (Vermont Urban and Community Forestry): emerald ash borer (EAB), Asian longhorned beetle (ALB) and hemlock wooly adelgid (HWA) have been detected throughout the Northeast, and are threateningly poised to devastate Vermont's woodlands and wood products, maple sugaring, and tourism industries to which they are connected (Vermont Invasives, "Impact"). Except where otherwise noted, the following profiles are summaries from the "Gallery of Forest Pests" pages on the Vermont Invasives website (www.vtinvasives.org).

Emerald ash borer

The emerald ash borer is a half-inch long, bullet-shaped, metallic green beetle that feeds only on ash (genus *Fraxinus*). Adult beetles lay their eggs in the folds beneath ash bark where the larvae tunnel through the bark and feed on the vascular tissue responsible for

transporting sugar and nutrients throughout the plant. As larvae feed on this vascular tissue, the ash becomes less able to transport nutrients to the top of the tree, killing the tree from the top down in a span of 2 to 5 years, depending on the size and health of the tree. Healthy ash trees will die within 1 to 3 years of their first sign or symptom. There is a 99.7% mortality rate in ash trees infested with EAB. The spread of EAB has been facilitated through human assisted dispersal, such as human transport of firewood. Another factor in facilitating the spread of EAB has been the lack of natural ash tree resistance and natural predators in the United States. As of this writing, EAB has been responsible for the destruction of 100 million trees in the United States. EAB was first detected in Vermont on February 27, 2018 in the Town of Orange (Zind, 2018), and is widespread throughout New England and Quebec (Emerald Ash Borer Information Network).

Signs of EAB infestation include d-shaped exit hole, crown dieback, epicormic shoots, serpentine galleries, and woodpecker foraging.


D-shaped exit hole


Crown dieback


Epicormic shoots


Serpentine galleries


Woodpecker foraging

Images sourced from the Town of Williston Emerald Ash Borer Preparedness Plan

Hemlock woolly adelgid

The hemlock woolly adelgid is a small, aphid-like insect that feeds on hemlock trees (genus *Tsuga*). The name "woolly" comes from the fuzzy "wool" it attaches to the twigs of affected trees. Native to eastern Asia, the insect was introduced to the Unites States in the 1920s in the Pacific Northwest, and in the 1950s in the Virginia area. It has since spread throughout the eastern U.S., and was detected in Windham County, Vermont in 2007. The hemlock woolly adelgid feeds on young twigs, causing widespread needle fallout; often trees will die in 4 to 6 years. The eastern hemlock has been most devastated by HWA due to the absence of natural controls.

Signs of HWA infestation include yellowing needles, needle fallout, branch dieback, and crown thinning.

Asian longhorned beetle

The Asian longhorned beetle is a beetle native to Asia that bores into maples and other hardwoods. Adult beetles are 0.75 to 1.50 inches long, with black and white banded

antennae and a glossy body with irregular white spots. ALB was introduced in the United States accidentally in cargo from Asia; its first breeding populations were discovered in New York in 1996 (USDA, *Invasive Species Info*). ALB kills young and mature trees by tunneling within the trunk and branches, disrupting the sap flow and weakening the tree. ALB threatens a wide variety of hardwood trees in North America—including maple, birch, elm, willow, ash, and poplar—which could have devastating effects for forest ecosystems in Vermont and throughout the Northeast if the pest becomes established over a large area. ALB has not yet been found in Vermont, but it has been found in Michigan, New Jersey, New York, and Pennsylvania, among other states.

Signs of ALB infestation include: exit holes that are round, drill-like, and pencil-sized; yellowing or drooping leaves; a series of chewed round depressions in bark; and sawdust buildup.

C. Invasive Pest Management Strategies

In order to minimize the cost and risk of property damage from tree pest outbreaks, the Town should combine both preventative and reactive measures in its management efforts. Different management actions include tree removal, plantings and replantings, insecticide treatment, and handling of infested wood after removal. Decisions will vary based on circumstances in a stand or neighborhood, and should also take into consideration the threat of an infestation spreading and the long-term health of trees. Pest management for public lands such as Indian Brook Park and Mathieu Town Forest should follow a forest management plan certified by a professional forester.

