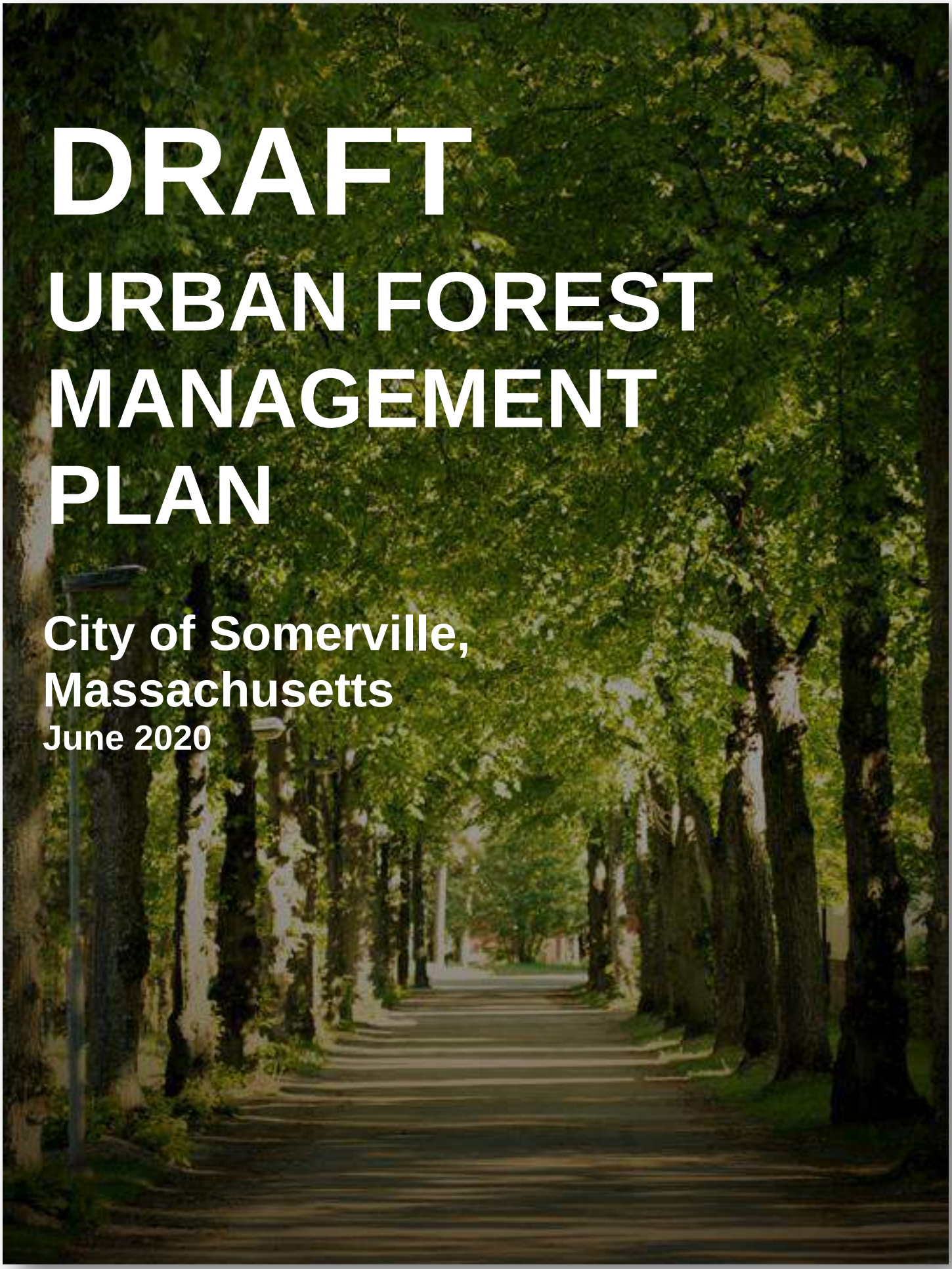

DRAFT
URBAN FOREST MANAGEMENT PLAN

City of Somerville, Massachusetts
June 2020

Prepared by:
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VISION STATEMENT

Somerville's vision for the urban forestry program is the have the best forest for a city, and the best city for a forest. The Urban Forestry Management Plan serves as a guiding document for the expansion, preservation and maintenance of a healthy and diverse urban forest to maximize environmental, economic, safety and aesthetic benefits for the Somerville community today and in the future.

ACKNOWLEDGMENTS

This Somerville Urban Forest Management Plan was made possible by grant funding from the Massachusetts Department of Conservation and Recreation in cooperation with USDA Forest Service and through its Urban and Community Forestry (U&CF) Grant Program. The U&CF Grant Program is designed to encourage communities to create and support long-term and sustained urban and community forestry programs throughout Massachusetts.

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LETTER FROM THE MAYOR

Need to add

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EXECUTIVE SUMMARY

This plan was developed by the City of Somerville's Public Space & Urban Forestry (PSUF) Division with inventories and research conducted by its consultant, Davey Resource Group (DRG), with a focus on addressing short-term and long-term maintenance needs for inventoried public trees. DRG completed a tree inventory to gain an understanding of the needs of the existing urban forest and to project a recommended maintenance schedule for tree care. Analysis of inventory data and information about the City's existing program and vision for the urban forest were utilized to develop this *Urban Forest Management Plan*. Also included in this plan are economic, environmental, and social benefits provided by the trees in Somerville.

State of the Existing Urban Forest

The 2018 Somerville tree inventory, conducted by DRG, includes trees, stumps, and currently available planting sites along the public street rights-of-way (ROW), all City-owned parks, and open spaces available to the public (State-owned land). A total of 14,486 sites were recorded during the inventory: 13,604 trees, 255 stumps, and 627 planting sites. Analysis of the tree inventory data found the following:

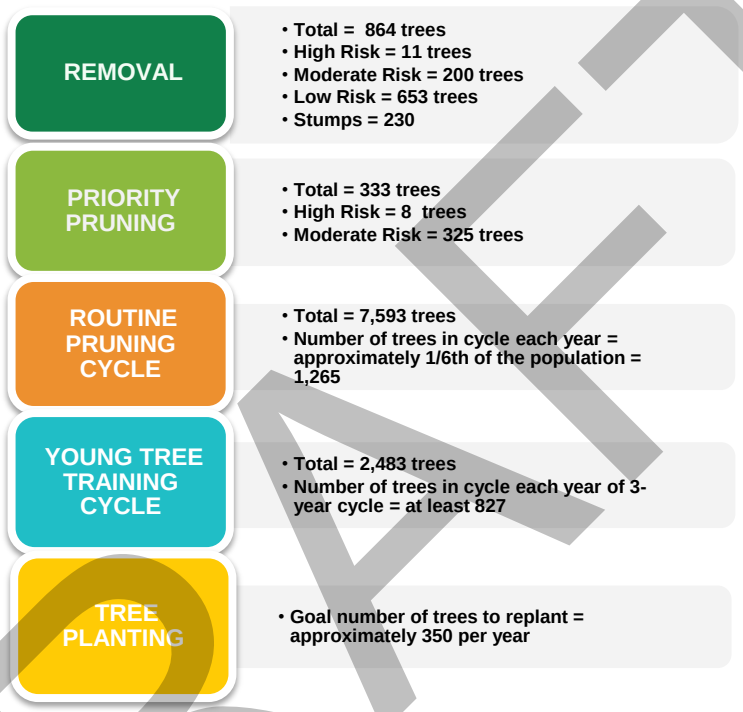
- Three species, *Acer platanoides* (Norway maple), *Pyrus calleryana* (callery pear) and *Acer rubrum* (red maple), comprise a large percentage of the City's trees (14%, 10%, and 10%, respectively). The predominant genus, *Acer* (maple), was found in abundance (28%). A more diverse species distribution is desirable to assure biodiversity and health.
- The diameter size class distribution of the inventoried tree population trends towards the ideal, with a greater number of young, and established trees than maturing, or mature trees.
- Overhead utilities interfering with trees occur among 5% of the population.
- Hardscape lifting from trees occurs among 16% of the population.
- Among potential pests, the invasive insect species granulate ambrosia beetle (*Xylosandrus crassiusculus*) and spotted lanternfly (*Lycorma delicatula)* can pose the biggest threats to the health of the trees that were inventoried. The current biggest threat to Somerville's trees is the emerald ash borer (*Agrilus planipennis*).
- Street trees provide approximately $1,047,466 in the following annual benefits:
  - *Aesthetic and other benefits*: valued at $474,384 per year.
  - *Air quality*: 14,333 pounds of pollutants removed valued at $70,989 per year.
  - *Net total carbon sequestered and avoided*: 1427 tons valued at $9,419 per year.
  - *Energy*: 620 megawatt-hours (MWh) and 228,644 therms valued at $408,793 per year.
  - *Stormwater peak flow reductions:* 10,485,157gallons valued at $83,881 per year.

Municipal Tree Maintenance & Planting Recommendations

Trees provide many environmental and economic benefits that justify the time and money invested in planting and maintenance. Recommended maintenance needs of the inventoried trees

include: Tree Removal (7%); Stump Removal (2%); Tree Clean (64%); Young Tree Train (20%); and Tree Planting (5%).

Maintenance should be prioritized by addressing trees with the highest risk first. The inventory noted many High and Moderate Risk trees (19 and 526 of the City-owned trees assessed, respectively); these trees should be removed or pruned immediately to promote public safety. Low Risk trees should be addressed after all elevated risk tree maintenance has been completed. Trees should be planted to mitigate removals and create canopy.



Proactive Pruning

Somerville's urban forest will benefit greatly from a three-year young tree training cycle and a six-year routine pruning cycle. Proactive pruning cycles improve the overall health of the tree population and may eventually reduce program costs. In most cases, pruning cycles will correct defects in trees before they worsen, which will avoid costly problems. Based on inventory data, at least 827 young trees should be structurally pruned each year during the young tree training cycle, and approximately 1,265 trees should be cleaned each year during the routine pruning cycle.

Tree Planting

Planting trees is necessary to maintain and increase canopy cover, and to replace trees that have been removed or lost to natural mortality (expected to be 1–3% per year), or other threats (for example, construction, invasive pests, or impacts from weather events such as ice, snow, storms, wind, drought and flooding,). The City's goal is to plant at least 350 trees of a variety of species each year to offset these losses, increase canopy, maximize benefits, and account for ash tree loss (due to the impending Emerald Ash Borer infestation).

Municipal tree planting should focus on replacing trees that are recommended for removal, as well as establishing new canopy in areas that promote economic growth, such as business districts, recreational areas, trails, parking lots, areas near buildings with insufficient shade, and areas where there are gaps in the existing canopy. Filling in these gaps is very important due to urban heat island effects which are increasing because of climate change. Various tree species should be planted, although known invasive species (such as *Acer platanoides* (Norway maple)) which are on the Massachusetts Prohibited Plant List (ww.Mass.gov) should be avoided, as well as any species that already have high populations in Somerville. The City's existing planting list offers smart choices for species selection (Section 3.1, and Appendix D). Due to the impending threats from emerald ash borer (EAB, *Agrilus planipennis*), no ash trees (*Fraxinus* spp.) or Fringe trees (*Chioanthus* spp.) should be planted at this time. Species that survive in conditions that are becoming more prevalent as the climate changes should also be considered.

The City of Somerville recognizes that its urban forest is critical to ecosystem health and economic growth. Planning and action are central to promoting and sustaining a healthy urban forest.

Urban Forest Program Needs

Adequate funding will be needed for the City to implement an effective management program that will provide short-term and long-term public benefits, ensure that priority maintenance is performed expediently, and establish proactive maintenance cycles. The estimated total cost for the first year of this seven-year program is $633,140. This total will decrease to approximately $551,400 per year by Year 7 of the program. Since high-priority removal and pruning is costly and most of this work is scheduled during the first few years of the program, the budget is higher for those years. After high-priority work has been completed, the urban forestry program will mostly involve proactive maintenance, which is generally less costly. Budgets for later years are thus projected to be lower.

Over the long term, supporting proactive management of trees through funding will reduce municipal tree care management costs and potentially minimize the costs to build, manage, and support certain City infrastructure. Keeping the inventory up-to-date through database management is crucial for making informed management decisions and projecting accurate maintenance budgets.

Somerville has many opportunities to improve its urban forest. Planned tree planting and a systematic approach to tree maintenance will help ensure a cost-effective, proactive program.

Investing in this tree management program will promote public safety, improve tree care efficiency, and increase the economic and environmental benefits the community receives from its trees.

FY 2021 $633,140

- 11 High Risk Removals
- 8 High Risk Prunes
- 114 Moderate Risk Removals
- 219 Moderate Risk Prunes
- YTT Cycle: 828 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2022 $643,855

- 86 Moderate Risk Removals
- 41 Low Risk Removals
- 106 Moderate Risk Prunes
- YTT Cycle: 828 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- Routine pruning of 1/6th of the population, $100,000
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2023 $611,350

- 100 Low Risk Removals
- YTT Cycle: 827 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- Routine pruning of 1/6th of the population, $100,000
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2024 $605,200

- 173 Low Risk Removals
- YTT Cycle: 828 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- Routine pruning of 1/6th of the population, $100,000
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2025 $571,400

- 200 Low Risk Removals
- YTT Cycle: 828 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- Routine pruning of 1/6th of the population, $100,000
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2026 $565,250

- 139 Low Risk Removals
- YTT Cycle: 827 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- Routine pruning of 1/6th of the population, $100,000
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2027 $551,400

- YTT Cycle: 828 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- Routine pruning of 1/6th of the population, $100,000
- $60,000 for ash tree treaments
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

INTRODUCTION

The City of Somerville is home to more than 81,360 (United States Census Bureau, 2017) full-time residents who enjoy the beauty and benefits of their urban forest. The City's Public Space & Urban Forestry division and the Department of Public Works manage and maintain trees, stumps and planting sites on public property, including in specified parks, public facilities, and along the street rights-of-way (approximately 11,500 trees). Funding for Somerville's Urban Forestry program comes from the City's municipal budget and federal funding.

Somerville, with Davey Resource Group (DRG), conducted an inventory of public trees between June 2017 and January 2019 (for ease of interpretation the inventory will hereafter be referred to as the 2018 inventory). Somerville has been a Tree City USA community for 25 years. The requirements for being a Tree City USA include having a tree ordinance, maintaining a budget of more than $2 per capita for tree-related expenses, and celebrating Arbor Day. Past urban forestry projects have demonstrated a desire to improve the environment through higher levels of tree care and have earned the City 5 Tree City USA Growth Awards.

Approach to Tree Management

The best approach to managing an urban forest is to develop an organized, proactive program using tools (such as a tree inventory and a tree management plan) to set goals and measure progress. These tools can be utilized to establish tree care priorities, build strategic planting plans, draft cost-effective budgets based on projected needs, and ultimately minimize the need for costly, reactive solutions to crises or urgent hazards.

This Urban Forest Management Plan considers the diversity, distribution, and general condition of the inventoried trees, and also provides a prioritized system for managing public trees. This comprehensive management plan that includes the following sections:

- *Section 1: The Importance of Trees in the City*
    - *Section 1.1: Somerville's Tree Canopy* discusses the total community tree canopy and the benefits the canopy provides, and compares these levels to other communities in the region.
    - *Section 1.2: Ecosystem Services of Somerville's Street Trees* summarizes the economic, environmental, and social benefits that the City's streettrees provide to the community. This section presents statistics of an i-Tree Streets benefits analysis conducted for Somerville.
- *Section 2: Somerville*'s *Trees* summarizes the 2018 tree inventory data and presents trends, results, and observations.
- *Section 3: Expand, Preserve, and Maintain*
    - *Section 3.1: Tree Planting Plan* provides a detailed statistical analysis of planting sites (including type, dimensions, and quantity). This section also includes a discussion on urban forest diversity issues, species selection, design methods, a detailed recommended species list, and recommendations for proper planting techniques and new tree maintenance tasks.

- *Section 3.2: Tree Maintenance Program* utilizes the inventory data to develop a prioritized maintenance schedule and projected budget for recommended tree maintenance over a seven-year period.
- *Section 3.3: Invasive Insect and Disease Management Strategy* summarizes potential threats to Somerville's tree population. Fundamentals of an Integrated Pest Management program are explained, as well as strategies that are being applied and/or should be applied to manage existing pest and disease issues.
- *Section 3.4: Storm Preparedness Plan* discusses policies and procedures to increase the efficiency and productivity of tree risk reduction and storm response operations.

- *Section 4: The Road Map*
  - *Section 4.1: Operations Review* summarizes the existing conditions of urban forestry operations in the City, identifies gaps in the procedures, and suggests goals, guidelines, and specific improvements that, once adopted, will help standardize and optimize urban forestry program management and arboricultural practices.
  - *Section 4.2: Funding Analysis* summarizes current funding level and sources, and compares these levels to the projected costs of completing tree planting, pruning and other maintenance, and removals at the suggested rate identified by the inventory and presented in *Section 3.2*.
  - *Section 4.3: Ordinance/Policy Review* provides a review of Somerville's tree ordinance and recommendations for improving and building upon the ordinance and other primary policies, specifications, and other guidelines relating to public tree management
  - *Section 4.4: Public Engagement* reviews current and potential partnerships for community engagement and resident involvement opportunities. Suggestions are provided for specific outreach projects, and basic public engagement tools and strategies.

SECTION 1: THE IMPORTANCE OF TREES IN THE CITY

Trees Matter

The urban forest plays an important role in supporting and improving the quality of life in a city. As global populations continue to shift to urban areas and the climate continues to change, city dwellers are growing an increased awareness of the unique challenges of creating and maintaining sustainable environments for people and for wildlife. Urban tree canopy is now more important than ever. Trees do more than beautify and provide shade; trees contribute to a community's quality of life and soften the often hard appearance of urban landscapes and streetscapes. Trees are integral parts of solutions to modern urban challenges and are a major component of urban infrastructure. When properly maintained, trees provide communities with abundant environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

Prevention of Water Pollution. Aging sewers struggle to keep up with the amount of stormwater during heavy rainfall, which can lead to overflow and pollution of nearby waterways. Trees act as mini-reservoirs, helping to slow and reduce the amount of rainwater in storm drains. 100 mature trees can intercept 100,000 gallons of rainfall per year (USDA Forest Service 2003a).

Cleaner Air. Trees cleanse atmospheric pollutants (chemicals, particles, etc.), produce oxygen, and absorb carbon dioxide.

Reduced Asthma in Children. Trees improve air quality by trapping and holding a significant percentage (up to 60%) of pollen, dust and smoke from the air (Coder 1996). Studies have shown that children who live on tree-lined streets have lower rates of asthma (Lovasi 2008).

Temperature Moderation. Not only do trees provide shade, but also tree leaves emit water vapor, which lowers the ambient temperature. Temperature differences of 5-15 degrees Fahrenheit can be felt when walking under tree-canopied streets (Miller 1997).

Reduced Energy Consumption and Lower Energy Costs. Trees moderate temperatures in the summer by providing shade and in the winter by acting as windbreaks. By moderating local environmental conditions, trees decrease energy consumption and save on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).

Wildlife Habitat. Trees provide shelter, food, and water for a variety of birds, insects, and small mammals. Connected urban greenways comprised of diverse shade and understory trees provide resources and habitat that help connect wildlife with fragmented urban forests.

Erosion Prevention. Trees, particularly tree roots, help stabilize hillsides by reinforcing soil shear strength (Kazutoki and Ziemer 1991).

Crime Reduction. Apartment buildings with medium to high levels of greenery have been found to have over 40% fewer crimes than apartment buildings without any trees (Kuo and Sullivan 2001a).

Higher Property Values. Trees can increase residential property and commercial rental values by an average of 7%. Conversely, values can decline by as much as 20% for properties with no trees (Wolf 2007).

Successful Business Districts. On average, consumers will pay about 11% more for goods in shaded and landscaped business districts (Wolf 1998b, 1999, and 2003). Consumers also feel that the quality of the products is better in business districts having trees (Wolf 1998a).

Better Health. Studies show individuals with views of, or access to, greenspace tend to be healthier. Employees experience 23% less sick time and greater job satisfaction, and hospital patients recover faster with fewer drugs (Ulrich 1984). Trees have also been shown to have a calming and healing effect on ADHD adults and teens (Burden 2008).

Stronger, More Connected Communities. Tree-lined streets can create stronger social ties. In one study, residents of apartment buildings with more trees reported they knew their neighbors better, socialized with them more often, had stronger feelings of community, and felt safer and better adjusted than did residents of more barren, but otherwise identical areas (Kuo 2001b).

Safer Streets. Traffic speeds and the amount of stress drivers feel are reduced on tree-lined streets, which also are likely to reduce road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001b).

Less Noise. Trees help reduce noise levels. A 100-foot wide densely planted tree buffer will reduce noise by 5-8 decibels (Bentrup 2008).

The management of the urban forest is complex. Like many cities across the country, Somerville is facing a number of challenges brought on by aging infrastructure combined with continued growth and development. Add to this the threat of tree loss and obstacles trees encounter when growing in an urban environment, and the challenges compound. Simultaneously balancing the recommendations of experts, the needs of residents, the pressures of local economics and politics, the concerns for public safety and liability issues, the physical aspects of trees, and the forces of nature and severe weather is a vitally important task. Urban forest managers must also consider how the physical constraints of the urban environment impact tree health as well as how climate change is influencing where different species can grow.