It is difficult to predict the total cost of comprehensive invasive tree pest management up-front. Some pests may never arrive in Essex, and new pests may emerge that target trees not yet considered susceptible. The cost of removal and replanting depends on the tree and the site, and insecticides for some pests are not available yet and have unknown costs. Given all that, budgeting for invasive pest management should be adaptive and flexible, with enough reserve to respond quickly to a sudden outbreak, which is very challenging for a municipal government.

Due to the more imminent threat of EAB and ALB, and the high proportion of public trees susceptible to those pests in Essex, the Town should prioritize management actions for those pests. Appendices B and C show cost estimates for EAB and ALB management using various treatment options, including removal and chemical treatments, based on data from the 2016 tree survey.

The Town of Essex has identified only one hemlock tree as a street tree, but the threat of HWA infestations is still present for the Town – such as in Town forests and on private

property. As with other invasive pests, quarantines, chemical treatments, and biological controls can effectively curb the spread of HWA, reducing infestation rates and protecting healthy or at-risk individual trees. For Town forests, these strategies should be included in a forest management plan.

1. Removal

In general, proactive removal of susceptible trees (before discovery of an infestation) carries a more predictable cost that can be spread out over time. If combined with selective replanting, it will eventually create a more diverse urban forest, preventing rapid spread of tree pests and reducing the risk that a single pest will affect a large area (see "Plantings and Replantings" for more details). This is especially important in areas with extensive single-species stands of ash, maple, hemlock, or other susceptible trees. However, proactive removal of pest-susceptible trees may result in the loss of resistant trees; therefore, the goal of proactive removal should be to improve the overall health of the urban forest, rather than simply removing all host trees to prevent the spread of a pest.

Reactive removal involves cutting down trees after an infestation is discovered, generally only after 50% of the canopy has died and they pose a public safety risk. The advantage of reactive removal is that no healthy trees are removed, retaining pest-resistant trees while preserving both the benefits of mature trees and the financial investment they represent. Reactive removal is more appropriate in areas of higher species diversity, because the risk of pests spreading is less, and can be used to contain a pest to a limited area.

However, there are several disadvantages of reactive removal. If infested trees are allowed to stand, the insects will breed and spread to other nearby trees, both naturally and from residents moving firewood or other wood products and debris. Dead trees quickly become hazards to people and property, and removing dead trees is 2 to 3 times more expensive than removing live or dying trees due to safety considerations and because dead trees have a tendency to shatter into many pieces when they fall, adding to clean-up costs (University of Purdue Extension). Lastly, reactive removal following a widespread infestation condenses almost all removals into a 2- to 3-year period, possibly overburdening the Town budget and creating a sudden void in the urban forest canopy.

2. Chemical treatments

An additional management strategy to removal is treatment of trees with insecticide, either as a preventative measure or as a treatment for limited infestations, but not over large areas. Chemical treatments are only effective for controlling pests in the early stages of infestation because once a tree's vascular system begins to fail, it cannot effectively translocate insecticides throughout the tree to where the insects are feeding (Childs, "HWA

FAQs"). Most insecticides must be applied by a licensed applicator, and the Town should maintain a list of certified applicators available for contract work.

One common method, soil drenching, is to apply insecticide to the soil around the tree so that the insecticide is absorbed through the roots, killing insects that burrow into the tree. For instance, the EAB soil treatment is available for homeowners at relatively low cost for small trees—$20 to $30 for a 10-inch DBH tree (Liesch, Nagai, and Williamson). The compound used is somewhat specific to the pest and may take 8 to 12 weeks to be absorbed by the tree and come into contact with the target pest. Soil drenching may affect other insects and possibly plants and may linger in the soil. It is better used as a spot-treatment on an infested tree and/or the trees around it to prevent a small infestation from spreading, rather than as a large-scale treatment, which would quickly become expensive.

Another common method is the injection of insecticide to the trunk of a tree. Trunk injections can be used on sites where soil treatments may not be practical, such as wet, sandy, or compacted soil environments. There are several methods of injection, including drilling at the base of the tree and high-pressure needle injections, which take 3 to 4 weeks to move through the vascular system of the tree.

Research and experiences in Wisconsin, where EAB is widespread, show success with emamectin benzoate insecticide treatments on landscape trees, at much lower costs than removal (Blake, "Emerald Ash Borer Treatments"). Biennial injection treatments from one Michigan arborist cost around $100 to $200 per tree, depending on diameter (Sutton, "Emerald Ash Borer"). However, treatment requires continued attention to trees, and still carries a risk that the infestation will spread to other trees. Optimal timing for EAB trunk injections is between mid-May and mid-June (Herms et al.). Imidacloprid can also be used to control EAB, but it is less effective than emamectin benzoate (Northern Research Station, "Evaluation of Systemic Insecticides…"), and as a neonicotinoid, it also harms pollinators and beneficial insects that are exposed to it. VT UCF recommends biennial treatment with azadirachtin, a derivative of neem oil, as an alternative to biennial emamectin treatments, but notes that annual treatments may be necessary for severe EAB infestations ("Options for Protecting Ash Trees…").

Chemical treatments for ALB are only effective as a preventative measure for trees that are at risk for infestation. Once a tree is infested, the only available treatment is removal, and the USDA APHIS program recommends treating all other susceptible trees in the area of an infestation with imidacloprid, either as a trunk injection or soil drenching. Imidacloprid treatment targets adult insects and can be applied at various points in the growing season (APHIS, 2017).

Imidacloprid is also effective against HWA, either as trunk injections or soil drenching; general-purpose foliar sprays may also kill active insects, but not eggs (Childs, "HWA FAQs). As with other pests, monitoring and follow-up treatments may be needed. An applicator based in Dahlonega, GA, estimates costs for imidacloprid soil injection for HWA-infested trees at $1.00 to $2.50 per inch DBH, though larger trees require a double dose and heavy infestations may require different chemicals and cost between $3.00 and $6.00 per inch DBH (Shearer, "Hemlock Doctor"). Again, the drawback of imidaclporid is its effect on beneficial insects.

Because HWA feeds on the outside of the tree, rather than burrowing into the trunk, horticultural oil sprays can be used as an alternative to chemical insecticides (Childs, "HWA FAQs"). Horticultural oils are made either from refined petroleum or plant-based oils, and act by mechanically smothering susceptible insects and their eggs; therefore, they are not toxic to mammals, birds, or reptiles. They are not selective, so they may kill beneficial insects present on a treated tree, but these may repopulate from surrounding trees after the oil has evaporated. Horticultural oils should be applied according to the label, often while the tree is dormant, to avoid damage to the tree (Pundt, "Horticultural Oils").

3. Biological Controls

Compared to other native tree pests, invasives such as EAB, ALB, and HWA are mainly problematic because they have no natural predators in North America and can spread without a biological control. The Forest Service is currently conducting several studies to find natural enemies (predators and pathogens) of these pests, such as other small insects from a pest's native environment. Though research for ALB is still in preliminary stages (Bauer, "ALB Natural Enemies"), the Forest Service has successfully established several EAB parasites in infested stands in southern Michigan (Bauer, "Biological Control of the EAB"), and three HWA parasites in the Mid-Atlantic (USFS, "HWA Biological Control"). Research is currently under way to determine if these predator species would be effective biological controls in the Northeast climate; the town should stay apprised of this research as it progresses.

4. Plantings and Replantings

A crucial aspect of this plan is tree planting and replanting to improve species diversity and overall resilience of the urban forest, which improves disease resistance and the rapid spread of pests. Planting and replanting will also mitigate the negative effects of removal or death (such as loss of canopy cover, decreased stormwater retention, etc.).

As a general rule of thumb, street tree populations should consist of no more than 10% of any one species, 20% of one genus, or 30% of any one family of trees (Simons and Johnson, 2008; Santamour, 1990). Currently, ash and maple are overrepresented among Essex's

public trees. New tree plantings should continue to support the goal of diversification of the community tree population. More details can be found in the "Recommendations" section of Part III, relevant to the data collected in the street tree survey.

The Vermont Urban and Community Forestry Program estimates that the cost of planting a new tree is about $200 per tree, including materials and labor.

Areas for replanting after preemptive or reactive removal should be prioritized in the following ways:

1. Streets or areas with previously high concentrations of monospecies that have been removed
    a. Streets or areas with low species diversity from which a handful of trees have been removed
2. Streets or areas with extensive impervious surface
3. Streets or areas with wide ROW's

5. Wood Disposal and Utilization

One effective way to reduce the spread of tree pests is proper disposal or utilization of the wood, brush, and stump grindings generated by removal of infested trees. If disposal of infested wood becomes necessary, Essex should seek assistance from the Chittenden Solid Waste District and the Department of Forests, Parks, and Recreation.