The City of Somerville must carefully consider each specific issue and balance these pressures with a local knowledge and an understanding of trees and their needs. If a balance is achieved, Somerville and its unique and attractive qualities as a place to live will grow stronger and the health and safety of its trees and residents will be maintained.

1.1 Somerville's Tree Canopy

The City of Somerville spans approximately 2,703 acres to the northwest of the City of Boston and is bordered in northeast by the Mystic River. Somerville's tree canopy is a vital asset, which provides numerous benefits to city dwellers. By understanding the location of tree canopy throughout the City, municipal leaders can begin to make decisions about where to focus future planting efforts.

Canopy cover measures amount of land area that is covered by trees, and is assessed by looking down at the ground from the sky (using flyover data from a plane or satellite). Canopy cover is an important metric for a city, as many of the benefits of trees are related to the amount of leaf area a tree has. Estimates of certain environmental benefits of trees can be quantified using canopy cover data. Additional benefits can be calculated with on the ground information based on a tree inventory.

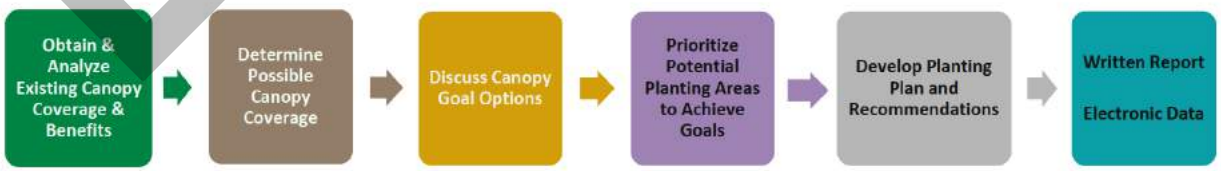
This section of the Urban Forest Management Plan provides details about the amount of canopy cover in Somerville through an Urban Tree Canopy (UTC) assessment (see *Appendix A* for methodology). The UTC is a broad analysis at the canopy scale which provides a valuable city-wide overview of tree cover. A more detailed analysis of the benefits that street trees provide, based upon Somerville's most recent tree inventory (see *Section 2: Somerville's Trees*), is found in *Section 1.2: Ecosystem Services of Somerville's Street Trees*.

Somerville's UTC assessment determined the location and quantity of the current canopy across the entire city based on aerial imagery from 2018, and calculated ecosystem service benefits resulting from this canopy cover. The following pages provide an overview of the UTC process, the assessment results, and recommendations for tree planting and management strategies.

Urban Tree Canopy Assessment Methods

The UTC assessment used a combination of data sources, tools and analytical methods, including USDA aerial imagery, remote sensing technology, census data, locally supplied data, and other scientific methods (see *Appendix A* for more details). Briefly, the UTC assessment was performed as follows:

- Existing tree canopy coverage across Somerville (including public and private land) was determined using aerial imagery. The ecosystem services provided by the current canopy were calculated using i-Tree Canopy and i-Tree Hydro (http://www.itreetools.org).
- An assessment of realistic locations for potential increases in canopy was then made by eliminating impervious areas and water bodies from possible planting areas.
- The potential planting areas were prioritized to provide a way for efficiently achieving canopy goals.



Somerville Canopy Cover

The urban tree canopy (UTC) analysis identified five land cover types in Somerville based on 2018 aerial imagery: tree canopy, grass/low vegetation, impervious surfaces (concrete, buildings, and roads), bare soil, and bodies of water ("hydrology") (Figure 1.1).

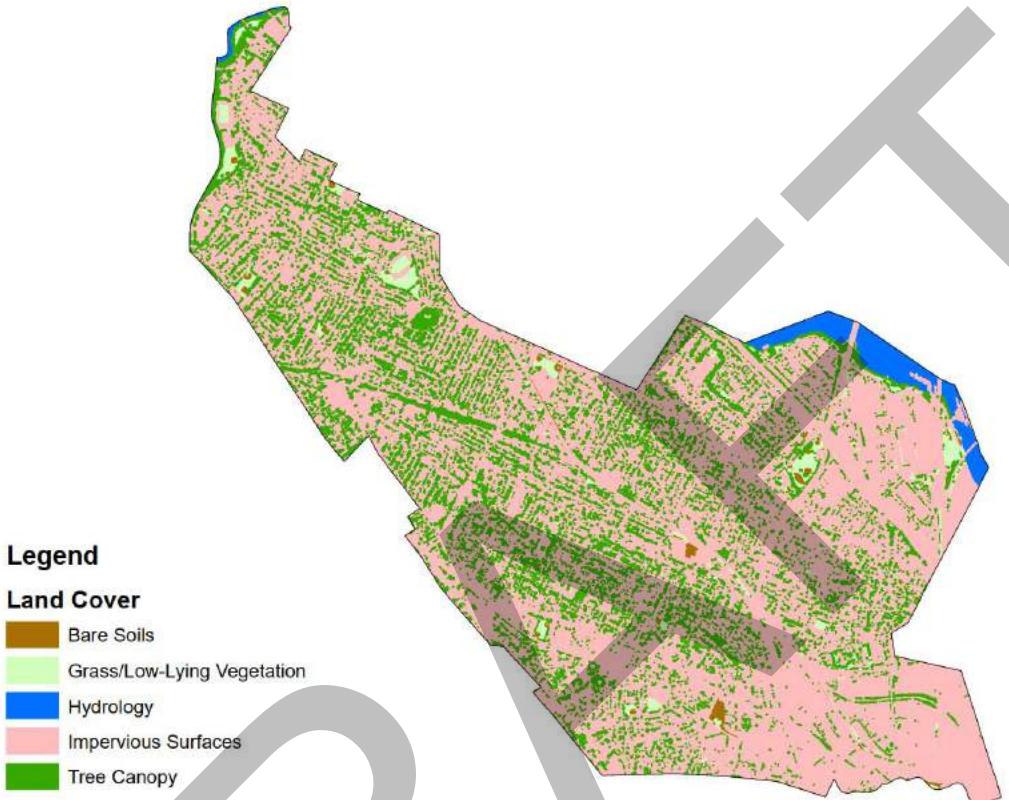
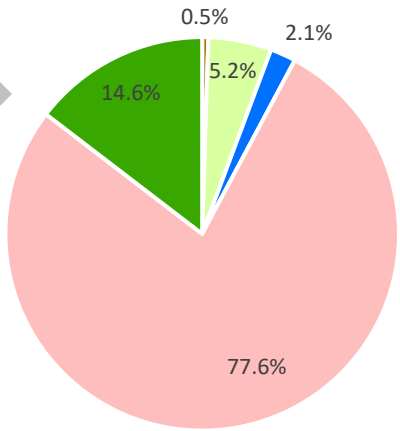


Figure 1.1. Somerville 2018 Land Cover



Based on this aerial imagery from 2018, **Somerville's tree canopy covers 14.6% of the city (just over 394 acres)**. In comparison to other cities in the region with available canopy cover data, Somerville has relatively low tree canopy cover (Table 1.1). The available area for tree canopy is much lower in Somerville than these other cities, which is primarily due to Somerville's higher density and smaller size. Somerville is the densest city in New England. Compared to Somerville, the larger cities listed in Table 1.1 have lower percentages of built up impervious area, and incorporate areas of open space and natural/naturalized areas that the Somerville does not have access to.

Table 1.1. Canopy Cover in Select New England Cities

	Canopy Cover	Study Area	Date Reported
Somerville, MA	14.6%	4.2 mi^2	2019
Providence, RI	24.4%	18.8 mi^2	2015
Boston, MA	27.8%	48.9 mi^2	2015
Cambridge, MA	30.0%	7.1 mi^2	2012
Worcester, MA	40.8%	38.5 mi^2	2015

Measurable Benefits

Various tree canopy assessment and analytical tools were used to quantify and value the benefits of Somerville's tree canopy (including public and private trees). These ecosystem benefits value the trees' ability to store carbon, intercept and absorb stormwater, and clean the air (*Appendix A*). For a more detailed analysis of these and other ecosystem services provided by Somerville's street tree population, see *Section 1.2: Ecosystem Services of Somerville's Street Trees*.

Overall Benefits

Overall, Somerville's existing canopy provides its residents with almost $283,869 annually in quantifiable benefits related to stormwater runoff reduction, air quality improvements, and carbon sequestration. On top of the annual benefits, the amount of carbon that has been stored over the lifetime of Somerville trees contributes an additional $2.2 million in benefits, bringing the collective benefit amount to $2.4 million. Table 1.2 lists a summary of the annual benefits provided by Somerville trees.

Stormwater Runoff Reduction

Trees intercept rainfall by temporarily holding rainwater on leaves and bark, delaying that water from reaching the ground and moderating peak runoff quantities. Tree roots also directly absorb stormwater by consuming water stored in soil pores, and thereby increasing the capacity of local soils to store rainwater. Trees in Somerville are able to intercept an impressive 4.36 million gallons of stormwater annually. Based on the U.S. Geological Survey 8-year annual average amount of rainfall in Somerville (annual average of 54.7 inches between 2005 and 2012), the stormwater reduction rate equates to almost 11,052 gallons of stormwater reduction per acre of tree canopy. This important infrastructure service the trees provide is valued at approximately $174,458.

Air Quality Improvements

Trees absorb gaseous pollutants from the air through the stomata in their leaves. Every year Somerville trees remove huge amounts of pollution from the air, including over 240 pounds of carbon monoxide

(CO), 4,160 pounds of nitrogen dioxide (NO_2), 17,280 pounds of ozone (O_3), 1,185 pounds of sulfur dioxide (SO_2) and 2,160 pounds of dust, soot and other "particulate matter" (PM_{10}). This equates to $21,248 worth of air quality improvements annually. Of these gaseous pollutants, the absorption of ozone pollution provides the greatest monetary benefit value to Somerville residents at $16,042. Reforestation efforts in and around urban areas have been shown to be one of the more cost effective and feasible methods for controlling dangerous ground level ozone, which is known to cause increases in respiratory and cardiovascular diseases and human deaths world-wide (Kroeger et al. 2014). However, it is important to note there are species-specific differences in air filtration and the emission of volatile organic compounds; thus, it is important to select high value species when the goal of a planting effort is to improve air quality.

Carbon Reduction

Tree leaves absorb carbon dioxide (CO_2) from the atmosphere and turn it into energy through the process of photosynthesis. Carbon is then stored in the living tissues of trees over their lifetimes. The leaves of the trees in Somerville are calculated to absorb over 1,902 tons of CO_2 carbon dioxide annually, which is valued at $88,162. Furthermore, the amount of carbon stored in the woody tissue of the living trees in Somerville over their lifetimes is calculated at almost 47,771 tons. These two carbon sequestration avenues represent a total benefit value of $2.3 million. Carbon sequestration in urban environments like Somerville is an important tool for mitigating climate change.

Table 1.2. Annual Benefits Provided by Somerville's Tree Canopy (Public and Private Trees)

Benefit	Quantity	Value
Stormwater: Avoided Runoff	4,361,443 gallons	$174,458
Air Quality: Carbon Monoxide (CO) Removed	240 lbs.	$105
Air Quality: Nitrogen Dioxide (NO_2) Removed	4,160 lbs.	$628
Air Quality: Ozone (O_3) Removed	17,280 lbs.	$16,042
Air Quality: Sulfur Dioxide (SO_2) Removed	1,185 lbs.	$52
Air Quality: Dust, Soot, Other Particles Removed (PM_{10})	2,160 lbs.	$4,422
Carbon Sequestered	1,902 tons	$88,162
Total Monetary Value		$283,869

Other Ecosystem Services

Trees provide additional important benefits to the people and wildlife of Somerville that are not monetarily quantifiable from tree canopy data. For details about additional benefits that street trees provide, please see *Section 1.2: Ecosystem Services of Somerville's Street Trees*.

Setting Goals

Clearly trees provide many benefits in Somerville, and to increase these benefits it is important to expand the canopy at every opportunity. Setting tree canopy and planting goals is an important step in the planning process as it provides metrics to measure performance throughout the coming years. It is essential to create realistic goals and a prioritized plan based on local issues and community values.

What canopy percent to aim for?

The USDA Forest Service, in collaboration with the Davey Institute, has established recommendations for determining an urban tree canopy goal (Leff 2016). These recommendations are based on the following questions:

- What is physically **possible?**
  - What lands can biologically support trees? If the area is already very densely developed there will be fewer opportunities to increase tree canopy cover.
  - A city in a desert can support fewer trees than one in a temperate climate.
- What is socially **preferable**?
  - Replacing open fields and parks with forested areas may not be socially acceptable.
- What is the **potential** plantable space?
  - A high percentage of existing commercial and industrial use will reduce available permeable areas for planting, but land cover can be changed if there are the resources and will to do so.

Determining realistic and acceptable tree canopy goals for Somerville will involve a multi-step process of answering the above questions and identifying an ideal canopy area, while balancing the City's other community, economic and social goals.

How much canopy is physically possible in Somerville?

The level of possible canopy is determined by adding the existing canopy to the amount of available planting space in Somerville. This data is important to have when setting realistic canopy goals. Analysis of available planting space involves more than simply assuming all pervious surfaces currently without trees (grass/low-lying vegetation or bare soil) are potential planting locations. Some pervious surfaces are not suitable for planting (ex. recreational fields, agricultural areas, cemeteries, and some parts of the rights-of-way).

Potential realistic plantable areas are therefore determined by taking all of the pervious surface in the City and excluding those areas unsuitable for planting. The maximum canopy possible is then determined by calculating the resulting canopy if 100% of these suitable planting areas were indeed planted with the largest canopy-producing tree possible for that location. That canopy can then be added to the existing canopy to reach a maximum canopy percentage. UTC analysis has identified approximately 112 acres of land (including public and private land) that could be planted with trees (Figure 1.2). **Planting 100% of these sites would add 4.1% canopy cover to the existing 14.6% canopy, setting the maximum UTC possible in Somerville to 18.7%.** Due to other competing land use needs across the city, a realistic canopy goal should be lower than this maximum canopy percentage.

Based on this analysis, the maximum UTC possible in Somerville is still lower than the current canopy cover of the other cities listed in Table 1.1. As explained above, Somerville is the densest city in New England. Thus expecting to reach the same canopy cover as other, less dense cities is unrealistic. To have similar percentages of canopy as these other cities, Somerville would have to convert built up impervious surfaces into tree canopy.

Nevertheless, not all impervious areas should be ruled out for planting, as trees can still be added in certain locations (such as trees in sidewalks and parking lot islands). Although a canopy analysis using this methodology cannot consider the multitude of factors that go into removing impervious surfaces for the purposes of planting, the City of Somerville should consider using these sorts of areas to increase its maximum tree canopy area in the long term.

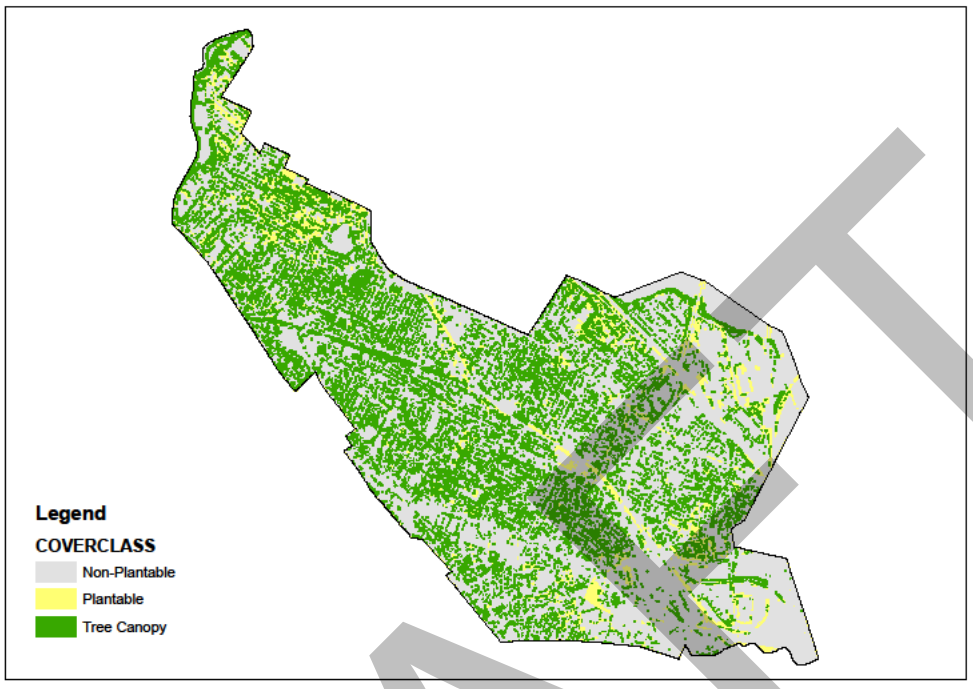


Figure 1.2. Somerville's Potential Plantable Area in Relation to Existing Tree Canopy

What should Somerville's canopy goals be? Now that the maximum possible canopy has been theoretically identified, realistic canopy goals can be developed. As the densest city in New England, the available land in Somerville must be shared among various stakeholders with various needs and interests. It is not realistic to suggest or recommend that all available pervious surfaces be completely planted. A determination of realistic local goals must be made based on what is spatially, economically, ecologically, and politically feasible for canopy across various land uses and jurisdictions. This will require input and support from the public, local leaders, and subject matter experts to set local goals that are based on local values, local environmental and quality of life goals, compliance with federal and local clean air and water regulations, economic development plans, and other community needs. Once realistic goals are determined, the City of Somerville and stakeholders can pursue those goals using policies, procedures, education, incentives, and various funding avenues.

Factoring in Loss of Ash Trees. Emerald Ash Borer (EAB) has been identified in Somerville and is a significant urban threat. Tree loss due to this exotic insect should be factored into the discussion of future tree canopy (refer to *Section 3.3: Invasive Insect and Disease Management Strategy* or *Appendix G* for more information on EAB). Despite Somerville's robust treatment program for public trees, the loss of privately-owned ash trees due to EAB must be considered. It is unknown how many privately-owned ash trees there are in Somerville. However, as EAB continues to spread through Somerville, tree replacement planting on at least a one-to-one ratio or greater should be considered, as privately owned

ash trees are likely contributing significant stormwater, urban heat island, and energy conservation benefits to the community.

Current Action Plan

The City of Somerville's current plan of planting an average of 350 trees per year and removing up to 145 trees per year that are dead, dying, or hazardous will result in a net gain of 205 trees per year, on average. For more details on the City's tree planting and removal plans refer to *Section 3.1: Tree Planting Plan* and *Section 3.2: Tree Maintenance Program*. By removing dead, dying, and hazardous mature trees (with an average estimated canopy spread of 645 square feet), and replacing them with young trees (with an average estimated canopy spread of 20 square feet), the canopy cover in the City may show an initial drop over the next few years. However, as the newly planted young trees grow and mature over the coming decades, Somerville can expect canopy cover to increase within the publicly-owned areas. Currently the publicly-owned plantable area in Somerville covers 36 acres (or approximately 2,376 medium sized trees). At Somerville's current net rate of tree gain of 205 trees per year, it would take approximately 12 years to completely fill this plantable area.

Trends in Somerville Tree Canopy

The following sections delve further into the tree canopy data to examine trends across the city. First, canopy cover is assessed by ward. Then, canopy cover is assessed by zoning classification. Finally, the extent of canopy cover in public land is compared to that of private land.

By Ward

The City of Somerville is divided up into seven wards. Canopy cover varies by ward; the lowest canopy cover is in Ward 1, whereas Wards 6 and 7 have the most canopy cover (Figure 1.3). Ward 1 presently consists of industrial areas or previously industrial areas that have historically had little to no canopy. In some of these areas trees are being planted, but as the newly planted trees are still relatively small they do not yet contribute significantly to the canopy cover. Wards 6 and 7 have some of the City's largest parks and open spaces that are covered by trees, including the Community Path, Alewife Brook Reservation, and Nathan Tufts Park.

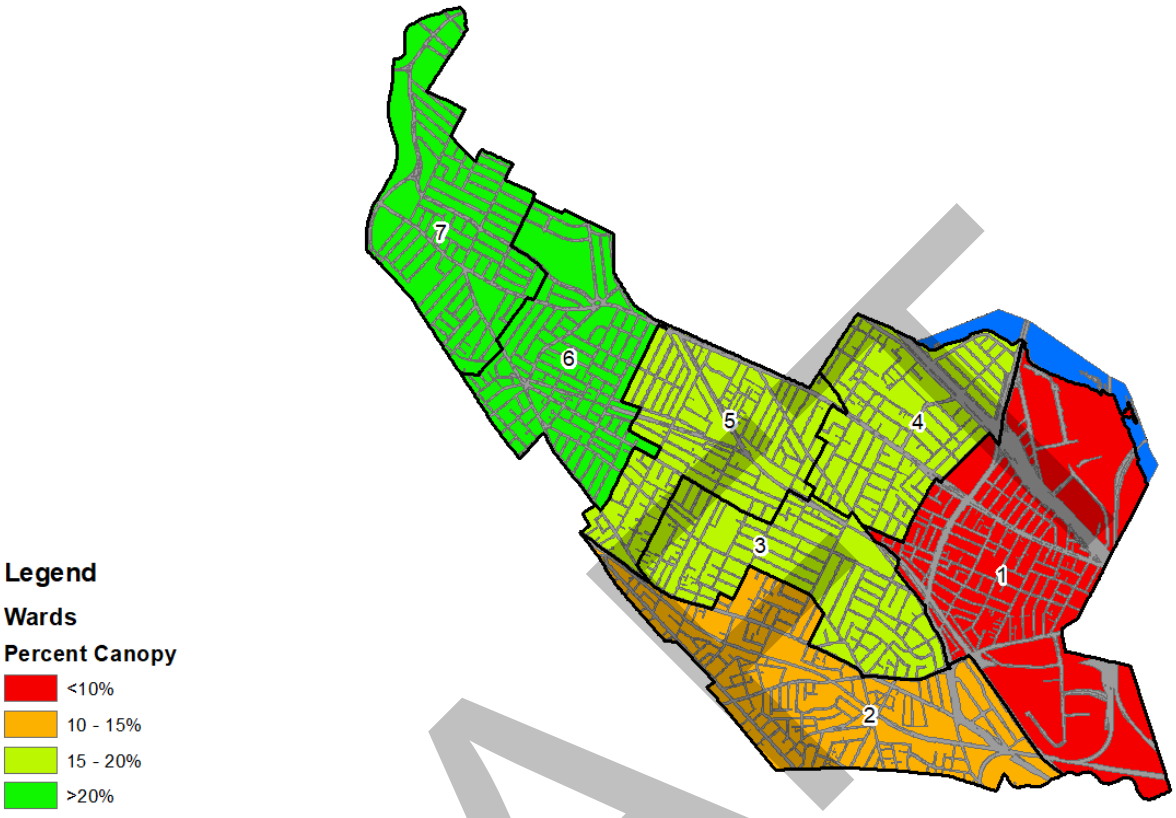


Figure 1.3. Somerville 2018 Canopy Percentage by Ward

Ward	Tree Canopy (%)
1	8.0%
2	10.4%
3	19.2%
4	15.2%
5	18.0%
6	21.8%
7	20.1%

By Zoning Classification

Tree canopy coverage was analyzed by zoning classifications based on the 2019 Somerville Zoning Ordinance. Eighteen zoning classifications were condensed into six broader categories: residential districts, mid & high-rise districts, commercial districts, civic special district, other special districts, and rights-of-way (ROW) (Figure 1.4; *Appendix A*). Resulting canopy coverage for each zoning class is shown in Table 1.3. Based on the 2018 tree canopy data and the 2019 zoning code, the highest percentages of tree canopy occurred in Civic Special Districts (23%), which includes parks and other civic spaces in the City. Residential Districts, which encompassed the largest and most predominant

land use category (46% of the City), also had relatively high canopy cover (19%). Rights-Of-way, which encompassed 27% of the City, had 13% canopy cover.

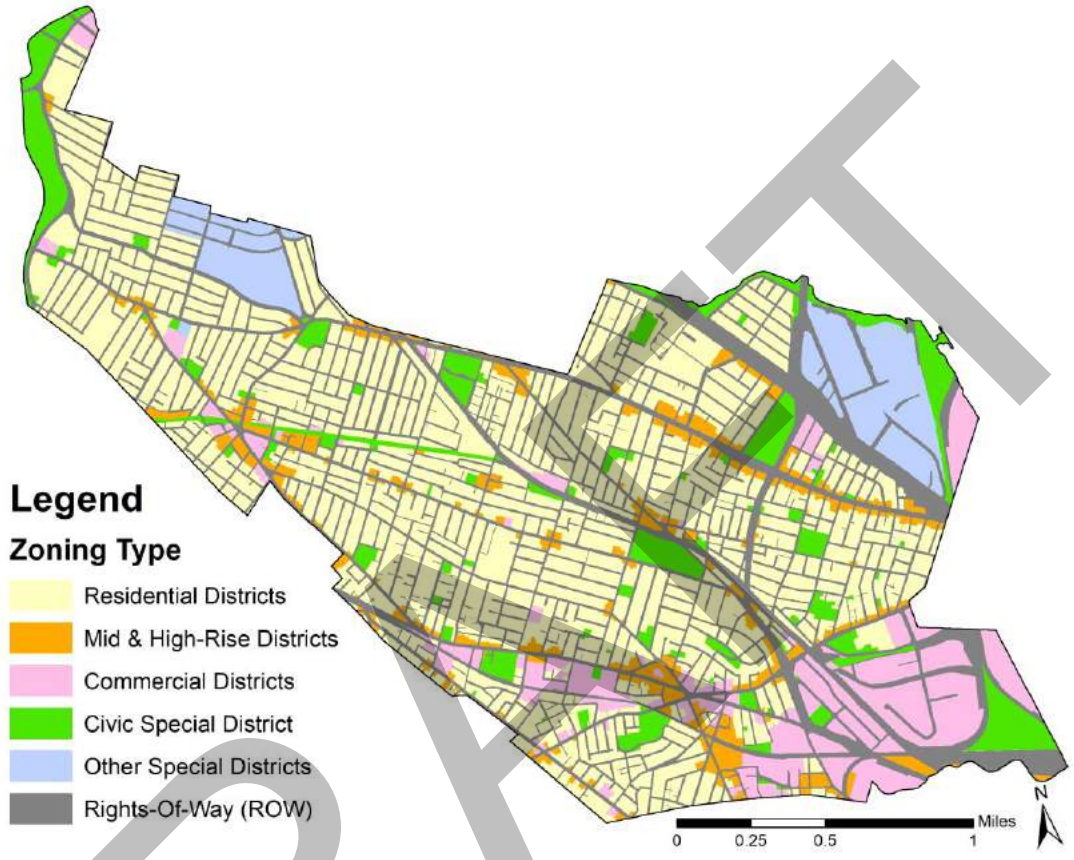


Figure 1.4. Map of Somerville Land Use Types Using 2019 Zoning Classification

Table 1.3. Amount of Tree Canopy and Potential Planting in Somerville by Zoning Type

Zoning Type	Zoning Type Acreage	Percent of Study Area	Acres of Canopy	Canopy Cover (% of City)	Acres of Potential Plantable Space	Potential Plantable Space (% of zoning type area)
Civic Special District*	213.31	8%	50.11	23.49%	28.96	13.58%
Commercial Districts	234.33	9%	8.20	3.50%	6.05	2.58%
Mid & High-Rise Districts	128.33	5%	10.63	8.28%	3.56	2.77%
Other Special Districts	147.98	6%	12.21	8.25%	17.79	12.02%
Residential Districts	1210.83	46%	227.00	18.75%	35.16	2.90%
Rights-Of-Way (ROW)*	708.5	27%	84.46	11.92%	20.32	2.87%

*Indicates zoning types for which the land is primarily City-owned

Commercial Districts, which include industrial areas such as Brickbottom, contain the lowest 2018 tree canopy coverage percentages (3.5%). Current research has demonstrated that business districts are more successful with tree canopies, and thus focusing planting efforts in these areas would be useful, not only for the residents of the city, but also for the businesses. Commercial Districts have 6.05 acres of plantable area according to the UTC analysis. Mid & High-Rise Districts and Other Special Districts (which includes Tufts and Assembly Square) have only 8% canopy cover (Table 1.3). Other Special Districts and Civic Special Districts (which includes parks and other civic spaces) have the highest percentages of potential plantable space. Residential Districts and Civic Special Districts have the most acres of potential plantable space available (35.16 and 28.96 acres, respectively), followed by Rights-of-Way (20.32 acres).

Canopy Cover on Public versus Private Land

Areas of the City that are largely City-owned (Civic Special Districts and Rights-Of-Way) comprise 35% the land and contain 34% of Somerville's total tree canopy. Conversely privately owned land comprises 65% of the land in the City and carries the remaining 66% of canopy cover. When comparing the public and privately owned land use categories, canopy distribution is roughly equal.

Additional plantable area in publicly controlled land totals 49 acres, which is 44% of the available plantable acres across the City of Somerville. Remaining plantable area in privately owned land totals 63 acres, or 56% of the total available plantable land in the City. This indicates that while significant improvement to Somerville's tree cover can be made by planting on public property, the greatest opportunities for substantial and long-term canopy gains will come through efforts on privately-held lands.

Within privately owned land, the land use category with the highest acreage of potential plantable space is Residential Districts, with over 35 acres of potential plantable space in Residential Districts. The land use category with the highest percentage of plantable area was Other Special Districts (which includes Tufts and Assembly Square), which has nearly 18 available plantable acres, and which presents an opportunity for a 12% increase in total canopy within that land use category.

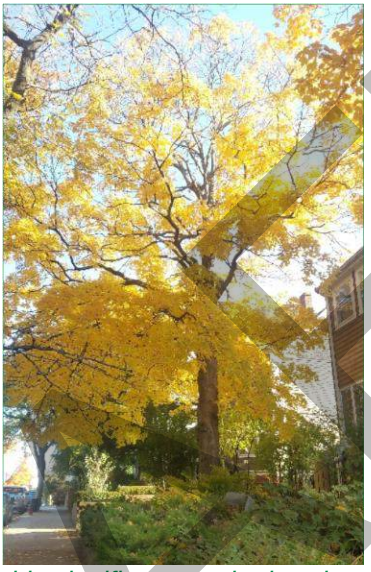
UTC Conclusions:

Based on this UTC assessment, municipal leaders can begin to set goals towards increasing the amount of tree canopy within Somerville. Reaching the desired urban tree canopy goals will be a challenge; however, establishing realistic goals for preserving existing canopy, planting new trees, and harnessing the maximum amount of ecosystem service benefits by planting large growing trees wherever possible are prudent, responsible, and rewarding endeavors.

In the future, Somerville can use this UTC data to explore and understand other patterns in the canopy data. For example, it may be interesting to explore how tree canopy cover relates to environmental problems such as flooding or excessive heat. Additionally, assessing how tree canopy cover varies in relation to the people who reside/work throughout the metropolitan area (socioeconomics and demographics) could provide useful insight for tree planting equity.

1.2 ECOSYSTEM SERVICES OF SOMERVILLE'S STREET TREES

The trees growing along the public streets are an important community resource and City infrastructure, whose value increases over time. As described at the beginning of *Section 1: The Importance of Trees in the City*, trees provide numerous benefits such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, education, and aesthetics.



Trees provide significant aesthetic value to the community. Additionally, the tangible services of trees provide quantifiable benefits that justify the time and money invested in planting and maintenance.

All of the services and benefits of trees in the urban and suburban setting were once considered to be unquantifiable. However, extensive scientific studies and practical research have led to the development of models that can confidently calculate these ecosystem services using tree inventory information.

The ecosystem service benefits calculated here are more detailed than the benefits calculated from tree canopy cover Urban Tree Canopy (UTC) assessment (see *Section 1.1: Somerville's Tree Canopy*). Here, the tree benefit values for the City of Somerville's street tree population were calculated using the City's 2018 tree inventory data (see *Section 2: Somerville's Trees* for more details about the inventory) and the i-Tree Streets application. The tree inventory contains more detail descriptions of each tree (species, size, etc.) than the urban tree canopy analysis. Thus, a larger variety of ecosystem service benefits can be calculated from the tree inventory, and the estimates are more accurate. The results from this analysis of Somerville's tree inventory provide insight into the overall health of the City's trees and the management activities needed to maintain and increase the benefits of trees into the future.

i-Tree Streets

i-Tree Streets, a component of i-Tree Tools (https://www.itreetools.org/tools), analyzes an inventoried tree population's structure to estimate the costs and benefits of that tree population. The assessment tool creates an annual benefit report that demonstrates the value street trees provide to a community.

These quantified benefits and the reports generated are described below.

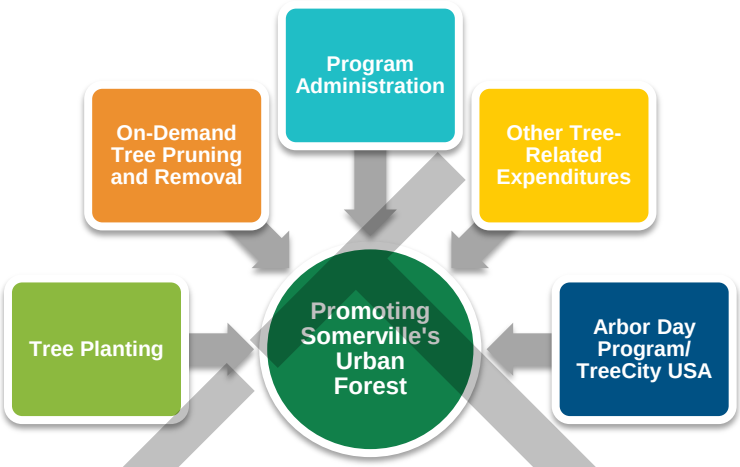
- **Aesthetic/Other Benefits:** Shows the tangible and intangible benefits of trees reflected by increases in property values (in dollars).
- **Stormwater:** Presents reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons.
- **Carbon Stored:** Tallies all of the carbon dioxide (CO_2) stored in the urban forest over the life of its trees as a result of sequestration. Carbon stored is measured in pounds and has been translated to tons for this report.
- **Energy:** Presents the contribution of the urban forest towards conserving energy in terms of reduced natural gas use in the winter (measured in therms [thm]) and reduced electricity use for air conditioning in the summer (measured in Megawatt-hours ([MWh]).
- **Carbon Sequestered:** Presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reductions in energy use. This is measured in pounds and has been translated to tons for this report. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.
- **Air Quality:** Quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces, and reduced emissions from power plants (NO_2, PM_{10}, volatile organic compounds [VOCs], SO_2) due to reduced electricity use in pounds. The potential negative effects of trees on air quality due to biogenic volatile organic compounds (BVOC) emissions is also reported.
- **Importance Value (IV):** IVs are calculated for species that comprise more than 1% of the population. The i-Tree Streets IV is the mean of three relative values (percentage of total trees, percentage of total leaf area, and percentage of canopy cover) and can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. IVs offer valuable information about a community's reliance on certain species to provide functional benefits. For example, a species might represent 10% of a population but have an IV of 25% due to its substantial benefits, indicating that the loss of those trees would be more significant than just their population percentage would suggest.

i-Tree Tools

i-Tree Tools software was developed by the U.S. Department of Agriculture, Forest Service (USDA FS) with the help of several industry partners, including The Davey Tree Expert Company. Learn more at www.itreetools.org.

THE BENEFITS OF SOMERVILLE'S URBAN FOREST

i-Tree Streets Inputs



In addition to tree inventory data, i-Tree Streets requires cost-specific information for the community's tree management program—including administrative costs and costs for tree pruning, removal, and planting. Regional data, including energy prices, property values, and stormwater costs, are required inputs to generate the environmental and economic benefits trees provide. If community program costs or local economic data are not available, i-Tree Streets uses default economic inputs from a reference city selected by USDA Forest Service for the climate zone in which your community is located. Any default value can be adjusted for local conditions.

Somerville's Inputs

The City of Somerville's 2018 tree inventory data (see *Section 2: Somerville's Trees*) were used to calculate the ecosystem service benefits these trees provide to the City its citizens in the i-Tree Streets program. The default regional economic inputs were used for the remainder of the settings (see *Appendix B*).

The i-Tree assessment was performed only on right-of-way (ROW) data. Although the 2018 inventory also included trees in parks and other public spaces, these trees were excluded from the analysis because the ecosystem service values provided by the i-Tree Streets analysis are specifically calibrated for street trees. For example, the analysis calculates the amount of energy savings that a nearby tree provides to homes and other buildings through shading and windbreaks. As there are no buildings near park trees, the calculated benefits would not be accurate for trees in these areas.

Annual Benefits

The i-Tree Streets model estimated that the 9,313 inventoried street trees provide a total annual benefit of $1,047,466. Essentially, this means that if the ROW trees in Somerville did not exist, it would cost the City an additional $1,047,466 to provide the same increase in property values, and the same amount of cooling to buildings, stormwater management, and air cleaning. On average, a single Somerville tree provides an annual ecosystem service benefit of $111.29.

The assessment found that, among all quantified ecosystem service benefits, the greatest value of the City's ROW trees comes from aesthetics and other tangible and intangible benefits trees provide that increase property values. These benefits account for 45% of the annual benefits that street trees provide. In addition to increasing property values, trees also play a major role in energy savings, which accounted for 39% of the annual benefits. These energy savings occur both in the summer and the winter, because trees provide shade in the summer and act as windblocks in the winter. Stormwater management comprises an additional 8% of the annual benefits provided by Somerville's street trees. The City's street trees are estimated to intercept 10.5 million gallons of rainfall annually, which equates to a savings of $83,881 in stormwater management costs. Somerville's street trees also improve air quality, both by removing air pollutants from the air and by helping to reduce power plant emissions by reducing electricity use. Air quality improvements account for

nearly 7% of the annual benefits the tree provide. Reductions in CO_2 are also important, but account for only 1% of the annual benefits these street trees provide.

Figure 1.5 summarizes the annual benefits and results for the entire street tree population. Table 1.4 presents results for individual tree species from the i-Tree Streets analysis. Original i-Tree Streets reports can be found in *Appendix B*.

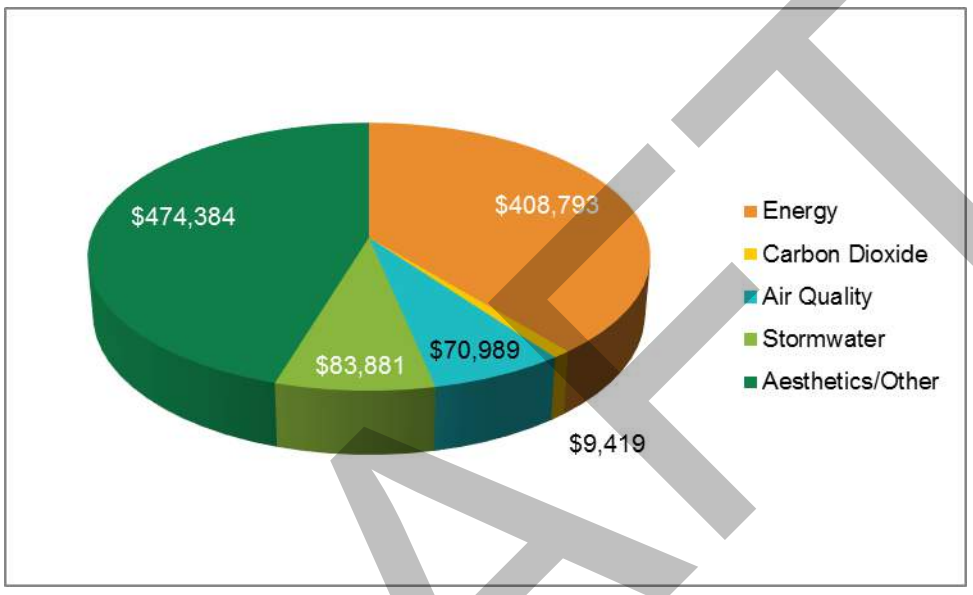


Figure 1.5. Total annual ecosystem service benefits provided by Somerville's street trees

Table 1.4. Ecosystem Service Data for Somerville's Most Common Street Trees by Species

Most Common Trees Collected During Inventory		Number Trees in the ROW	Percent of Total Trees	Canopy Cover	Total Rainfall Interception	Benefit Provided By Street Trees				
						Aesthetic/ Other	Stormwater	Carbon Dioxide Stored	Energy	Carbon Sequestered
Common Name	Botanical Name		(%)	(ft^2)	(gal)	(Average/$/Tree)				
Norway maple	*Acer platanoides*	1330	14.1	1,014,340	1,677,944	48.49	10.09	13.02	53.40	1.49
callery pear	*Pyrus calleryana*	1289	13.7	744,830	1,412,916	88.80	8.77	4.98	36.47	1.21
red maple	*Acer rubrum*	1068	11.3	438,140	964,713	46.37	7.23	3.47	31.41	0.61
honeylocust	*Gleditsia triacanthos inermis*	907	9.6	1,037,136	1,616,115	65.78	14.25	9.19	72.06	1.42
littleleaf linden	*Tilia cordata*	662	7.0	462,989	807,623	30.54	9.76	9.87	49.69	0.94
green ash	*Fraxinus pennsylvanica*	654	6.9	582,636	1,028,458	48.10	12.58	5.70	62.87	1.21
Japanese zelkova	*Zelkova serrata*	481	5.1	322,920	596,739	77.02	9.92	4.58	56.03	1.10
London planetree	*Platanus x acerifolia*	420	4.5	321,578	550,456	44.35	10.48	5.19	53.25	1.05
cherry/plum	*Prunus* spp.	325	3.5	70,694	102,285	11.07	2.52	3.67	18.38	0.42
Japanese tree lilac	*Syringa reticulata*	236	2.5	27,249	37,128	9.25	1.26	0.67	10.19	0.20
kwanzan cherry	*Prunus serrulata*	203	2.2	37,058	52,205	10.46	2.06	2.23	15.64	0.33
northern red oak	*Quercus rubra*	139	1.5	155,622	283,087	46.90	16.29	20.68	66.14	1.65
hybrid elm	*Ulmus x*	137	1.5	25,606	54,830	57.90	3.20	0.93	14.96	0.35
sweetgum	*Liquidambar styraciflua*	126	1.3	44,508	75,821	34.80	4.81	1.78	27.27	0.49

white ash	*Fraxinus americana*	122	1.3	84,080	151,972	44.71	9.97	5.01	48.91	0.93
pin oak	*Quercus palustris*	104	1.1	61,478	115,933	50.42	8.92	10.22	34.95	1.01
hedge maple	*Acer campestre*	80	0.8	20,544	31,788	19.81	3.18	2.76	19.94	0.46
other street trees	~99 species	1,029	12.0	468,834	925,143	33.05	6.06	4.93	27.05	0.63
ROW Total	~116 species on the ROW	9,312	100	5,920,243	10,485,157	50.40	8.91	6.88	43.43	1.00

Aesthetic &Other Benefits

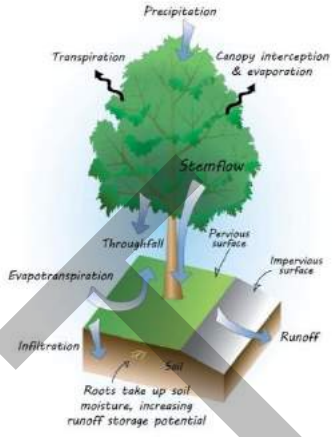
Street trees provide important benefits to residents such as increasing property values, slowing down traffic, and helping to create safer, more connected communities. The total annual benefit associated with property value increases and other tangible and intangible benefits of street trees was $474,384. The average benefit per tree equaled $50.40 per year.