Disposal yards are a safe and effective way to collect infested wood. They allow municipalities and tree service companies to drop off cut material for processing and disposal in a manner that prevents spread of invasive pests. Essex will need to abide by state and federal quarantines on the movement of infested wood before transporting any timber from removed trees.

If the Town decides to pursue pre-emptive removal of susceptible species, every effort should be made to utilize tree products to recoup removal costs instead of complete disposal of timber, brush, sawdust, and stump grindings. Ash and maple trees in particular have much commercial value. In order to make use of their commercial value, trees must be removed preemptively before an infestation leads to rotting of the wood.

Trees with a DBH of 12" or greater (about 50% of urban ash trees in Essex) may have some value as sawlogs, and the Town could choose to sell the trees as sawlogs, firewood, or woodchips to reclaim some percentage of the cost of removal (Bashaw et al., 2012). Firewood or woodchips for use as mulch could be used by Public Works or Parks and Recreation in parks and in rights-of-way (ROW), and can also be given away for free to low-income residents or to residents who lost ROW trees adjacent to their property. However,

donations of firewood or woodchips must accompany public education to avoid transport of wood materials across state lines, per government quarantine measures (VT Dept. of Forests, Parks, and Recreation, "Firewood Quarantine").

D. Implementation of the Invasive Pest Management Plan

Administration of the Invasive Pest Management Plan

The Town Tree Warden, with assistance from the Conservation and Trails Committee and review by the Selectboard, shall oversee the plan, identify problems, and recommend actions to be carried out by the Public Works Department. Public Works may use staff and contractors to conduct any work required, ranging from tree removal and planting to pesticide application and quarantine establishment. Work within the Town right-of-way (ROW) is governed by the ROW deed or easement; information on the extent and nature of these ROW can be obtained from the Land Records office and from the GIS Coordinator. The Parks and Recreation Department has oversight of the management of trees in Town Parks and natural areas. The Conservation and Trails Committee will assist with public education and outreach, inventory assistance and revision of this management plan. All staff and volunteer boards are managed by the Unified Manager and the Selectboard, respectively.

All treatment or removal of public trees shall be at the discretion of the Tree Warden, with input from the Conservation and Trails Committee; Public Works will carry out these recommendations. In general, treatment should take into account public and staff safety, funding needs and availability, and priority of response to infestation as follows:

Prior to infestation:

1. Ash, maple, and hemlock trees that are in poor condition;
2. Ash, maple, and hemlock trees that are located on streets with a high percentage of ash, maple, or hemlock trees, compared to other species.

During infestation:

3. Ash, maple, and hemlock trees that constitute a public health and safety concern;
4. Visibly diseased or damaged trees.

Recommendations

Using the data gathered in the 2016 tree survey, the CTC, the Tree Warden, and Public Works should identify areas with unbalanced species diversity for proactive removal and replanting, starting with trees that are already dying, dead, or pose a public safety risk. Any removal or replanting should also follow the guidelines in Section III(D) of this plan ("Street Tree Management Recommendations – Street Tree Plantings"). Furthermore,

healthy, mature trees should not be removed unless there is an imminent threat from an invasive tree pest that would make the tree hazardous or costly to remove, and pesticide treatment is not an option.

Given the threat of EAB and the prevalence of green ash among public trees, these should be prioritized for proactive removal (unless threats to maple or other prevalent species become more imminent). Assuming that the overall number of trees remains the same as in the 2016 survey, in order to achieve the goal of no more than 10% ash trees in the entire Town, approximately 59 ash trees would need to be removed or replaced with other non-susceptible, non-dominant species (see calculations below):

190 green ash trees / 1,309 total public trees = 14.5% green ash in 2016
1,309 total trees * 10% green ash = 130.9 (round to 131)
190 (current # green ash) – 131 (goal # green ash) = **59 green ash to remove/replace**

The Tree Warden would collaborate with Public Works to develop a timeline for removal or replacement, but it is recommended that the Town remove 10% of the target of 59 (about 6 trees) each year over 9 years to reach a final species diversity of 10% green ash.

In the event of an infestation, the CTC and Public Works should evaluate the potential cost of various treatment options given the extent and location of the infestation, and consult with the Selectboard on preferred action. See Appendices B and C for a detailed annual and total cost analysis.

<u>Public Outreach and Education</u>
Active tree management should be accompanied by continued public outreach and education by the Conservation and Trails Committee and the Tree Warden. Because pest infestations have the potential to spread undetected, the Town's efforts to protect the health of urban forests will be more successful if trees on private land are monitored for signs of invasive infestation and removed if pests are detected. In particular, outreach to the public on how they can monitor and protect trees on private property should concentrate on increased awareness about the dangers of moving firewood (and other wood products and debris) for spreading pests and disease, and how to detect signs of infestation (see Section C of Part IV).

The CTC should also educate private landowners about maintaining better tree diversity on their properties and neighboring ones. One possible way to achieve this is to incorporate a tree diversity requirement into development application review, either as part of the approval process or through recommendation by the CTC to the Planning Commission. These recommendations should be based on the latest available tree survey information.

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Appendix A

Table of Street Tree Management Goals

Abbreviations: ComDev = Community Development Department; CTC = Conservation and Trails Committee; PW = Public Works Department; VT UCF = Vermont Urban and Community Forestry Program, NRM = Natural Resource Management Account, AVCC =Association of Vermont Conservation Commissions, MPG = Municipal Planning Grants, TAC = Village Tree Advisory Committee

Goal	Action	Lead responsibility	Timeline	Partners	Funding
1. Pursue Tree City USA designation	**A.** Establish an urban forest management budget of at least $2 per capita, funded through tax and/or non-tax revenues	Selectboard, CTC	Within 1-2 years	VT UCF, PW	Tax revenue (budget appropriation, fund balance transfer), VT UCF grants, AVCC grants
	B. Designate a citizen board to oversee urban tree care	Selectboard	Within 3 years	CTC, TAC	None needed
	C. Adopt a Tree Care Ordinance using the standards of the Arbor Day Foundation and the Vermont Urban and Community Forestry Program	CTC, Selectboard	Within 3 years	Tree Warden, VT UCF	Staff time
	D. Proclaim and observe Arbor Day through celebrations and activities	CTC, Selectboard	Annually	TAC, Tree Wardens, VT UCF	Urban forestry budget, AVCC grants
2. Continue to monitor the health of public trees in Essex	**A.** Keep the town's public tree data current by performing periodic inventories	CTC, ComDev	Every 5-8 years, to align with Town Plan updates	VT UCF, PW, volunteers	ComDev budget, VT UCF grants, NRM, AVCC grants, MPG
	B. Perform a rural areas survey so that invasive species prevention, monitoring, and treatment are not limited to urban trees	CTC, ComDev	Start within 1-2 years, repeat every 5-8 years to align with Town Plan updates	VT UCF, PW, volunteers	NRM, ComDev budget, MPG, AVCC grants
3. Improve and maintain the health of the urban forest in Essex	**A.** Increase species diversity by replacing some trees and planting new trees where space allows	Tree Warden, PW, CTC	Within 10 years	VT UCF	Urban forestry budget, NRM, PW Conservation account, VT UCF grant, AVCC grant, MPG
	B. Adopt Site Plan and Landscaping guidelines that take into account urban forest health and aim to prevent the spread of invasive pests	Planning Commission, CTC	As soon as possible	VT UCF, ComDev staff	ComDev budget, MPG, VT UCF grants
	C. Monitor the health of individual street trees, especially larger ones; prune and treat as needed	Tree Warden	Ongoing	CTC, VT UCF, UVM Extension	Urban forestry budget, VT UCF grant, MPG
	D. Replace street trees that are dead or dying	Tree Warden, PW	Ongoing	Contracted arborists	Urban forestry budget, Conservation account, NRM
	E. Identify sites for new street trees, especially in the Town Center area and Susie Wilson corridor	CTC, ComDev	Within 5 years	VT UCF, PW	Urban forestry budget, NRM, VT UCF grants, MPG
	F. Invest in new street trees, especially in the Town Center area and Susie Wilson corridor	Selectboard, CTC, ComDev	Within 10 years	VT UCF, PW	Urban forestry budget, NRM, VT UCF grants, public-private partnerships, MPG