Of the various species in the City's ROW, callery pear and Japanese zelkova contributed the most to the aesthetic/other benefits (Table 1.4).

Stormwater Benefits

Trees intercept rainfall, which helps lower costs to manage stormwater runoff (Figure 1.6). The inventoried ROW trees in Somerville intercept 10,485,157 gallons of rainfall annually (Table 1.4). On average, the estimated annual savings for the city in stormwater runoff management is $83,811.

Of all species inventoried, Norway maple contributed most of the annual stormwater benefits (due to the large number of Norway maple trees in the inventory). The population of Norway maple (14% of ROW trees) intercepted approximately 1.7 million gallons of rainfall. On a per-tree basis, the most value is provided by large trees with leafy canopies, such as honeylocust and northern red oak (which comprised 10% and 2% of the ROW population, respectively).



- *Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and releasing water into the atmosphere.*
- *Tree roots and leaf litter create soil conditions that promote the infiltration of rainwater into the soil.*
- *Trees help slow down and temporarily store runoff and reduce pollutants by absorbing nutrients and other pollutants from soils and water through their roots.*
- *Trees transform pollutants into less harmful substances.*

Figure 1.6: How trees reduce runoff and pollutants

Air Quality Improvements

The inventoried ROW tree population removes 14,333 pounds of air pollutants (including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter) annually through deposition. The tree population is also estimated to avoid 8,594 pounds of power plant emissions annually through reduced electricity use.

While trees do a great deal to absorb air pollutants, they also emit various biogenic volatile organic compounds (BVOCs) such as isoprenes and monoterpenes, which can negatively contribute to the formation of ozone, a harmful gas that pollutes the air and damages vegetation. The i-Tree Streets calculation takes these BVOCs into account when calculating the net air quality benefit provided by the trees. Due to high BVOC emitters in Somerville, the net air quality benefit is not as great as it would be if these compounds were not present.

i-Tree Tools

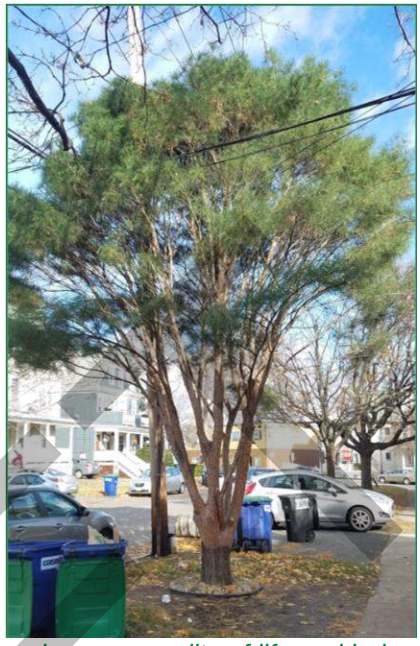
A common example of a natural BVOC is the gas emitted from pine trees, which creates the distinct smell of a pine forest.

Using the annual per-tree values in Table 1.4, honeylocust, green ash, and northern red oak had the most impact on air quality, ranging from $11.01 to $12.49 per tree.

Carbon Storage and Carbon Sequestration

During photosynthesis, trees absorb carbon dioxide (CO_2) from the atmosphere. This prevents CO_2 from reaching the upper atmosphere, where it can react with other compounds and form harmful gases like ozone, which adversely affects air quality. These trees also sequester some of the CO_2 during growth (Nowak et al. 2013) and store it in their tissues (ex. trunk, stems, roots).

The i-Tree Streets net carbon benefit calculation also takes into account the carbon emissions that are *not* released from power stations due to the heating and cooling effect of trees (i.e., conserved energy in buildings and homes). It also includes a calculation for emissions released during tree care and maintenance, such as driving to the site and operating equipment. Based on all of these factors, the net carbon benefit of the inventoried ROW trees in Somerville is approximately $9,419 per year.



Trees improve quality of life and help enhance the character of a community. Trees filter air, water, and sunlight, moderate local climate, slow wind and stormwater, shade homes, and provide shelter to animals and recreational areas for people.

The city's street trees store 9,810 tons of carbon (measured in CO_2 equivalents). This amount reflects the amount of carbon they have amassed during their lifetimes. Through sequestration and avoidance, 1427 tons of CO_2 are removed from the atmosphere or prevented from being produced each year. On a per tree basis, silver maple provided the most carbon benefits, with each tree storing an average of $44.02 and sequestering an average of $1.85 worth of carbon per year.

Energy Benefits

Acer plantanoides (Norway maple)	*Pyrus calleryana* (callery pear)	*Gleditsia triacanthos inermis* (honeylocust)	*Quercus rubra* (nothern red oak)
14.1% of ROW	13.7% of ROW	9.6% of ROW	1.5% of ROW
107MWh Electricity	78MWh Electricity	103MWh Electricity	14MWh Electricity
39,849thm Natural Gas	25,673thm Natural Gas	36,148thm Natural Gas	5,105hm Natural Gas
$53.40 Average $/tree	$36.47 Average $/tree	$72.06 Average $/tree	$66.14 Average $/tree

Figure 1.7. Energy Benefits of Specific Tree Species (Norway maple, callery pear, honeylocust, and northern red oak).

Public trees conserve energy by shading structures and surfaces, which reduces electricity use for air conditioning in the summer. Trees also divert wind in the winter to reduce natural gas use. Based on the inventoried trees, the annual electric and natural gas savings are equivalent to 620MWh of electricity and 228,644 therms of natural gas, which accounts for an annual savings of $408,793 in energy consumption citywide.

Norway maple contributed $53.40 per tree to the annual energy benefits of the urban forest, but its contribution was mostly due to its dominance on the streets. Other tree species, specifically honeylocust and northern red oak, contributed more to energy usage reduction on a per-tree basis. The annual value these trees provide exceeds $66 per tree, although they comprise only 9.6% and 1.5% of the population, respectively. The large leafy canopies of honeylocust and northern red oak are valuable because of the shade they provide, which reduces energy usage. Smaller trees inventoried, such as Japanese tree lilac and cherry/plum spp., were found to have smaller reductions in energy usage on a per-tree basis.

Importance Value (IV)

The importance of a tree species to the community is based on its presence in the ROW and its ability to provide environmental and economic benefits to the community. To calculate a species' IV value, the i-Tree Streets model takes into account the total number of trees of that species, its percentage of the total street tree population, and its total leaf area and canopy cover. The IV can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. If IV values are greater or less than the percentage of a species in the ROW, it indicates that the loss of that species may be more important or less important than its population percentage implies.

The i-Tree Streets assessment found that Norway Maple has the greatest IV in the ROW population at 15.1 (Figure 1.7), primarily because it comprises the largest percentage of the population (14.7% of the ROW). The high IV of Norway maple indicates that the loss of the Norway maple population would be economically detrimental to the city and its residents. The second highest IV was for honeylocust (14.5), followed by callery pear (12.8) and red maple (9.8) (Figure 1.7). The IV of honeylocust is greater than callery pear, even though it is less abundant (9.6% versus 13.7% of the population). Species with larger canopies provide more environmental benefits to the community. Honeylocust is larger growing than callery pear, which would explain its higher IV.

Discussion/Recommendations

The i-Tree Streets analysis found that, by virtue of their mere presence on the street, Somerville's right of way trees provide numerous environmental and economic benefits to the community. The aesthetic/other benefits provided by ROW trees were rated as having the greatest value to the community. The property value increase provided by trees is important to stimulate economic growth. In addition to increasing aesthetics and property values, trees manage stormwater through rainfall interception, provide shade and windbreaks to reduce energy usage, and store and sequester CO_2. Even though these environmental benefits were not found to be as great as the aesthetic/other benefits, they are noteworthy. In Somerville 9,313 ROW trees absorb over 10.48 million gallons of rainfall, reducing runoff during storm events. While air quality is impaired by the number of high-BVOCs emitting trees, this effect can be offset by smart tree-planting efforts. Some of the highest BVOC producing species are sweetgum, black gum, sycamore/London plane, oak, poplar, black

locust, and willow. Conversely, some species that produce very low levels of BVOCs and actually help lower ozone levels are mulberry, cherry, linden, and honey locust.

The i-Tree Streets analysis demonstrated that the Norway maple is the most influential tree along Somerville's ROW. If this species was lost to Asian longhorned beetle (*Anoplophora glabripennis*) or other threats, its loss would be felt more than the community may realize.

To increase the benefits the urban forest provides, the city should plant young, large-statured tree species that are low emitters of BVOCs wherever possible. Leafy, large-stature trees consistently created the most environmental and economic benefits. The following list of tree species are recommended for improving air quality (ICLEI 2006):

- *Betula nigra* (river birch)
- *Celtis laevigata* (sugar hackberry)
- *Fagus grandifolia* (American beech)
- *Metasequoia glyptostroboides* (dawn redwood)
- *Tilia cordata* (littleleaf linden)
- *Tilia x europea* (European linden)
- *Tilia tomentosa* (silver linden)
- *Ulmus americana* (American elm)
- *Ulmus procera* (English elm)

For a comprehensive planting plan for the City, see *Section 3.1: Tree Planting Plan*.

SECTION 2: SOMERVILLE'S TREES

Somerville's trees provide numerous benefits to the City's residents, as described in *Section 1: The Importance of Trees in the City*. In order to better appreciate, manage, and protect the urban forest, it is important to understand exactly what and where the trees are, and the site conditions that Somerville's trees are experiencing. This information can be used to educate City officials and residents alike, and to plan for the future of a healthy urban forest.

From June 2017 through January 2019, City staff worked with arborists from Davey Resource Group (DRG) to assess and inventory trees, stumps, and currently available planting sites across all areas of public property, including along the street "Right of Way" (ROW), in all City-owned parks, in the areas around public buildings, and in State-owned open spaces. For simplicity, this inventory is hereafter referred to as the "**2018 tree inventory**". The 2018 tree inventory is the City's first comprehensive inventory since 2009 (Davey Resource Group, 2009). A total of 14,486 sites were assessed during the inventory: 13,604 trees, 255 stumps, and 627 vacant planting sites (planting sites were only inventoried on what was currently available along the ROW). Of the 14,486 sites collected, 69% were collected along the street ROW, 16% were collected in City-owned open spaces (parks and public buildings), and the remaining 15% were collected in State-owned property. Figure 2.1 provides a detailed breakdown of the number and type of sites inventoried. Note that 37% of the open space in Somerville is City-owned, 51% is State-owned, and 12% is Privately-owned (City of Somerville, 2017).

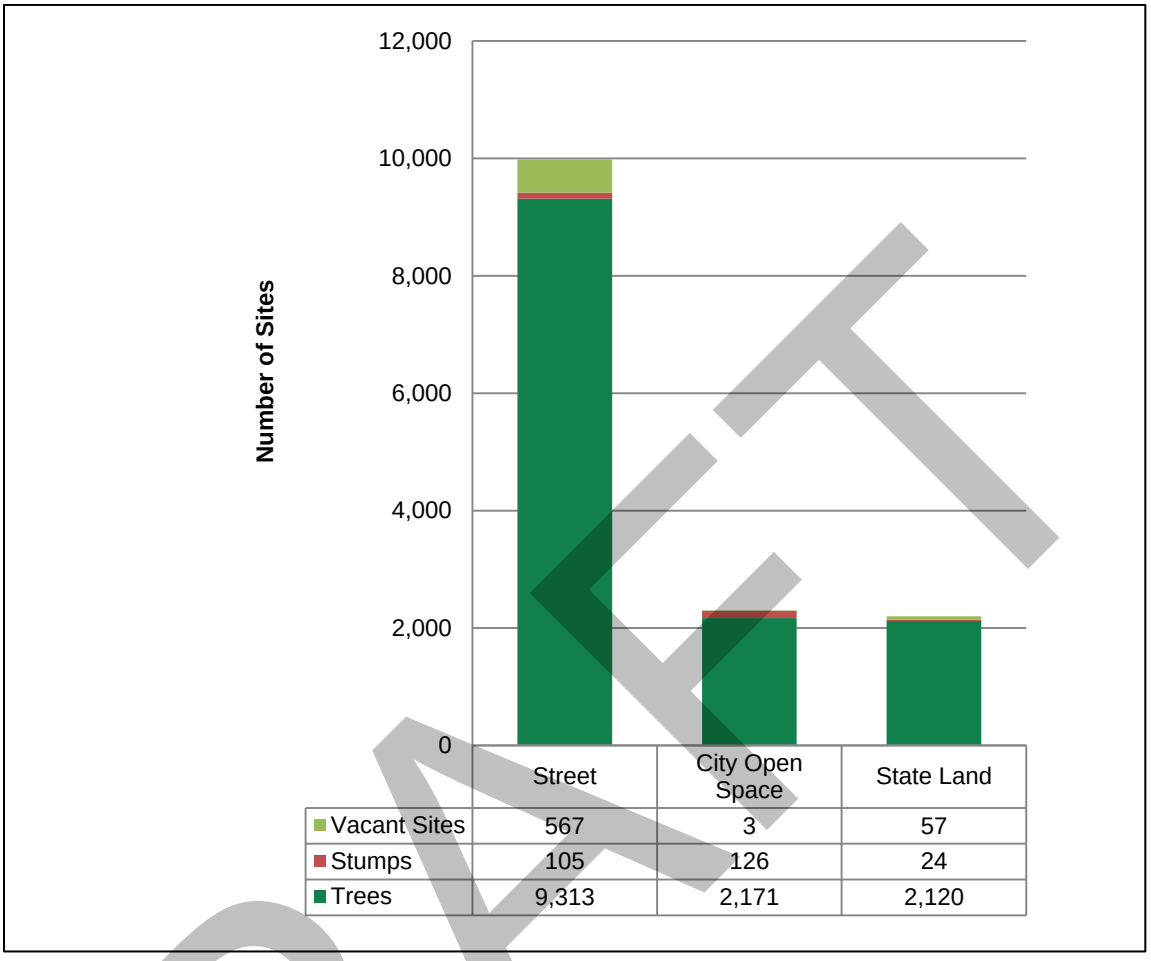


Figure 2.1. Sites collected during the Somerville 2018 tree inventory.

Definitions & Methodology

A "tree" is defined as a perennial woody plant that can grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms. A "street tree" is further defined as a tree growing within the public right of way (ROW). These street trees may be growing in sidewalks, tree lawns or parkways, islands, or medians. A "city open space tree" is defined as a tree growing in a City-owned park or public space, or on City-owned property such as municipal building lots or other facilities.

The inventory also included trees on State-owned land (including State-owned parks, public space, and right-of-way). For the purpose of managing trees, sometimes the information about trees on State-owned land will be excluded from the management plan details as the City has no jurisdiction over what is done in these State owned areas.

Appendix C contains a complete list of the City-owned open spaces and State-owned lands that were inventoried. *Appendix C* also contains additional details on data collection and site location methods.

Assessment of Tree Inventory Data

Recognizing trends in the tree inventory data can help guide short-term and long-term management planning. Data analysis and professional judgment were used to make generalizations about the state of the inventoried tree population. In this plan, the following criteria and indicators of the inventoried tree population were assessed:

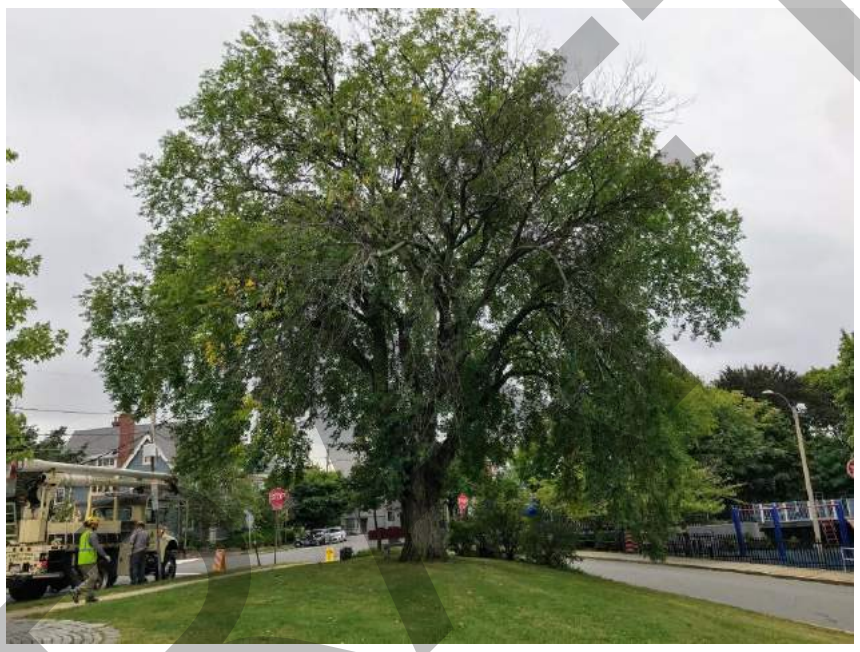
ISA Certified Arborists inventoried trees along street ROW and in community parks to collect information about trees that could be used to assess the state of the urban forest.

- *Species Diversity*, the variety of species in a specific population, affects the tree population's ability to withstand threats from invasive pests and diseases. Species diversity also impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.
- *Diameter Size Class Distribution Data*, the statistical distribution of a given tree population's trunk-size class, is used to indicate the relative age of a tree population. The diameter size class distribution affects the valuation of tree-related benefits as well as the projection of maintenance needs and costs, planting goals, and canopy continuity.
- *Condition*, the general health of a tree population, indicates how well trees are performing given their site-specific conditions. General health affects both short-term and long-term maintenance needs and costs as well as canopy continuity. Condition was further separated out in the inventory by canopy condition (full leaf area to dead), and wood condition (strong/no decay to dead). For the management plan these were combined to create an overall condition of the health of the tree.
- *Other Observations* include the analyses of other types of inventory data that provide insight into past maintenance practices and growing conditions; such observations may affect current maintenance practices and future management decisions. Examples of "Other Observations" include infrastructure conflicts, growing space type, and site observations.
- *Further Inspection* indicates whether field observations led to a conclusion that a particular tree requires additional inspection, such as a Level III risk inspection in accordance with ANSI A300, Part 9 (ANSI 2011), or periodic inspection due to particular conditions that may cause the tree to be a safety risk and, therefore, hazardous.

Species Diversity

Species diversity affects maintenance costs, planting goals, canopy continuity, wildlife habitat, and the Urban Forestry Program's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics, such as the devastating results of Dutch elm disease

(*Ophiostoma novo-ulmi*) throughout New England and the Midwest. Due to the spread of Dutch elm disease in the 1930s, combined with the disease's prevalence today, massive numbers of *Ulmus americana* (American elm), a popular street tree in Midwestern cities and towns, have perished (Karnosky 1979). Several Midwestern communities were stripped of most of their mature shade trees, creating a drastic void in canopy cover. Many of these communities have replanted to replace the lost elm trees. Ash and maple trees were popular replacements for American elm in the wake of Dutch elm disease. Unfortunately, some of the replacement species for American elm trees are now overabundant, causing a new biodiversity concern. Emerald ash borer (EAB, *Agrilus planipennis*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are non-native invasive insect pests that attack some of the most prevalent urban shade trees and certain agricultural trees throughout the country.

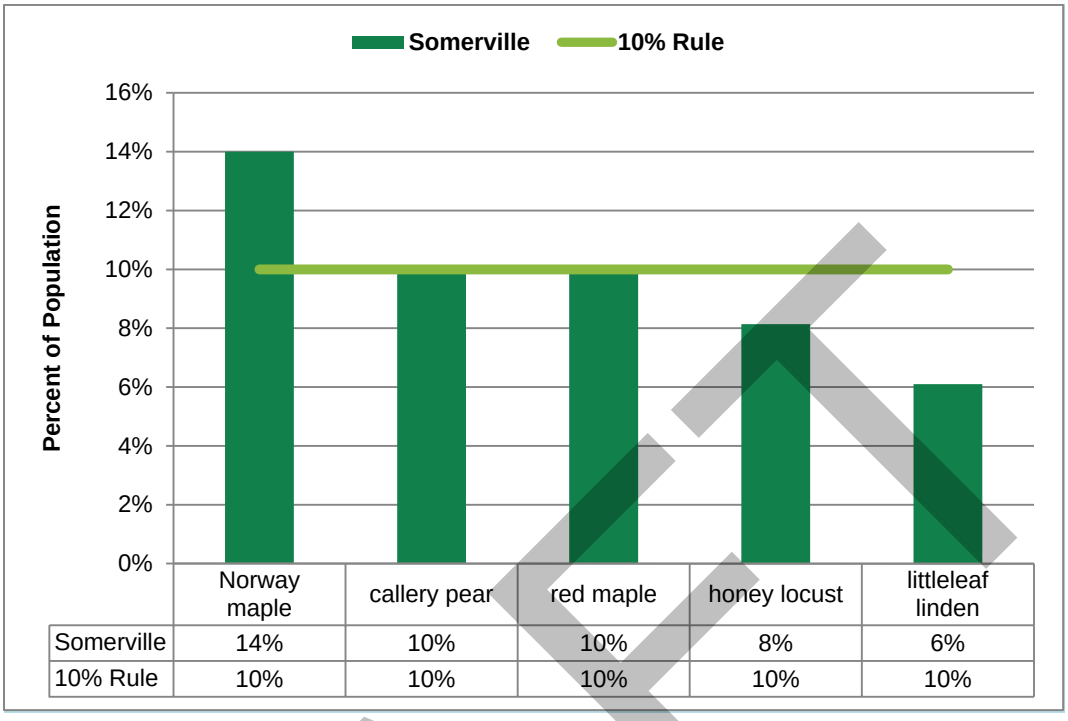


This Elm tree at Prospect Hill Park is one of the last remaining American Elm trees in the City. It was diagnosed with Dutch Elm Disease in 2019. It is being treated to help it survive as long as possible.

The best practice for the composition of an urban forest tree population is to follow the **10-20-30 Rule** for species diversity, namely that a single species should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30% (Richards, N. A. 1983).

Findings

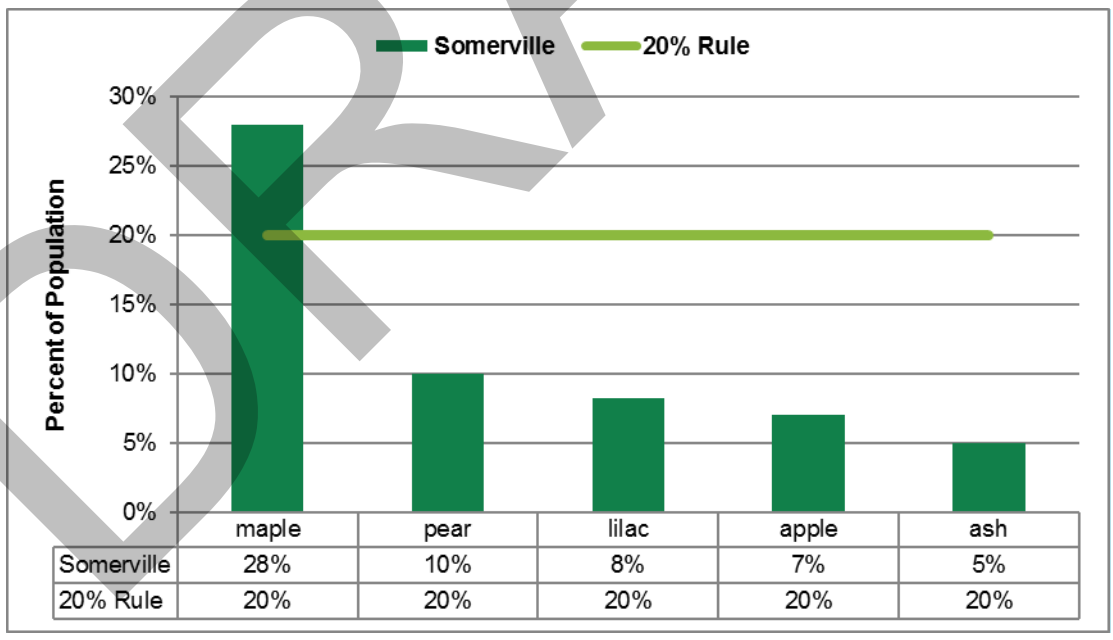
Figure 2.2 uses the 10% Rule to compare the percentages of the most common species identified throughout the entire tree inventory (which is not a comprehensive analysis of the City's true biodiversity as the inventory did not include trees on private property). *Acer platanoides* (Norway maple) exceeds the recommended 10% maximum for a single species in a population, comprising 14% of the inventoried tree population. Additionally, *Pyrus calleryana* (callery pear), and *Acer rubrum* (red maple) are at the 10% threshold.



	Norway maple	callery pear	red maple	honey locust	littleleaf linden
Somerville	14%	10%	10%	8%	6%
10% Rule	10%	10%	10%	10%	10%

Figure 2.2. Five most abundant species of the inventoried population compared to the 10% Rule.

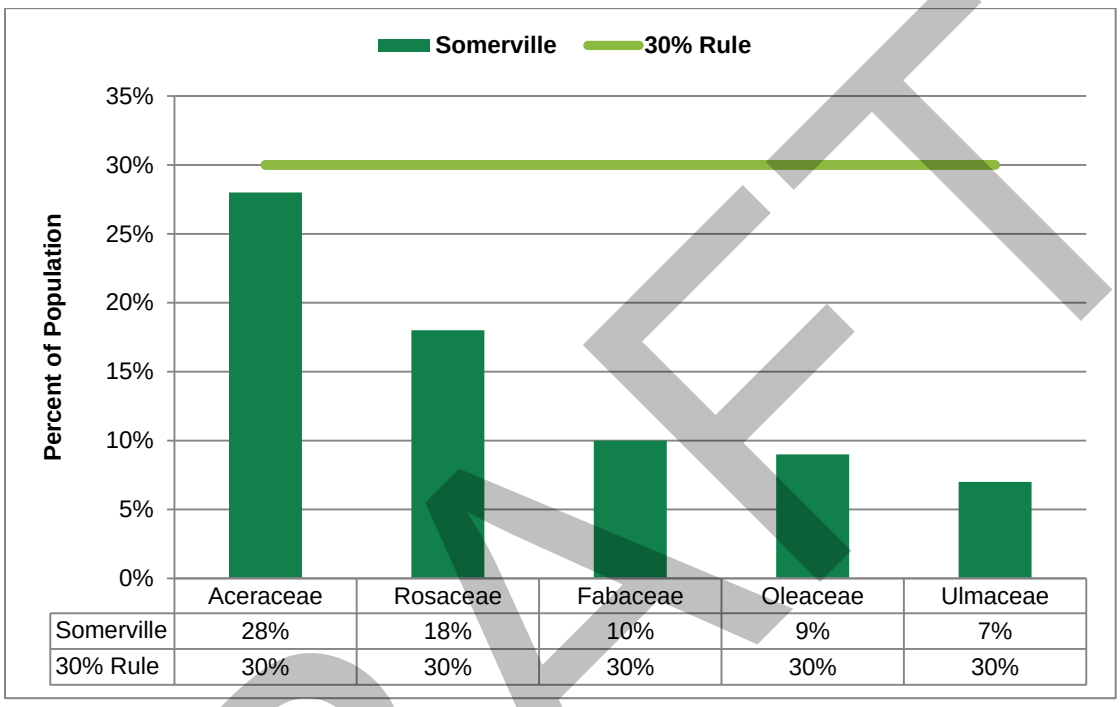
Figure 2.3 uses the 20% Rule to compare the percentages of the most common genera identified in the inventory. *Acer* (maple) comprises 28% of the inventoried tree population, thus exceeding the recommended 20% maximum for a single genus.



	maple	pear	lilac	apple	ash
Somerville	28%	10%	8%	7%	5%
20% Rule	20%	20%	20%	20%	20%

Figure 2.3. Five most abundant genera of the inventoried population compared to the 20% Rule.

Figure 2.4 uses the 30% Rule to compare the percentages of the most common families identified in the inventory. No family of trees exceeds the recommended 30% maximum. However, *Aceraceae* (maple family) is approaching this threshold as it currently comprises 28% of the inventoried tree population. The other most common families in the inventory include Rosaceae (rose family), Fabaceae (legume family), Oleaceae (olive family), and Ulmaceae (elm family).



	Aceraceae	Rosaceae	Fabaceae	Oleaceae	Ulmaceae
Somerville	28%	18%	10%	9%	7%
30% Rule	30%	30%	30%	30%	30%

Figure 2.4. Five most abundant families of the inventoried population compared to the 30% Rule.

Discussion/Recommendations

Acer platanoides (Norway maple) dominates the streets and parks of Somerville. It was overplanted in the past because it tolerates urban conditions well. This is a biodiversity concern not only because its abundance in the landscape makes it a limiting species but also because it can out-compete other trees and make it difficult for other plants to establish. In 2005 Norway Maple was characterized as an invasive species in the State of Massachusetts, and it is thus banned from import, sale, or trade. Continuing to plant a diversity of tree species is an important objective that will ensure Somerville's urban forest is sustainable and resilient to future invasive pest infestations.

Acer rubrum (Red maple) and *Pyrus calleryana* (callery pear) are also very abundant in the City, and thus future planting of these species should be limited. Similar to Norway maple, it was heavily planted in the past due to its tolerance of urban conditions. It was also a favorite species because of the beautiful white blossoms it produces in the spring. However, due to the poor canopy structure that often results in large limb breakage, callery pear has not been planted by the City for a number of years.

Considering the large quantity of *Acer* (maple) in the City's population, along with its susceptibility to the invasive species ALB and potentially the invasive species spotted lanternfly (*Lycorma delicatula*) (see *Section 3.3: Invasive Insect and Disease Management Strategy*), the planting of *Acer* (maple) should be limited to minimize the potential for loss in the event that ALB or spotted lanternfly threaten Somerville's urban tree population

See *Appendix D* for a recommended tree species list for planting.

Diameter Size Class Distribution

Analyzing the diameter size class distribution provides an estimate of the relative age of a tree population and offers insight into maintenance needs and practices.

The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches DBH), established trees (8.1–17 inches DBH), maturing trees (17.1–24 inches DBH), and mature trees (greater than 24 inches DBH). These categories were chosen so that the population could be analyzed according to Richards' ideal distribution (1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that an ideal tree population would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees. In this ideal distribution, the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while the smallest fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). This ideal distribution is correlated to a good population stability, where these younger trees will grow and fill in as replacements for mature trees at the end of their life cycle.

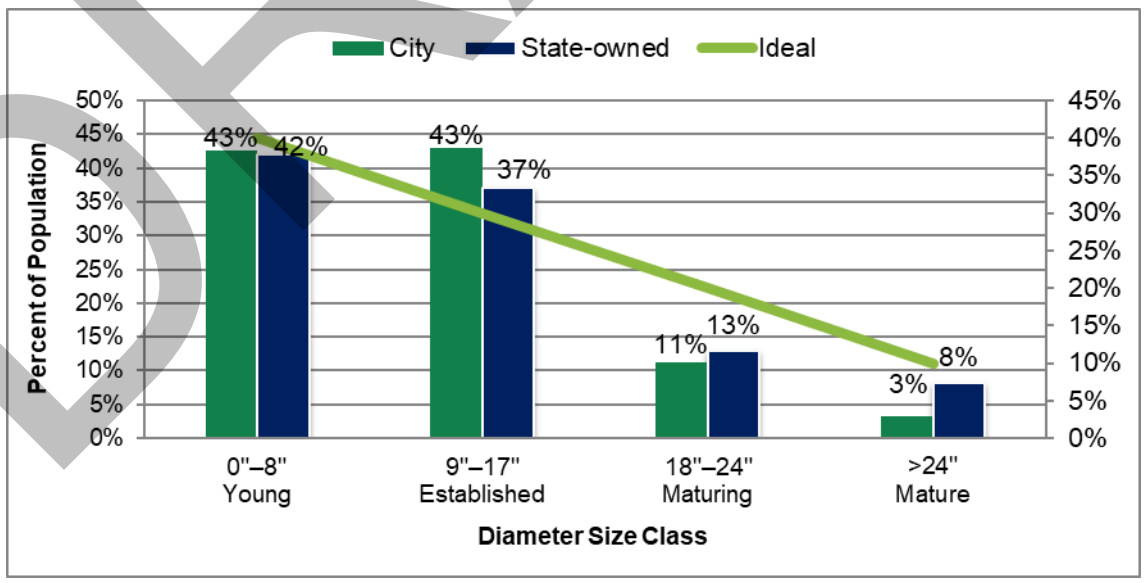


Figure 2.5. Comparison of diameter size class distribution for the inventoried trees to the ideal distribution, separated by City-owned (ROW and open spaces) and State-owned populations.

Findings

Figure 2.5 compares the diameter size class distribution of Somerville's inventoried tree population (separated by City-owned and State-owned trees), to the ideal distribution proposed by Richards (Richards, 1983). The distribution of City-owned tends towards the ideal, but with slightly more trees in the smaller diameter size classes (3% more young trees and 13% more established trees than the ideal distribution), and slightly fewer trees in the larger diameter size classes (9% fewer maturing trees and 7% fewer mature trees than the ideal distribution). Compared to the City-owned trees distribution, the distribution of State-owned trees aligns even more closely with the ideal distribution.

Discussion/Recommendations

One of Somerville's objectives is to have an ideal distribution of trees at the street, park, and citywide levels. Somerville's public tree population has too few maturing and mature trees, which indicates that the distribution is skewed. The City should promote tree preservation and proactive tree care to ensure the long-term survival of the older trees. See Appendix F for more information on risk assessment and priority maintenance. The City should also support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and replace older declining trees. Tree planting and tree care will allow the distribution to normalize over time. See Appendix D for a recommended tree species list for planting. See Appendix E for planting suggestions and information on species selection for planting sites.

Planting trees is necessary to increase canopy cover and replace trees lost to natural mortality (expected to be 1%–3% per year) and other threats (for example, invasive pests or impacts from weather events such as storms, wind, ice, snow, flooding, and drought). Planning for the replacement of existing trees and identifying the best places to create new canopy is critical.

Tree Condition

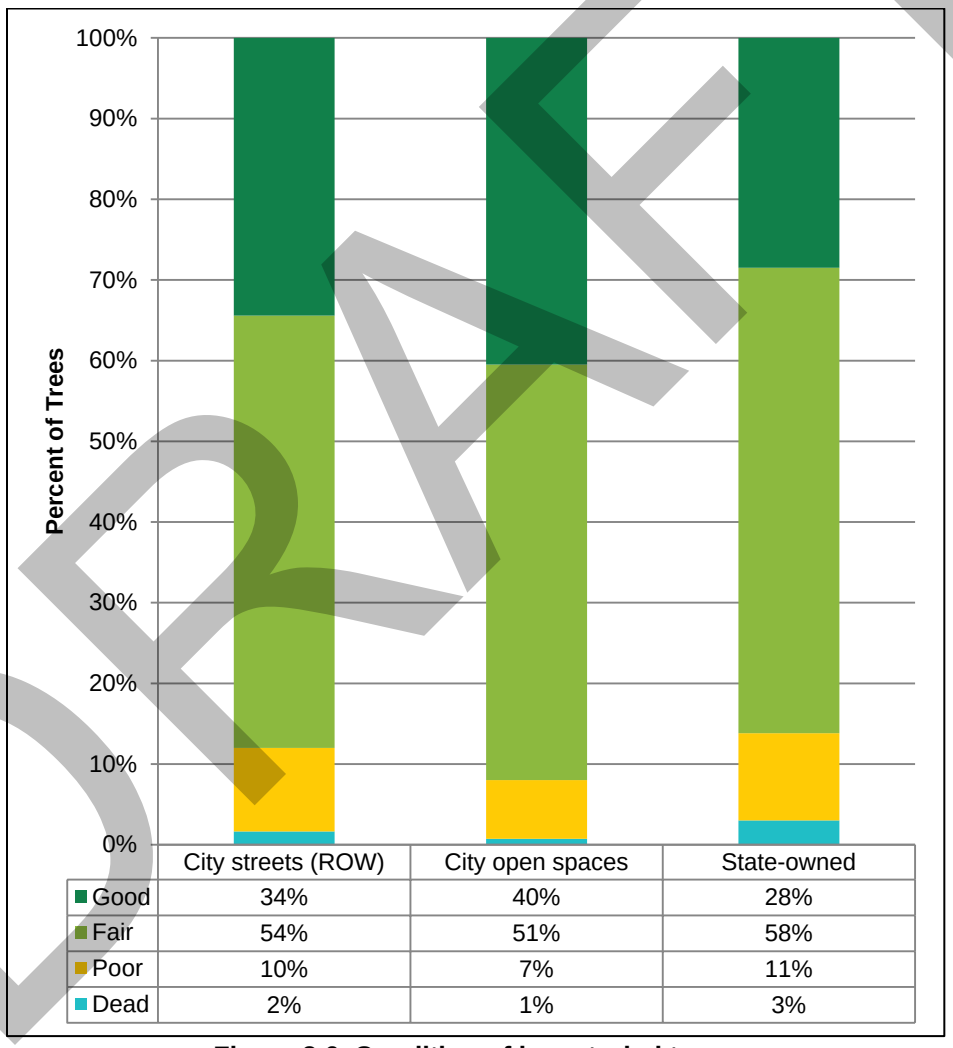
Urban trees grow in challenging conditions. In addition to withstanding varied environmental conditions and pest damage, urban trees encounter a variety other factors that can impact their health. Soil compaction and hardscape features can impact root health, vehicles can cause damage to trunks and canopies, and branches can be excessively pruned for utility, pedestrian, or building clearance. Understanding the condition of a tree provides insight into its current health and stability, and is useful in determining if corrective management actions to improve vitality are warranted.

The condition of individual trees was identified based on methods defined by the International Society of Arboriculture (ISA). The condition assessment considered several factors for each tree, including:

- root characteristics
- branch structure
- trunk, canopy, and foliage condition
- the presence of pests

The condition of each inventoried tree was rated as Good, Fair, Poor, or Dead. The canopy and wood condition of each inventoried tree was assessed separately, and each tree's overall condition was calculated as an average of the two scores. If a tree's classification landed in-between two categories, it was assigned the lower of the two categories.

Comparing the condition of the inventoried tree population with relative tree age (or size class distribution) can provide insight into the stability of the population. Since tree species have different lifespans and mature at different diameters, heights, and crown spreads, actual tree age cannot be determined from diameter size class alone. However, general classifications of size can be extrapolated into relative age classes. The following categories are used to describe the relative age of a tree: young (0–8 inches DBH), established (8.1–17 inches DBH), maturing (17.1–24 inches DBH), and mature (greater than 24 inches DBH).



	City streets (ROW)	City open spaces	State-owned
Good	34%	40%	28%
Fair	54%	51%	58%
Poor	10%	7%	11%
Dead	2%	1%	3%

Figure 2.6. Condition of inventoried trees.

Findings

Figures 2.6 and 2.7 illustrate the general health and distribution of trees relative to their condition.

Most of the inventoried City-owned and State-owned trees were recorded to be in Good or Fair condition, with a slightly higher percentage of City-owned trees in Good condition and a slightly higher percentage of State-owned trees in Fair condition (Figure 2.6).

The condition rating of trees by size class (relative age) indicates growing condition as well as how trees were managed over time. Only City-owned trees (both street trees and open space trees) were used in this analysis because the City has no jurisdiction over the management of State-owned trees. Figure 2.7 illustrates that most of the young City-owned trees were found to be in Good condition, whereas most of the established, maturing, and mature City-owned trees were found to be in Fair condition.

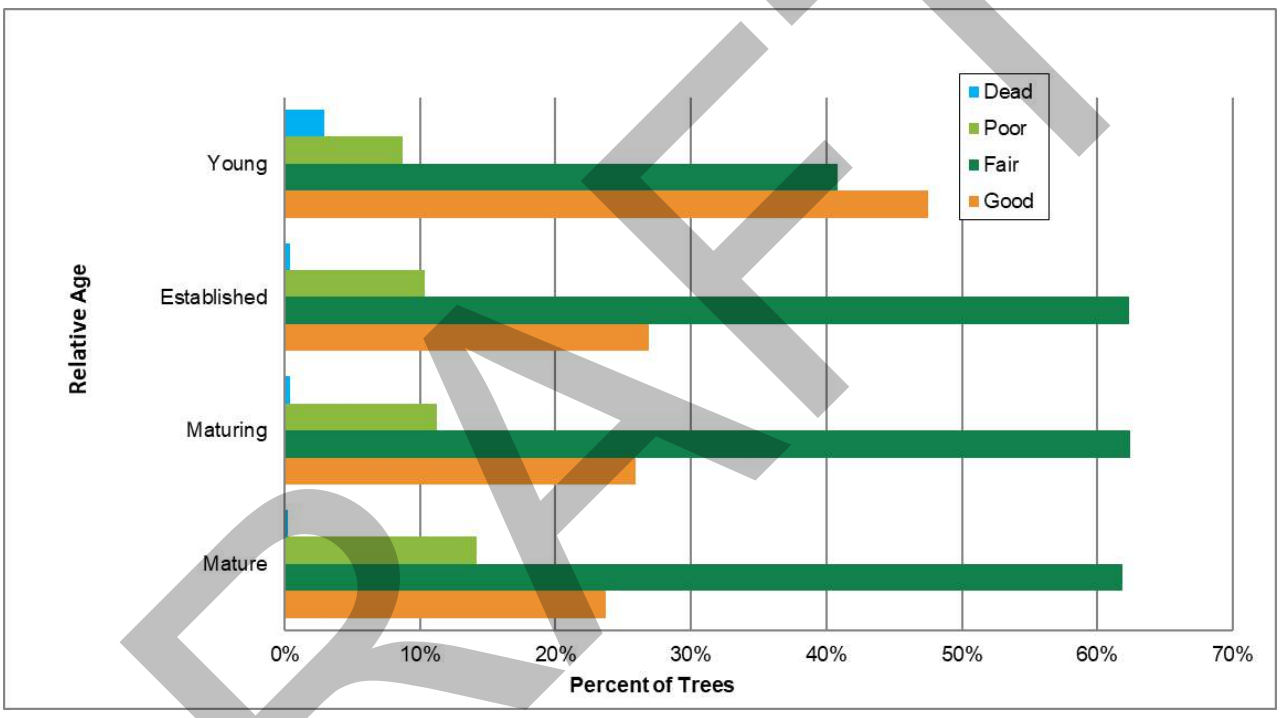


Figure 2.7. Condition of City-owned trees by relative age.