Appendix A

Table of Street Tree Management Goals

4. Prevent or mitigate impacts of invasive tree pests on public trees in Essex	**A.** Monitor public trees for signs of invasive pests	Tree Warden, CTC	Ongoing	VT UCF, PW, Volunteers, UVM Extension	Urban forestry budget, staff time, VT UCF grants
	B. Maintain up-to-date forest management plans for Town-owned forests that include sections on invasive pests	Parks and Recreation	Every 10 years for each property	Chittenden County Forester, CTC	Parks and Rec budget, timber sales, VT UCF grant, timber sales
	C. Provide public training and outreach on identifying signs of invasive pests	CTC, Tree Warden	Ongoing	VT UCF, UVM Extension	Urban forestry budget, VT UCF grants
	D. Create an invasive pest response plan and associated budget that is revisited and refined each fiscal year	CTC, Tree Warden, ComDev	Annually	VT UCF, Selectboard, PW	Urban forestry budget, VT UCF grants, AVCC grants, MPG
	E. Maintain a list of certified arborists and pesticide applicators for treatment and/or removal of infested trees	Tree Warden, CTC, PW	Ongoing	VT UCF	None needed

Appendix B

Cost estimates for emerald ash borer treatment

Emerald Ash Borer Susceptible Species				Proactive removal		Reactive removal (2.5x)		Imidacloprid insecticide single injection*		Biennial Emamectin insecticide Injection		Emamectin injection over 10 years	
DBH	Avg DBH	Count	Cost/DBH"	Cost per tree	Total Cost	Cost per tree	Total Cost	Cost per tree	Total Cost	Cost per tree	Total Cost	Cost per tree	Total Cost
3-6"	4.5	9	$14.00	$63.00	$567.00	$157.50	$1,417.50	$130.00	$1,170.00	$28.00	$252.00	$140.00	$1,260.00
6-12"	9	93	$14.75	$132.75	$12,345.75	$331.88	$30,864.38	$260.00	$24,180.00	$56.00	$5,208.00	$280.00	$26,040.00
12-18"	15	87	$18.00	$270.00	$23,490.00	$675.00	$58,725.00	$682.50	$59,377.50	$94.00	$8,178.00	$470.00	$40,890.00
18-24"	21	21	$21.75	$456.75	$9,591.75	$1,141.88	$23,979.38	$975.00	$20,475.00	$130.00	$2,730.00	$650.00	$13,650.00
24-30"	27	2	$25.10	$677.70	$1,355.40	$1,694.25	$3,388.50	$1,267.50	$2,535.00	$168.00	$336.00	$840.00	$1,680.00
Total		212			$47,349.90		$118,374.75		$107,737.50		$16,704.00		$83,520.00

$400.00	Bulk price per L imicide		$0.40	Price per mL	
Imicide HP (Mauget) treatment costs*					
DBH	Circumference	# Injections (0.5/DBH")	Injection vol (mL)	Total volume	Total cost
1.5	4	0	0	0	$0.00
4.5	14	2	1	2	$130.00
9	28	4	1	4	$260.00
15	47	7	1.5	10.5	$682.50
21	65	10	1.5	15	$975.00
27	84	13	1.5	19.5	$1,267.50
33	103	16	1.5	24	$1,560.00
39	122	19	2	38	$2,470.00
42	131	21	2	42	$2,730.00

Source for label: http://mauget.com/wp-content/uploads/2015/07/ImicideHp.pdf

Source for costs: https://www.healthytreeplanthealthcare.com/collections/all-products/products/imicide-hp-mauget?variant=33613027913

*Does not include cost of labor or tree removal, which may vary

Emamectin treatment costs*			
Avg DBH	Circumference	Cost multiplier	Total cost per tree
1.5	4	2	$8.00
4.5	14	2	$28.00
9	28	2	$56.00
15	47	2	$94.00
21	65	2	$130.00
27	84	2	$168.00
33	103	2	$206.00
39	122	3	$366.00
42	131	3	$393.00

*Source: Michigan Tree Doctor, http://www.tree-doc.com/page/page/3788874.htm

Emamectin Benzoate 4.0% product label: https://www3.epa.gov/pesticides/chem_search/ppls/000100-01309-20140318.pdf