Discussion/Recommendations

The condition of Somerville's inventoried tree population is typical for an urban population. The data analyses provide the following insight into historical maintenance practices and maintenance needs:

- The similar trends in condition for street and open space trees reflect both the growing conditions and past management practices. In Somerville, street trees have historically had more maintenance than park trees, while park trees are growing in better growing conditions. These differences lead to both groups having a majority of trees in Fair condition. Through the "Parks Tree Health Program" and the "Young Tree Training Program," both started in 2019, the City is working towards improving the management of parks trees and the growing conditions of street trees such that both populations will improve over time, particularly for the younger tree populations.

- Dead trees and some trees in Poor condition should be removed because of their failed health; these trees will likely not recover, even with increased care.
- The health of younger trees rated in Fair or Poor condition may improve over time with interventions such as watering, fertilizing and/or mulching, and structural pruning. Pruning should follow the standards in *ANSI A300 (Part 1)* (ANSI 2008). The goal of the City's "Young Tree Training Program" is to address structural pruning needs of the City's younger trees.
- Poor condition ratings among mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their vigor. Some of these trees are unlikely to recover and should be removed because they pose a danger to people or property.
- Implementing a proactive maintenance program that takes a holistic approach to tree health will help improve the condition of Somerville's trees. This type of program is based on identifying and correcting deficiencies in a tree's structure before they become a problem. The City's "Young Tree Training Program" and "Parks Tree Health Program" take a proactive maintenance approach. This approach should be extended to the ROW and other City-owned trees.

Proper tree care practices are needed for the long-term general health of the urban forest. Following guidelines developed by ISA and those recommended by *ANSI A300 (Part 6)* (ANSI 2012) will ensure that tree maintenance practices ultimately improve the health of the urban forest. For a more in depth review of Somerville's maintenance practices and needs please refer to *Section 3.2: Tree Maintenance Program* and Section *4.1: Operations Review*.

Site Observations

Additional observations were recorded during the tree inventory to further describe a tree's growing location and/or site conditions. These conditions can affect the overall health of a tree and/or influence maintenance needs. Site observations recorded during the inventory include:

- *Root flare*–The presence of a root flare indicates whether tree was planted at the proper depth and relates to the health of structural roots.
- *Girdling root*–A girdling or strangling root can impact the health and long-term survivability of a tree.
- *Sidewalk condition*–New sidewalk around a tree may negatively impact tree health if the installation of the sidewalk resulted in roots being crushed or severed. Alternatively, new sidewalk around a tree could also be beneficial to a tree if it resulted in a larger tree well opening.
- *Ground maintenance*–Maintenance needs at the ground level (ex. pruning suckers, weeding, etc.) were recorded for each tree.

Findings

A **root flare** (also called a trunk flare) is the lower part of the trunk of a tree, where the trunk meets the roots. A visible root flare indicates that a tree was planted at the correct depth. The majority of the inventoried trees in Somerville have a visible root flare (76% of City-owned trees, and 94% of State-owned trees). Trees that are planted too deep (i.e. those with no visible root flare) are likely to decline and/or have shorter lifespans. This is because the root collar stays damp, which makes it susceptible to insects and disease. Also the rate of oxygen and carbon exchange drops, causing the roots to suffocate and decay. Trees that are planted too deep are susceptible to having girdling surface roots, and these roots can cause canopy decline and/or weak spots in the trunk.

The tree on the left side as no visible root flare, indicating it was planted too deep. The tree on the right has been planted correctly and the root flare can clearly be seen.

The presence of **girdling roots** was identified during the tree inventory. A girdling root is a root that is growing on top of or around another root or the trunk itself. As the girdling root grows, it will encircle that that root or trunk, cutting off the supply of water and nutrients to that portion of the tree. Girdling roots can result from planting a tree too deep or from growing a tree in limited space. In some cases, trees that arrive from the nursery have circling roots (due to being container grown or balled and burlaped) which can become girdling roots. These roots should be pruned before the tree is planted, or if they are particularly bad the tree should be rejected from the nursery. 19% of City-owned trees were found to have girdling roots. At the time of the inventory, 168 (8%) of the City-owned trees noted for girdling roots were recommended for removal.

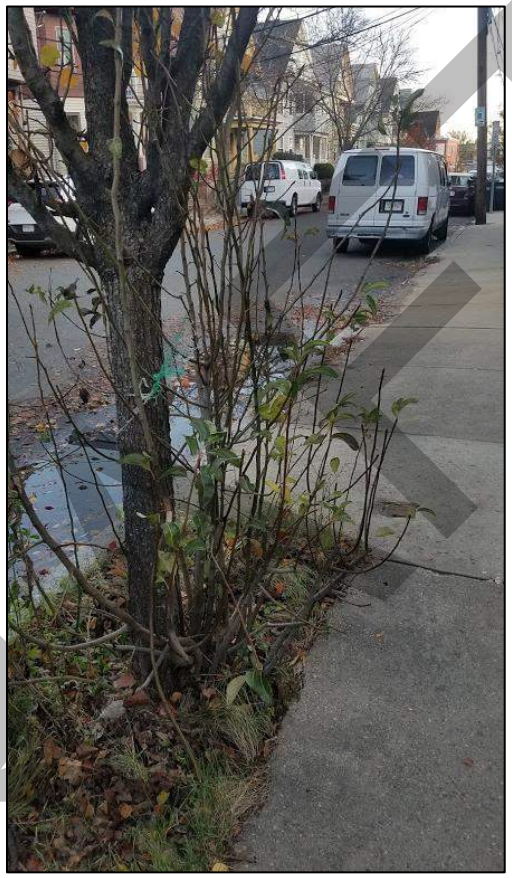
This tree has two roots that are wrapping themselves around the trunk and other roots. As these girdling roots continue to grow they will eventually choke off the supply of water and nutrients to the rest of the tree, and will cause the tree to die.

Sidewalk condition around trees was recorded during the inventory. New sidewalks around a tree well may indicate the sidewalk was replaced because the tree roots were lifting or cracking it. In addition, it is possible that some roots are cut during sidewalk replacement, which could impact tree health, longevity, and stability. 20% of City-owned trees were surrounded by new sidewalks, and of these trees surrounded by new sidewalk, 111 of them (5%) were recommended for removal.

Note the color changes of the sidewalk. The lighter gray color of the sidewalk is where the sidewalk has been replaced.

This photograph is a good example of where a sidewalk was replaced, and the root flare was cut to allow for a flat surface. This is a major issue as the critical, anchoring roots have now been removed making the tree unstable.

The need for **ground level maintenance** around trees was determined during the inventory. Ground maintenance was recommended if the area around the tree had a sufficient amount of weeds or suckers (small branch offshoots around the base of the tree). These weeds and suckers can block a sidewalk path, take nutrients away from the tree, and can be unsightly. Certain species (*e.g.* callery pear, linden) are more prone to growing suckers. At the time of the inventory, 10.5 % of the City-owned trees needed to have the area around them maintained.



This callery pear was listed as needing ground level maintenance as it has several suckers growing in the tree well.

A summary of the site observations for City-owned Trees is presented in Table 2.1 and a summary of the site conditions for State-owned Trees is presented in Table 2.2.

Table 2.1. Site Observations for City-owned Trees

Observations	Number of Trees	Percent of City-owned trees
Visible Root Flare	8,677	75.56%
Girdling Root	2,222	19.35%
New Sidewalk	2,320	20.20%
Maintain Ground	1,206	10.50%
Total Number of City-owned Trees	**11,484**	**-**

Table 2.2. Site Observations for State-owned Trees

Observations	Number of Trees	Percent of State-owned trees
Visible Root Flare	1,999	94.29%
Girdling Root	242	11.42%
New Sidewalk	17	0.80%
Maintain Ground	93	4.39%
Total Number of State-owned Trees	**2,120**	**-**

Discussion/Recommendations

Site conditions and maintenance can impact a tree's health and long-term survival. The following recommendations will help to provide each tree with its best chance of success:

- Ensure trees are planted at correct depth and that root flare is visible at the time of planting. For those trees that are already in the landscape, consider replanting the trees with no visible root flare that are small enough. Otherwise, if possible, carefully scrape away the soil from around the trunk until the root flare is visible.
- Unless slated for removal, trees noted as having girdling should be inspected. Corrective actions should be taken when warranted and possible. If their condition worsens, removal may be required.
- Sidewalk repairs are often necessary to ensure the sidewalks remain accessible. When performing sidewalk repair/replacement it is important to work around the existing roots, particularly the structural roots, instead of cutting them. Cutting structural roots not only reduces the ability of the tree to acquire sufficient water and nutrients, but can also inadvertently make the tree unstable.
- Performing ground level maintenance on trees that have numerous suckers growing out of their base or which are surrounded by excessive weeds can help to increase tree vitality while also improving accessibility and the tree's appearance.
- When present, young trees that were staked or had other temporary hardware were noted (398 City-owned trees). Staking should only be installed when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to trees with a loose, flexible material. Installed hardware that has been attached to any tree for more than one year, and hardware that may no longer be needed for its intended purposes, should be inspected and removed as appropriate.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure such as buildings, sidewalks, and utility wires and pipes, which may, in turn, pose risks to public health and safety. Existing or possible conflicts between trees and infrastructure recorded during the inventory include:

- *Overhead Utilities*—The presence of overhead utility lines above a tree or planting site was noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.
- *Hardscape Damage*—Trees can adversely impact hardscape, which affects tree root and trunk systems, as well as pedestrian accessibility. The inventory includes tree-related damage that has caused curbs, sidewalks, and other hardscape features to lift or crack.

These data should be used to schedule pruning and plan repairs to damaged infrastructure. The information about trees conflicting with overhead utilities is helpful when working with Eversource's vegetation management crews. The City of Somerville has a good relationship with Eversource, and they work together to ensure trees are not overly pruned but are still safe and remain clear from the powerlines. To limit hardscape damage caused by trees, trees should be planted in growing spaces where adequate above ground and below ground space is provided. In urban sites this can be difficult as there are many possible conflicts, but maximizing the amount of growth space and choosing the correct type of tree for the available space and environmental conditions greatly lessen these issues.

Findings

There were 4,269 trees in the complete inventory with utility lines directly above, or passing through, the tree canopy. Of those trees, 729 (5% of trees) were directly touching the lines.

There was hardscape damage surrounding 16% of the tree population. Hardscape damage included raised sidewalk slabs or curbs greater than or equal to 1 inch.

Table 3. Trees Conflicts with Overhead Utility Infrastructure

Conflict	Presence	Number of Trees	Percent
Overhead Utilities	Present and Conflicting	729	5.36%
	Present and Not Conflicting	3,540	26.02%
	Not Present	9,335	68.62%
Total		**13,604**	**100%**

Table 4. Trees and Hardscape Damage

Conflict	Presence	Number of Trees	Percent
Sidewalk Deflection Greater Than or Equal to 1 inch	Yes	2,229	16.38%
	No	11,375	83.62%
Total		**13,604**	**100%**

Significant uplift of a sidewalk from a Japanese zelkova along Broadway.

Discussion/Recommendations

Tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with *ANSI A300 (Part 9)* (2011). Minimum clearance distance guidelines are as follows: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

Planting only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet of overhead utilities, and large-growing trees 40 feet or more from overhead utilities will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines. Since 2017, when the City first hired a full time urban forester, Somerville has been actively planting the "right tree in the right place," and will continue to do so for future plantings.

When planting in hardscape such as sidewalks, it is important to give the tree enough growing room above ground. Guidelines for planting trees among hardscape features are as follows: give small-growing trees at least 3–5 feet, medium-growing trees at least 6–7 feet, and large-growing trees 8 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger-diameter structural roots. For more planting recommendations please refer to *Section 3.1: Tree Planting Plan*.

Growing Space Type

Tree health and longevity can be influenced by the type of space it is growing in and the growing space available for root development. Thus, data about each tree's growing space was collected in the tree inventory. These data included growing space type as well as growing space size, which was

recorded as the minimum width and length of the available growing space. Growing space types were categorized as follows:

- *Island*—surrounded by pavement or hardscape (for example, parking lot divider)
- *Median*—located between opposing lanes of traffic
- *Open/Restricted*—open sites with restricted growing space on two or three sides
- *Open/Unrestricted*—open sites with unrestricted growing space on at least three sides
- *Raised Planter*—in an above-grade or elevated planter
- *Tree Lawn*—located between the street curb and the public sidewalk
- *Unmaintained Area*—urban areas that do not appear to be regularly maintained
- *Natural Area*—areas that do not appear to be regularly maintained purposefully
- *Well/Pit*—growing space that is at grade level and surrounded by sidewalk

Discussion/Recommendations

The ultimate size of a tree and how vigorously it grows depends on various factors such as species, soil quality, and water availability. Trees that have more soil available tend to grow larger and be more robust. To prolong the useful life of street trees, the minimum dimensions of tree wells or tree lawns should be 3 x 5 feet for small-growing tree species, 3 x 8 feet for medium-size tree species, and 3 x 10 feet for large-growing tree species. The useful life of a public tree ends when the cost of maintenance exceeds the value contributed by the tree. This can be due to increased maintenance required by a tree in decline, or it can be due to the costs of repairing damage caused by the tree's presence in a restricted site.

Further Inspection

This data field indicates whether a particular tree requires further inspection, such as a Level III risk inspection in accordance with *ANSI A300, Part 9* (ANSI, 2011), or periodic inspection due to particular conditions that may cause it to be a safety risk and, therefore, hazardous. If a tree was noted for further inspection, City staff should investigate as soon as possible to determine corrective actions. The City's primary concern is in removing any hazards to people or property.

This pin oak along Alewife Parkway needs further inspection. There is a weak attachment with a crack forming. This tree may need to be cabled/braced, or removed. An ISA Certified Arborist should perform the additional inspection.

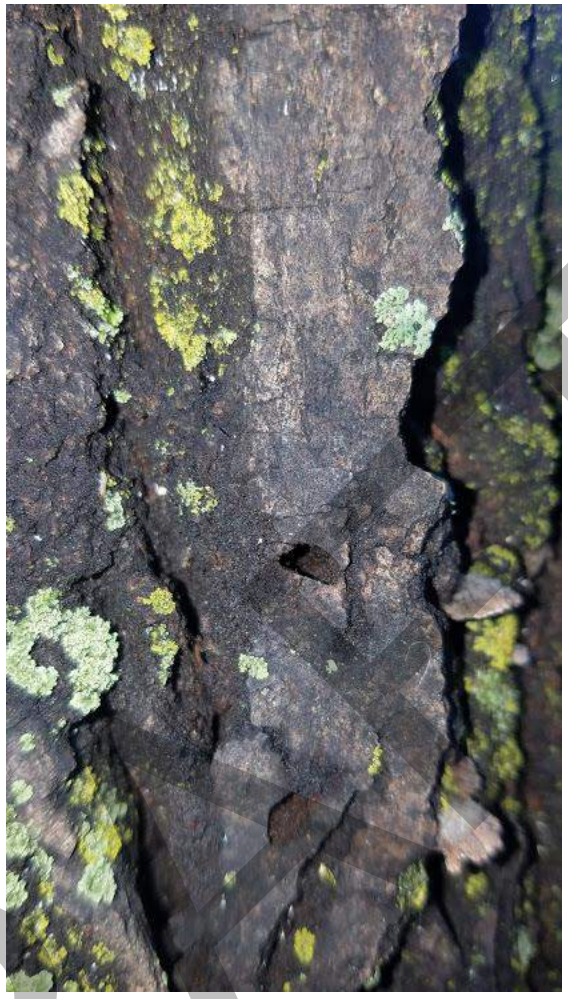
Findings

In the inventory, Davey Resource Group recommended 1,021 City-owned trees for further inspection. Of these trees 145 (14%) were recommended for multi-annual checks, 835 (82%) for insect/disease monitoring, and 41 (4%) for a Level III assessment (ANSI A300, Part 9 (ANSI, 2011)). Of the 835 trees recommended for insect/disease monitoring 95% of these trees are ash trees, and 3% are American elms.

Discussion/Recommendations

An ISA Certified Arborist should perform additional inspections of the trees that need multi-annual checks and Level III assessments. If it is determined that these trees exceed the threshold for acceptable risk, the defective part(s) of the trees should be corrected or removed, or the entire tree may need to be removed.

There were only a couple inventoried ash trees that showed possible symptoms of the invasive insect pest Emerald Ash Borer (EAB). These specific trees should be monitored closely. If signs of EAB manifest, the tree should be removed and the site should be inspected for potential replacement. See *Section 3.3: Invasive Insect and Disease Management Strategy* for more details on the City's ash tree treatment and monitoring program.



This white ash tree along Elm Street needs to be re-inspected for emerald ash borer (EAB). There is a small D-shaped borer hole, which looks similar to what would be created by EAB. The City may want to have an entomologist inspect this tree.

Potential Threats from Pests

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensuring the health and continuity of the City's street and park trees. *Section 3.3: Invasive Insect and Disease Management Strategy* and *Appendix G* provide more detailed information about some of the current potential threats to Somerville's trees, including the emerald ash borer (EAB).

Many pests target a single species or an entire genus. The inventory data were analyzed to provide a general estimate of the percentage of trees susceptible to some of the known pests in Massachusetts (see Figure 2.8). It is important to note that Figure 2.8 only relates to the public trees that were inventoried. Many more trees throughout Somerville, including those on private property, may be susceptible to these invasive pests.

Findings

Granulate ambrosia beetle (*Xylosandrus crassiusculus*) and spotted lanternfly (*Lycorma delicatula*) can pose the biggest threats to a large percentage of the trees in the complete inventory (52% and 45%, respectively). These pests have not yet been detected in Somerville, but if they were detected, the City could see severe losses in its tree population.

Granulate ambrosia beetle's range is typically in the Southeast. However, it was found in Oregon and Virginia in 1992, and in Indiana in 2002 (Cole 2008). With climate change both inducing more stress on trees, and also causing hardiness zones to change, this pest is one to keep in mind.

Spotted lanternfly (*Lycorma delicatula)* is an invasive insect native to China. It was first discovered in Pennsylvania in 2014, and has since spread into New Jersey, Maryland, Delaware, and Virginia. While there are no known infestations in Massachusetts, this insect has been found in multiple counties in neighboring states. Spotted lanternfly prefers the host tree-of-heaven (*Ailanthus altissima*), but it feeds on a wide range of fruit, ornamental and woody trees, and agricultural crops (such as apples, peaches, grapes, and hops). Spotted lanternfly is discussed in greater detail in *Section 3.3: Invasive Insect and Disease Management Strategy*.

Also of particular note is the impact of emerald ash borer (EAB) on Somerville's trees. EAB has been recently found in Somerville. One EAB beetle was found on a trap in 2018, and 25 EAB beetles were found on traps in 2019. A total of 1,034 publicly-owned ash trees were inventoried, and the majority did not yet show signs or symptoms of infestation, but once EAB is found it spreads quickly. The City's healthy ash trees are being proactively treated with an organic insecticide to help protect them from EAB. The unknown number of private trees that were not part of this inventory may be an additional future concern. See *Appendix G* and *Section 3.3: Invasive Insect and Disease Management Strategy* for more information about EAB and Somerville's ash tree management strategy.

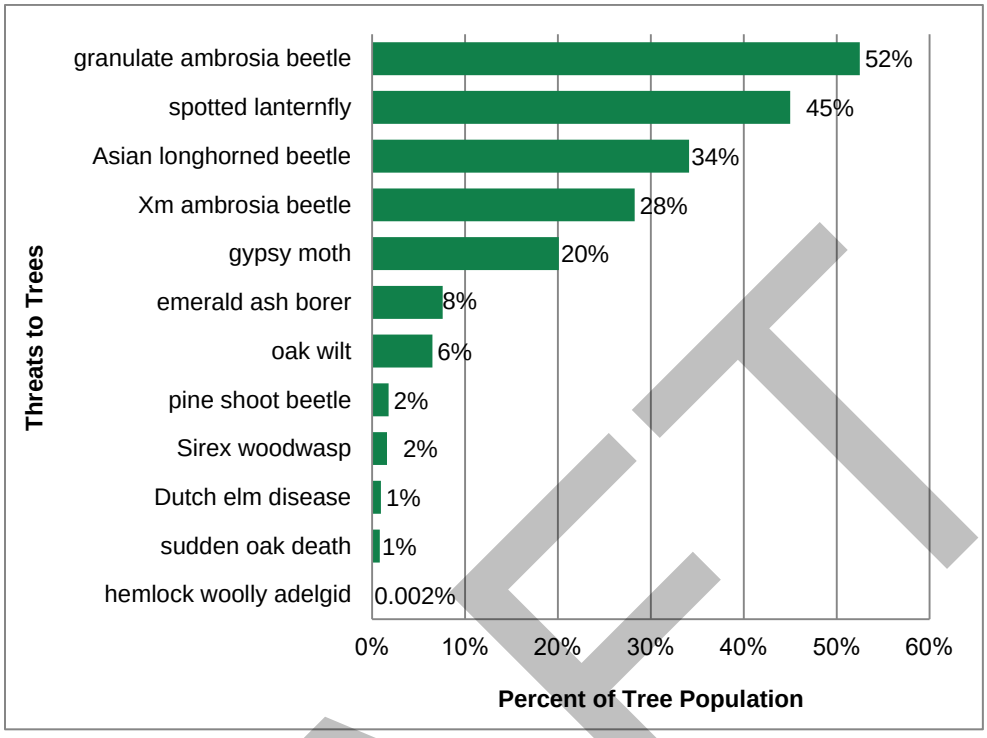


Figure 2.8. Potential impact of insect and disease threats to all inventoried trees.