Appendix C

Cost estimates for Asian longhorned beetle treatment

Asian Longhorned Beetle Susceptible Genera				Proactive Removal		Reactive Removal (2.5x)		Single Insecticide Treatment*	
DBH	Avg DBH	Count	Cost/DBH"	Cost per tree	Total Cost	Cost per tree	Total Cost	Cost per tree	Total cost
0-3"	1.5	14	$14.00	$21.00	$294.00	$52.50	$735.00	$0.00	$0.00
3-6"	4.5	61	$14.75	$66.38	$4,048.88	$165.94	$10,122.19	$0.80	$48.80
6-12"	9	301	$18.00	$162.00	$48,762.00	$405.00	$121,905.00	$1.60	$481.60
12-18"	15	190	$21.75	$326.25	$61,987.50	$815.63	$154,968.75	$4.20	$798.00
18-24"	21	48	$25.10	$527.10	$25,300.80	$1,317.75	$63,252.00	$6.00	$288.00
24-30"	27	8	$25.10	$677.70	$5,421.60	$1,694.25	$13,554.00	$7.80	$62.40
30-36"	33	7	$25.10	$828.30	$5,798.10	$2,070.75	$14,495.25	$9.60	$67.20
36-42"	39	5	$25.10	$978.90	$4,894.50	$2,447.25	$12,236.25	$15.20	$76.00
42+"	42	1	$25.10	$1,054.20	$1,054.20	$2,635.50	$2,635.50	$16.80	$16.80
Total		**635**			**$157,561.58**		**$393,903.94**		**$1,838.80**
				*Does not include costs of labor or tree removal, which will vary					

$400.00	Price per L (bulk)	$0.40	Price per mL		
Imicide HP (Mauget) treatment costs					
DBH	**Circumference**	**# Injections (0.5/DBH")**	**Injection vol (mL)**	**Total volume**	**Total cost**
1.5	4	0	0	0	$0.00
4.5	14	2	1	2	$0.80
9	28	4	1	4	$1.60
15	47	7	1.5	10.5	$4.20
21	65	10	1.5	15	$6.00
27	84	13	1.5	19.5	$7.80
33	103	16	1.5	24	$9.60
39	122	19	2	38	$15.20
42	131	21	2	42	$16.80
Source for label: http://mauget.com/wp-content/uploads/2015/07/ImicideHp.pdf					
Source for costs: https://www.healthytreeplanthealthcare.com/collections/all-products/products/imicide-hp-mauget?variant=33613027913					

Appendix D

List of Streets Surveyed

Alder Ln.
Alderbrook Rd.
Allen Martin Dr.
Allen Martin Pkwy.
Andrew Av.
Baker St.
Billie Butler Dr. *(Upper Main – Carmichael St.)*
Bixby Hill Rd.
Bluestem Rd.
Bobolink Cir.
Butternut Ct.
Carmichael St.
Cavendish Dr.
Cedar Ct.
Cedar St.
Cemetery Rd.
Cindy Ln.
Clover Dr.
Commonwealth Ave.
Creek Rd.
Dalton Dr.
Dartmoor Ct.
Deer Crossing Ln.
Devon Hill Ct.
Essex Wy.
Ethan Allen Av.
Forest Rd.
Foster Rd.
Fox Run Rd.
Freeman Wds.
Gardenside Ln.
Gauthier Dr.
Glenwood Dr.
Greenfield Rd.
Hagan Dr.
Hampshire Ct.
Ira Allen Dr.
Irene Av.
Iris St.
Joshua Wy.
Kellogg Rd.
Kimberly Dr.
Lasalle Rd.
Laurel Dr.
Lavigne Rd.
Lilac Ln.
Linden Ln.
Margaret St.
Marion Av.
Morse Dr.
New England Dr.
Oakwood Ln.
Old Colchester Rd.
Old Stage Rd. *(Center Rd. – Willoughby Dr.)*
Parizo Dr.
Partridge Dr.
Patricia Pl.
Peacham Ln.
Perry Dr.
Pinecrest Dr.
Pinewood Dr.
Pomfret Ln.
Raymond Dr.
Ridge Rd.
Ronald Ct.
Rustic Dr.
Sage Cir.
Sand Hill Rd.
Saxonhollow Dr.
Saybrook Rd.
Skyline Dr.
Stannard Dr.
Stonebrook Cir.
Sunset Dr.
Tanglewood Dr.
The Common.
Thistle Ln.
Thomas Ln.
Thompson Dr. *(Allen Martin Dr. – Red Pine Cir.)*
Towers Rd.
Turcotte Rd.
Valleyview Dr.
Weathersfield Bow
Wildwood Dr.
Willoughby Dr.
Windridge Rd.
Winterlane Cir.
Wolff Dr.
Woodlawn Ct.
Woodlawn Dr.