Discussion/Recommendations

Somerville should be aware of the signs and symptoms of potential infestations and should be prepared to act if a significant threat is observed in its tree population or in a nearby community. An integrated pest management plan should be established. The plan should focus on identifying and monitoring threats, understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results. Most of this information for key pests is provided in *Section 3.3: Invasive Insect and Disease Management Strategy*, including recommendations for managing the ash tree population and mitigating EAB.

Community Outreach

Discussion/Recommendations

The inventory data collected and analyzed to develop this plan contribute significant information about the tree population and can be utilized to guide the proactive management of that resource. Trees provide oxygen we need to breathe, shade to cool our neighborhoods, and canopies to stand under when it's hot or when it rains. These data can also be utilized to promote the value of the urban forest and the tree management program in the following ways:

- Tree inventory data can be used to justify necessary priority and proactive tree maintenance activities as well as tree planting and preservation initiatives (see *Section 3: Expand, Preserve & Maintain*).
- Species data can be used to guide tree species selection for planting projects with the goals of improving species diversity and limiting the introduction of invasive pests and diseases.
- Information in this plan can be used to advise residents about threats to urban trees (such as granulate ambrosia beetle, emerald ash borer, and gypsy moth).

Various avenues for outreach are described in *Section 4.4: Public Engagement*.

SECTION 3: Expand, Preserve & Maintain

Trees are clearly an important asset providing numerous benefits to the inhabitants of Somerville (*Section 1: The Importance of Trees in the City*). The City's urban forest is a complex network of trees, site conditions, and maintenance requirements (see *Section 2: Somerville's Trees*). Understanding this system is important for proper decision-making regarding species selection, tree planting practices, and maintenance needs. This section of the Urban Forest Management plan provides details and recommendations for expanding the tree canopy through tree planting, performing maintenance on the City's tree population to encourage tree health and public safety, and how to best prepare for current and potential issues that the City's tree may face like pests and storms.

- *Section 3.1: Tree Planting Plan* provides guidelines for planting new trees in the city, including details on where to focus planting efforts, and best practices for species selection and planting techniques.
- *Section 3.2: Tree Maintenance Program* describes a seven-year tree maintenance program designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles and other urban forest maintenance activities.
- *Section 3.3: Invasive Insect and Disease Management Strategy* provides strategies for managing exotic pests and other diseases that may impact the City's urban forest. Emerald Ash Borer is the main focus of this section as it is currently the most damaging and prevalent pest in Somerville.
- *Section 3.4 Storm Preparedness Plan* outlines a storm preparedness plan to aid the City in mitigating, responding to, and recovering from an emergency or natural disaster in a timely manner.

3.1 Tree Planting Plan

This *Tree Planting Plan* provides guidelines for the implementation of an organized and comprehensive tree planting strategy that results in the prioritization of tree planting locations and the expansion of Somerville's urban tree canopy. These guidelines provide information on suitable planting locations in the City along with general recommendations on choosing suitable trees for each site. This planting plan provides specific and in-depth guidelines for the future plantings to allow for more accurate budget projections and more effective use of tree care funds.

The scope of this plan includes:

- A brief description of the type of known planting sites available in the City.
- A prioritization of planting areas throughout the City based on current canopy cover and other environmental and demographic parameters.
- Recommendations for specific planting needs related to species diversity, site restrictions, and functionality of the urban forest.

 Recommendations for tree planting strategies in order to maximize investments in the purchasing, planting, and maintenance of new trees by meeting industry standards (such as ANSI, and the Society of Municipal Arborists) and making practical decisions in species selection. [How to Plant]

Where to Plant

There are numerous opportunities to plant more trees on public property in the City of Somerville. Here, potential planting locations are identified from the 2018 tree inventory, as well as from prioritized areas of the City based on specific criteria used in a canopy analysis.

Tree Planting Parameters

Trees an important part of City, but they must coexist with various other aspects of the built environment. To provide ample space for a growing tree while also maintaining public safety and protecting other City infrastructure, the City uses the following guidelines when choosing new planting locations:

- New tree wells in the sidewalk provide a minimum of 18 square feet of open soil (ex. a 3’ x 6’ tree well).
- Trees must be planted a minimum of:
    - 20 feet away from any intersection, crosswalk, or stop sign
    - 5 feet away from any fire hydrant or utility pole
    - 10 feet from any streetlight
    - 3 feet from any driveway or walkway
    - 1 foot away from any underground utilities (ex. gas and water)
- The width of the sidewalk must also be taken into account, as per ADA regulations a 3 foot sidewalk with must remain.
- Trees must be spaced out in such a way that they have room to grow. Small trees are spaced at least 15 feet on center, medium trees are spaced 25-30 feet on center, and large trees are spaced 40 feet on center.

These guidelines are summarized in Figure 3.1.

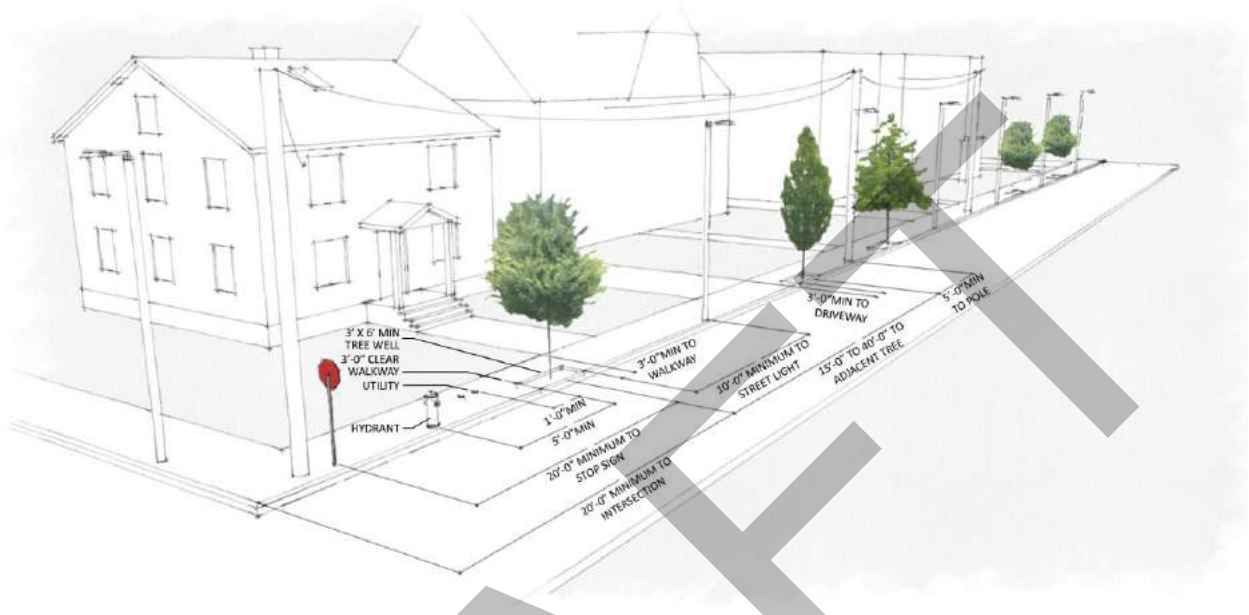


Figure 3.1. Tree planting parameters for new trees in Somerville

Currently Available Planting Sites

Somerville's 2018 tree inventory (see *Section 2: Somerville's Trees*) included an assessment of available planting sites within the existing right-of-way (ROW). This inventory was limited to tree wells and other locations that were currently open but not yet planted, and locations that recently had a tree but where the tree was removed and paved over with asphalt.

The type of space available for tree growth is also listed in the inventory. The common site types include: *Island*, *Median*, *Unmaintained Area*, *Open* (unrestricted in all directions), *Tree Lawn* (the space between a curb and a sidewalk), *Raised Planter*, *Natural Area*, and *Well* (a tree pit surrounded by pavement).

The growing space type and size can be a limiting factor of the growth and natural habit of trees, and dictates which species are suitable for any given planting site. For each location, the length and width (measured in feet) of each growing space type is recorded in the inventory, as well as the presence of all overhead utility lines (including, but not limited to, power, telephone, and cable lines).

Tree Inventory Results

In the 2018 public tree inventory, a total of 567 planting sites were currently available along the city-owned right-of-way (ROW). A site was designated as a currently available planting site if

there was an appropriate amount of open space (ex. in a tree lawn or naturalized area, median, island, etc.), or an open tree well (including ones with asphalt) that could be expanded if needed. The space available for a tree to be planted and thrive is a major factor that dictates the type of species best suited for a given location. Of the available sites, 100 were designated as "large", meaning that they are suitable for large growth habit trees (3' x 10' or greater grow space size and no overhead wires). There were 130 "medium" sites (at least 3' x 8' growing space and no overhead wires) and 337 "small" sites (at least 3' x 5' and/or has wires overhead) in the inventory. Regardless of the available growing space size, all locations with overhead wires present were designated as "small" planting sites. Figure 3.2 shows the distribution of the vacant planting sites by appropriate mature tree size. This distribution is typical for a dense community like Somerville.

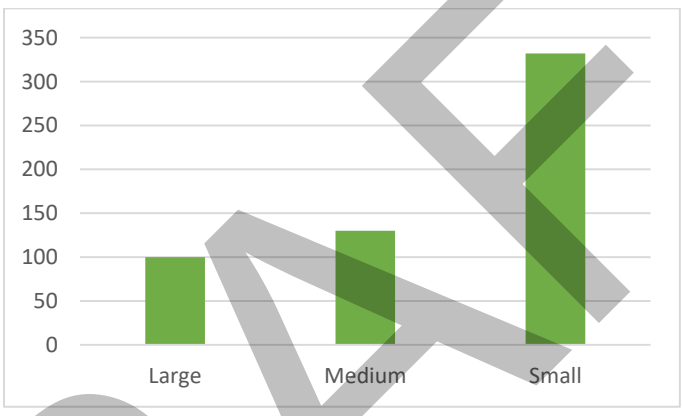


Figure 3.2. Potential Planting Sites along the City-Owned Right of Way, by Size Class

Stocking

Somerville's 2018 tree inventory shows the City's potential street tree population is 9,985 trees, which includes 9,313 existing trees (93%), 567 vacant planting sites (6%) and 105 stumps (1%) (see *Section 2: Somerville's Trees*). This value only considers the currently available planting areas along the street ROW, and not impervious surfaces that could become planting locations. Nor does this value incorporate potential planting locations in parks or other Civic spaces. Based on these values, the City of Somerville's ROW is 93% stocked. Stocking is a traditional forestry term used to measure the density and distribution of trees. In this case it means that, of the total number of available planting sites in the public ROW, 93% currently have a tree present.

There are currently 864 trees in the City that are recommended for removal (see *Section 3.2 Tree Maintenance Program*), including 11 high risk removals (0.1% of the City's potential street tree population), 200 moderate risk removals (2%), and 653 low risk removals (6.5%). These recommended removals represent a future increase in total number of potential planting sites. An important benchmark in maintaining a sustainable urban forest is to keep it at least 90% stocked, such that no more than 10% of the existing planting sites remain vacant. The City should make every effort to budget for tree planting in the future to maintain the urban forest at least 90% stocked and to continue increasing its canopy.

Full Stocking Potential

Full tree stocking can be an elusive goal, since mortality of young and old trees continually make more planting sites available. Nevertheless, working toward full stocking can help make other less glamorous aspects of urban forestry more palatable, especially removals.

With a current stocking level of 93%, the City is well on its way towards achieving full tree stocking. This means that the City is in a position to seek out new areas that would be appropriate for planting, both by turning previously impervious surfaces into pervious planting areas and by planting in areas that were not identified in the tree inventory process. A full tree stocking program would be proactive, and would involve plantings beyond those requested by homeowners. High priority planting areas are identified below.

With a total of 567 vacant sites, the City would reach its full stocking potential in under two years following the desired planting schedule of 350 trees per year. This goal assumes that no trees are removed, no new streets are added, and all of the new plantings survive.

A more accurate formula for determining the planting rate for such a goal comes from the textbook *Urban Forestry: Planning and Managing Urban Greenspaces* by Robert W. Miller (1997) and is written as:

$$N = \frac{R + (V/G)}{S}$$

Where:

N = number of trees to be planted annually
R = number of trees to be removed annually
V = existing vacant sites
G = years remaining to achieve full stocking potential goal
S = expected planting survival rate

For example, Somerville has 567 available planting sites scattered throughout its existing ROW. Assuming that 145 trees per year will be removed (this number is based on the average number of Priority Maintenance Removals in Years 1 through 6 of the program as demonstrated in *Section 3.2 Tree Maintenance Program*) and the planting survival rate over that period is 80% (Miller, 1997), the City will achieve full stocking in less than 5 years if it follows its current planting plan of 350 trees per year:

$$N = \frac{145 + (567/5)}{0.80} = 322 \text{ trees/year}$$

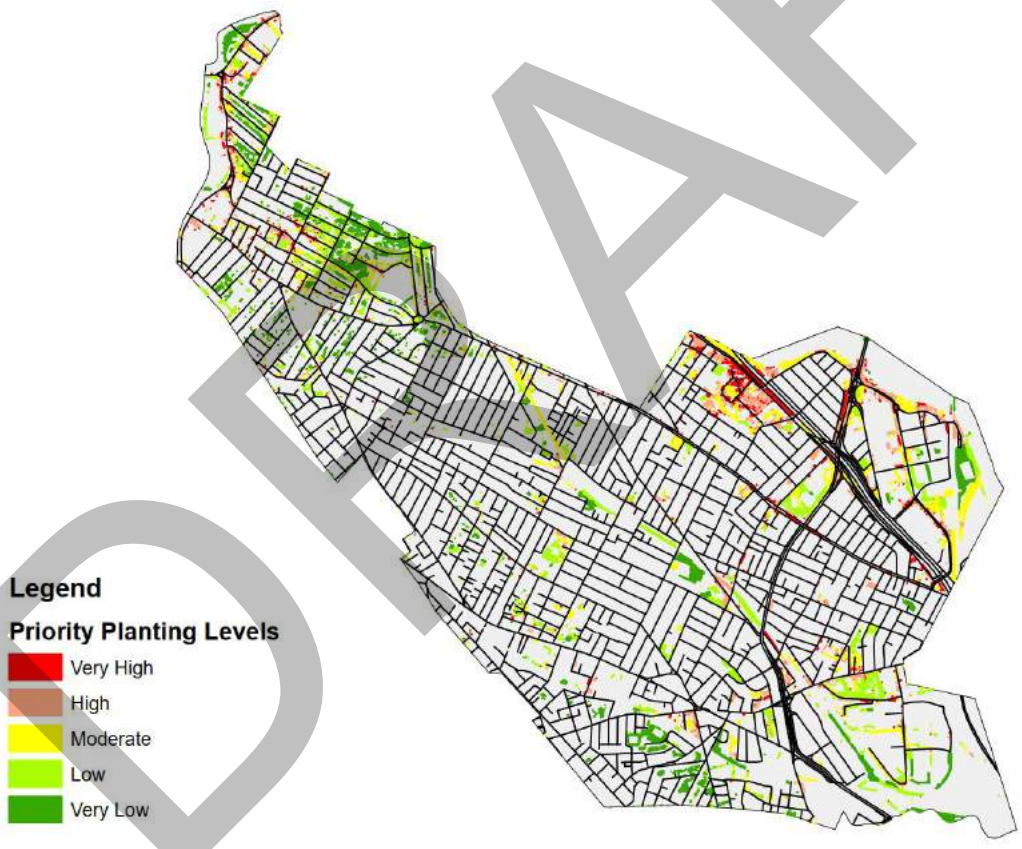
It should be noted that not all trees removed can be replaced in the same location due to utility/space conflicts. In these instances a new planting location will need to be chosen for a tree.

Prioritized Planting Locations based on Tree Canopy Data

Planting locations throughout the city were identified and prioritized as part of the urban tree canopy analysis (*Section 1.1: Somerville's Tree Canopy*). Potential planting locations included

all viable areas of the City that were classified as grass/open space and bare ground in the urban tree canopy analysis. All potential planting sites were not treated equally as some sites were considered to be more suitable than others. To identify and prioritize planting potential, an analysis was performed that included various environmental and demographic variables, including proximity to hardscape, canopy fragmentation, floodplain proximity, soil permeability, slope, soil erosion factor (K-factor), urban heat island index, and proximity to bus routes and bike lanes. In addition, planting potential was prioritized in Environmental Justice areas (which include parameters of income, minority populations and English language isolation) and where there are vulnerable populations (elderly housing, schools, child care and medical centers). For more details on how the analysis was performed, see *Appendix A*.

A priority level ranging from Very Low to Very High was assigned to each of the potential planting locations (Map 3.1). While available planting sites may ultimately be planted over the next several decades, the trees that are planted in the next several years should be planned for areas in most need, and where they will provide the most benefits and return on investment.



Map 3.1. Priority planting locations in Somerville based on canopy analysis

What to Plant - Correct Species Selection

The City must determine which tree species will be planted on a specific site. The phrase **"right tree, right place"** is the most important concept in planting. Trees have different characteristics suitable for different landscapes. It is recommended that all characteristics be recognized, including, but not limited to, the desired function (e.g., seasonal flowering, shade canopy, wind resistance), mature size and shape for the intended location, soil conditions, maintenance requirements, potential pest problems, and survivability in the face of climate change

Historically, there has been some misuse of available planting sites in Somerville. There are large growing trees under power lines, and there are small growing trees in sites suitable for larger trees. Large trees in small spaces can damage sidewalks and curbs, require severe pruning for overhead utility lines and street clearance, and often have a much shorter service life due to the restricted growing area. Small trees in large spaces limit the use of mature shade trees on public streets. It is well known that larger growing trees provide the most environmental and economic benefits to cities, and appropriate areas to plant them rarely exist in older, well developed communities. Proactive planning should be made to plant the "right tree, right place" in the vacant sites, considering available growing space, presence of utilities, and traffic and pedestrian clearance issues, while obtaining the desired aesthetic effects and function of the street tree. Planting the proper type of tree for each planting area will result in a more effective and attractive urban forest.

Suggested Species

Careful planning is necessary to introduce a level of variety into the street tree population. The Suggested Tree Species provided in *Appendix D* is meant to be a guideline for selecting which species to plant during future street tree plantings. The list considers maintenance requirements, adaptability to specific planting sites, and suitability to the restrictive conditions of the urban environment, among others. The suggested species have been categorized by mature height classes (small, medium, and large) that match the potential planting site size designations. The size of the site refers to the mature size of a tree suitable to be planted in that particular site. Selecting trees from this list will help to ensure that appropriate sized trees are planted in a site suitable to sustain the tree's natural habit. The suggested species list also contains a select number of species that are not recommended for planting along streets, but which are appropriate for planting in parks and public spaces.

How to Plant - Planting Plan

Upon hiring its first Urban Forester and Landscape Planner in 2016, the City of Somerville began a formal structured tree planting program. In the past "right tree, right place" was not always considered, and generally only 60 or so trees were planted each year. Since the City hired an Urban Forestry and Landscape Planner, planting practices within the City of Somerville have greatly improved. These improvements include: carful species selection, acquiring quality stock from nurseries, updating planting specifications to ensure best practices, oversight of contractor plantings, and ensuring that newly planted trees are maintained during their two-year warranty period. Moreover, based on scientific literature and industry best practices, the City now plants 2 inch caliper trees, which are the most appropriate and adaptable sized tree to plant

as they are small enough to tolerate and recover from transplant shock, but are large enough to not block pedestrian traffic and can handle small amounts of mechanical damage.

While continuing to develop the planting program, it is important to understand and put to use species diversity goals (rule of thumb is 10% species and 20% genus). Most importantly, keep in mind that choosing the proper tree species to complement site restrictions will help provide the greatest return on the investment of planting and caring for new street trees.

Developing an Effective Public Tree Planting Program

Tree species and planting location designations are significant components of a municipal tree care program because of the long-term impact of these decisions. It is important to develop an overall planting strategy, initially concentrating on streets and City areas with the greatest need for improvement. These areas are identified within the prioritized planting analysis shown below.

Success of a continuing tree planting program will be judged by the health of the trees after planting and the amount of money spent on planting and maintaining the new trees. With a small amount of planning, healthy trees with greater life expectancy can be established with minimal up-front investment and relatively minor maintenance costs.

Many of the key elements for a successful tree-planting program described below are based upon the exceptional reference, *Principles and Practice of Planting Trees and Shrubs* by Gary Watson and E. B. Himelick (1997).

Tree Species Diversity

Tree plantings greatly add to the aesthetic appeal of neighborhoods, historic districts, commercial areas, and industrial areas alike. Species diversity in new plantings should be of major importance. As stated in *Section 1: Somerville's Trees*, Norway maple accounts for 14% and callery pear accounts for 10% of Somerville's total tree population. The dangers of planting monocultures have proven to be devastating. One of Somerville's goals should be to increase species diversity throughout the City, such that no species represents more than 10% and that no one genus comprises more than 20% of the total population. Consideration should be given to large trees that provide shade, are aesthetically pleasing, and provide food or habitat for native insects and wildlife. Although the City should consider focusing efforts on planting species that are native to the region, particularly in the face of climate change, the wider effort should focus on urban-tolerant and/or wind-resistant species, regardless of origin.

Tree Species Selection

Somerville is located in Zone 6b of the USDA Hardiness Zone Map. This zone identifies a climatic region where the average annual minimum temperature is between -5º and 0º F, precipitation averages 48 inches per year, and the growing season lasts approximately 160 days. Tree species selected for planting in the City should be an appropriate mix of native and non-native tree species for this zone.

Matching a species to its favored climatic and soil conditions is the most important task when planning for a low maintenance landscape. Plants that are well matched to their environmental conditions are much more likely to resist pathogens, insect pests, and severe storm damage and will therefore require less maintenance overall.

In addition to considering site characteristics such as climate, precipitation, native vegetation, availability of space, soil pH, and water availability, specific tree features must also be scrutinized to ensure public safety. Some considerations for street trees are the amount of litter dropped by mature trees, the maintenance required, and public acceptance. For example, some species, such as *Salix* spp. (willow), have weak wood and typically drop many small branches during a growing season. They are also prone to dropping larger branches, which can be a safety hazard. Other species, such as *Liquidambar styraciflua* (American sweetgum), drop high volumes of syncarps (fleshy aggregate fruits). Similarly, female trees of *Magnolia grandiflora* (southern magnolia) or *Ginkgo biloba* produce large or offensive fruits. A few species of trees, including *Chorisia speciosa* (silk floss tree) and *Zanthoxylum clava-herculi* (Hercules-club), may have substantial thorns. Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring can add a great deal of interest to surrounding landscapes.

Above all, given the tough growing conditions in an urban environment, tree species should be selected for their durability and low maintenance requirements. These attributes are highly dependent on site characteristics as well as species characteristics. Refer to *Appendix D* for specific tree species and cultivars suitable for planting in Somerville.

Tree Planting Methodology

As trees are purchased through local nurseries or reliable planting contractors, the key consideration should be species selection, such that the right tree is planted for the right place. This will aid in increasing species diversity throughout Somerville and giving trees the best chance of thriving in the long term. Once appropriate tree species have been selected for planting, it is essential that proper planting methods are followed.

***Choosing Healthy Planting Stock*:** Trees in Massachusetts are largely available as balled and burlapped (B&B) stock. It is important to inspect trees upon delivery in order to ensure that they are healthy and able to survive during the initial shock of planting. Trees with the following symptoms should be rejected: trees with circling or girdling roots; trees with an unhealthy appearance or weak, poorly formed, scarred, or cracked trunks or branches; trees with double leaders or with branches clustered together on the trunk; trees with leaves of abnormal size or unexplained yellowing (possible indication of a health problem) and trees with insects, disease symptoms or signs, or mechanical damage.

***Site Preparations*:** Some existing tree wells are too small for an ideal growth space for a tree, and cuts will need to be made in the concrete. The size of tree (large, medium, or small) will determine the area needed for the correct amount of growth space.

Appendix E explains the proper method of excavating a planting hole. In general, the tree-planting hole should be relatively shallow (typically slightly less deep than the height of the root ball) and quite wide (ideally three times the diameter of the root ball). This will ensure the soil is properly aerated and decompacted prior to planting. Once the soil is loosened, it should be backfilled with native soil (i.e. the same soil that was excavated) to the proper root ball depth. In some instances the site may require additional soil, however native soil is preferred due to new/different soil creating a pot-effect (when different soils are next to each other, water tends to stay in one of them and not the other).

Care should be taken to ensure that the root collar of the new tree is at the same level or slightly higher than the surrounding soil grade. In most situations, it is not recommended to add soil amendments to the planting hole as this can lead to severe differences between texture and structure of soils inside the planting hole and the surrounding soil. Such differences can lead to water being wicked away from or accumulating in the planting hole.

Tree Planting: Proper planting of new trees is an essential part of a successful planting plan. The steps taken to properly plant trees must continue to be clearly outlined for City crews and/or contractors performing the work. Planting oversight and/or post planting inspections must continue to be performed to ensure that the work meets the guidelines set forth by the City.

One of the most important facets of proper planting is making sure the tree is placed at the correct height in the soil. The root flare of the tree should be place at grade or even 1 inch above grade. This ensures that the structural roots are near the top of the soil. The root flare of many trees gets buried in the nursery. Thus it is essential that, prior to planting, any excess soil is removed from the top of the root ball to expose the root flare. At the time of planting, the entire wire basket and at least 2/3 of the burlap on B&B trees should be removed. Any remaining burlap must be biodegradable.

After planting, the soil should be thoroughly soaked. The tree should be watered with at least 20 gallons of water (10 gallons per inch caliper) at least two times per week for 30 days after planting, and then one time per week for the remaining portion of the growing season.

Staking of the tree should only be done when necessary to keep the tree from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to the tree with a loose, flexible material, and all staking materials must be removed within one growing season. See *Appendix E* for more information.

After a tree is planted properly, some additional maintenance activities are highly recommended in order to ensure the health of the young tree. Maintenance activities include watering (the most important activity), weed control, mulch application, fertilizing, and pruning. Post-planting care of trees is important and necessary for a successful planting plan and can be accomplished inexpensively. Somerville's current planting contracts include watering (weekly during the summer months) and other maintenance activities for a period of two-years after planting.

Tree Mulching/ Ground Cover:

Mulch should be applied to the surface of the soil around each newly planted tree. Mulch should never be piled up around the root collar (*i.e.* in mulch "volcanoes"), but rather should be pulled away from the root collar (Figure 3.3). Mulch that buries the root collar provides shelter for insects, fungi, and mammals that could damage the tree, and also encourages the growth of adventitious roots which can eventually turn into girdling roots. Mulch should be applied to an area three times the diameter of the root ball to a depth of two to four inches (with no mulch applied within 1-3 inches of the trunk). Mulch not only suppresses competition from grass and weeds, but also provides a zone where mowing is not needed, thereby keeping mowers and string trimmers safely away (thus preventing mechanical damage). Mulch also helps to hold moisture in the surface of the soil where most of the feeder roots are to be established.

As an alternative to bark mulch, the City may consider planting short, spreading, perennial groundcovers in some locations. These plants, sometimes referred to as "green mulch" or "living mulch", provide many of the same benefits as bark mulch, while also providing food and habitat for pollinating insects and other wildlife. Some initial investment (in both time and money) would be required to purchase and maintain these plants, so this may not be a viable alternative for all locations.

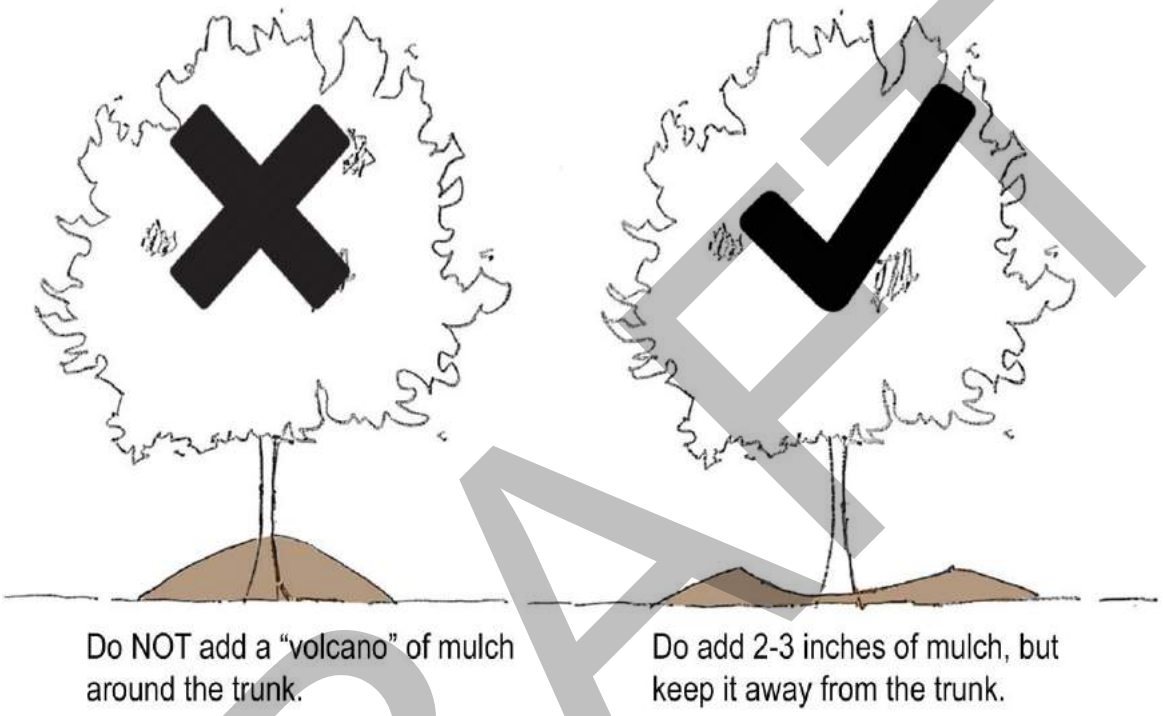


Figure 3.3. Improper mulching (mulch volcano) vs. proper mulching.

Tree Fertilization

Any fertilization process should not be thought of as "feeding" or "energizing" the plant; instead, arboricultural fertilizers should be understood as essentially replacing soil elements or minerals that are lacking or in short supply for a variety of reasons. Soil pH is also an important consideration. Nutrients may be in adequate supply, but be unavailable for uptake by the tree because of extreme high or low pH conditions. Application of fertilizer may not improve the situation until measures are taken to alter pH levels or to replace the plant with a species better suited for the existing soil conditions.

In Somerville a slow release fertilizer is typically used at the time of planting to help with transplant shock, and to increase nutrients of the soil in the tree well. Slow-release fertilizers applied in autumn will help root growth and will still be available the following spring. At the beginning of the second growing season, fertilizers can be applied to the root zone. Nitrogen is usually the limiting nutrient for plant growth. Soil analysis, particularly when combined with a foliar analysis, can determine when other elements are in short supply. The soil analysis should

only be reserved for sites that continue to have tree decline, as the process to include all sites would be costly.

Tree Pruning

Assuming that the proper tree has been selected for the site, pruning a young tree to improve branch structure is the most cost-effective method of reducing maintenance costs as the tree matures. At the time of planting, the only pruning that should be done is the removal of broken or dead branches. In the second growing season, minor pruning can be done to remove branches with poor attachments. In subsequent years, selective pruning should be done to achieve proper spacing of branches. This selective pruning can be accomplished through a Young Tree Training program (see *Section 3.2: Tree Maintenance Program*).

Tree Purchases

In Somerville, tree prices are reflected on contractor plantings and maintenance. Based on recent planting contracts, the average cost of planting a street tree is approximately $1,000 per tree, which includes the site preparation, planting, and watering/maintenance for 2 years. Currently the City does not have in-house staff to do the plantings, but it something the City should consider in the future. As the City works at planting more trees annually, they will be able to save more money on the cost per tree, which will allow a greater number of trees to be purchased.

Although a good working relationship with contractors is very beneficial, it is equally important to consider high-quality stock, good prices, and wide species availability. Somerville should explore local and regional sources for trees and discuss the pricing and the possibility of contract growing with a nursery source. Due to the requirement to work towards species diversity, it may be necessary to use several nurseries as sources for trees.

Tree Planting Designs

Prior to conducting tree inventories, most cities determine available planting sites primarily through resident requests. Resident requests are a main driver of tree plantings in Somerville, but with the updated tree inventory data City officials now also know the exact location of additional planting sites that are available. Moreover, the development of prioritization scheme based on canopy data allows the City to begin significant tree planting efforts in high priority areas of the City.

Planting in business districts is useful to increase the beauty and attractiveness of those areas. Tree selection for business and shopping areas must take into consideration the need for shoppers to view storefronts, as well as the need to provide shade, safe passage, and clean sidewalks for visitors. Tree canopies should be open, as in *Nyssa sylvatica* (black tupelo), and the branching habit must be high enough to allow pedestrians to walk comfortably beneath the trees. Other options are tall, narrow, upright growing (fastigiate) species, such as Regal Prince Oak (*Quercus x warei* 'Long'). These trees provide beauty, a look of uniformity, and a formal appearance to the shopping district.

Tree plantings in residential areas can be selected to match the existing types of trees growing on each street and block (such as large growth-habit trees or flowering tree species) or can be

selected to begin to develop a uniform look for a given street. It is important to keep species diversity in mind when developing any type of tree planting design. Often, in older neighborhoods, one side of the street has utility lines, which precludes the use of large trees. The primary aesthetic role that street tree plantings can play in a residential neighborhood is to visually link individual homes into a unified landscape. It is this unified quality that makes older neighborhoods with large, mature trees so attractive in many communities. Either formal or informal planting schemes are appropriate for neighborhood streets. In most instances, medium or large trees, spaced so that their canopies overlap, are desirable.

Young Tree Maintenance Program

A systematic program of maintenance, specifically designed for newly planted trees, is necessary to provide them with the greatest chance of long-term survival.

Activities such as watering, fertilization, removal of staking materials, and inspections should be adopted to ensure that proper care is taken to protect the investment of a tree planting program and the trees themselves.

In addition, all new trees planted in accordance with this *Public Tree Planting Plan* should be pruned 3 years after planting and added to the Young Tree Training cycle (Section 3.2 Tree Maintenance Plan).

Tree Planting Program Funding Assistance and Public Relations

The new objective of the tree planting program should be directed at filling the identified sites in addition to fulfilling resident requests for trees.

In any tree planting program, funding and participation can often be achieved by soliciting certain sectors of the community. Businesses, institutions, and corporations in the City are often willing to donate funds for tree plantings in exchange for recognition in some way (either through the media or during Arbor Day ceremonies). Additional details on program funding and public relations are discussed in *Section 4.2: Funding Analysis* and *Section 4.4: Public Engagement.*

3.2 TREE MAINTENANCE PROGRAM

Statement of purpose

This tree maintenance program was developed to uphold Somerville's comprehensive vision for preserving its urban forest. This seven-year program is based on the tree inventory data (see *Section 2: Somerville's Trees*); the program was designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. The program also includes tree planting to mitigate removals and increase canopy cover.

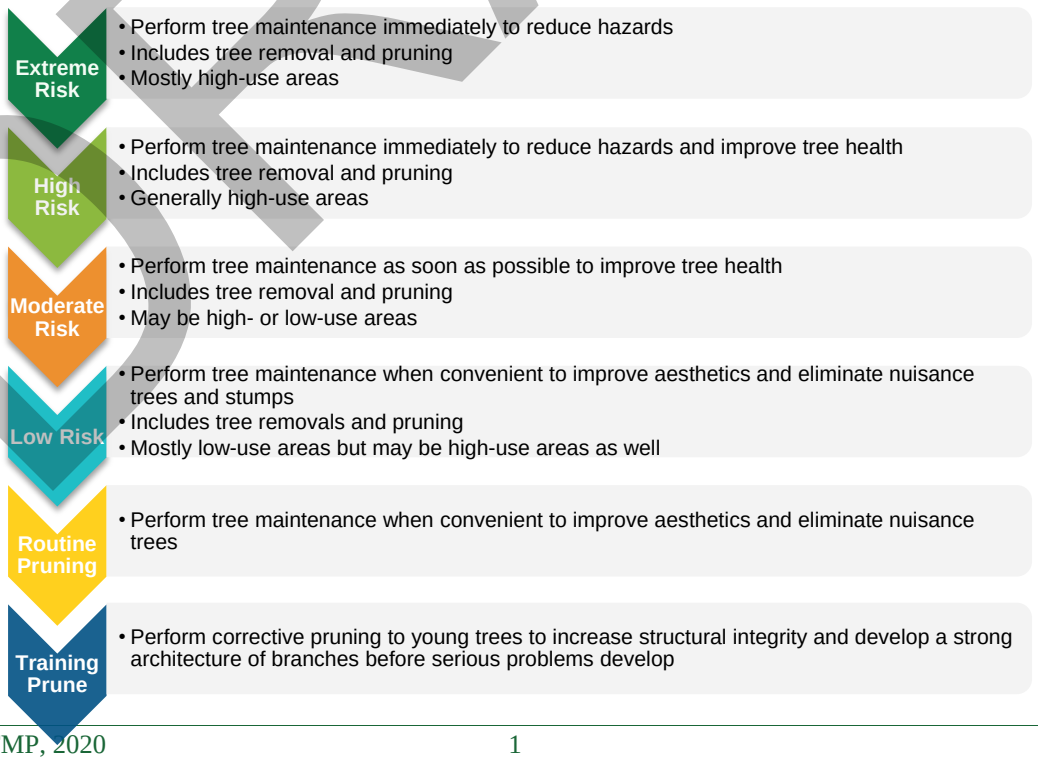
Implementing a tree care program is an ongoing process. Tree work must continually be prioritized to reduce public safety risks. Work identified in the inventory should be completed based on the assigned risk rating. However, routinely monitoring the tree population is essential so that other Extreme or High Risk trees can be continually identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work (especially for Extreme or High Risk trees) must take precedence to ensure that risk is expediently managed.

Priority & Proactive Maintenance

In this plan, the recommended tree maintenance work was divided into either '**priority**' or '**proactive**' maintenance programs.

Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of High or Extreme Risk. This work should be done first for reasons of public safety.

Proactive maintenance includes pruning of trees with an assessed risk of Moderate or Low Risk as well as pruning young trees. Tree planting, inspections (for structural integrity, presence of disease/pests), and community outreach are also considered proactive maintenance. Appendix F



has further information on risk rating and priority/proactive maintenance.

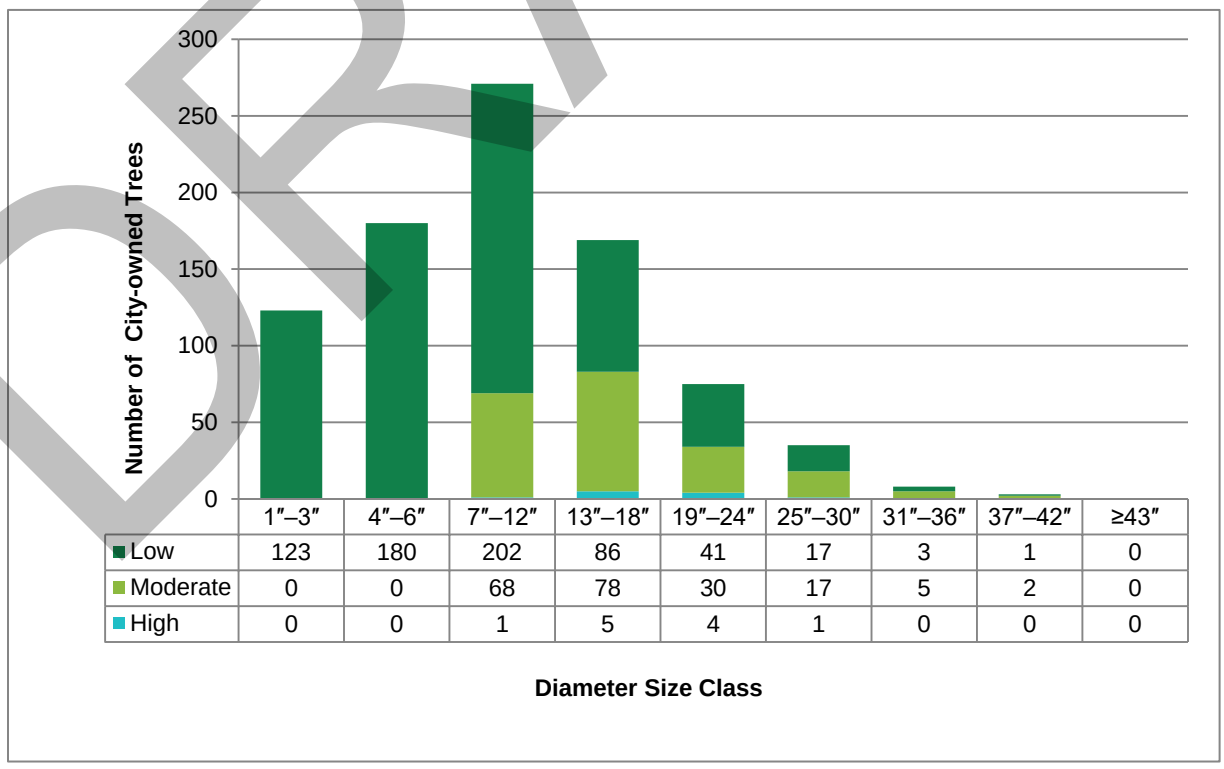
PRIORITY MAINTENANCE

A. Tree and Stump Removal

Although tree removal is usually considered a last resort, there are circumstances in which removal is necessary. Trees fail from natural causes including old age, diseases, insect pest infestation, and extreme weather events, and from physical injury due to vehicles, vandalism, and root disturbances. Trees must be removed when they present a danger to the public. Additionally, trees should be removed when corrective pruning will not adequately eliminate the hazard or when correcting problems would be cost-prohibitive. Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased and nuisance trees (invasive trees and trees in poor locations) also warrant removal.

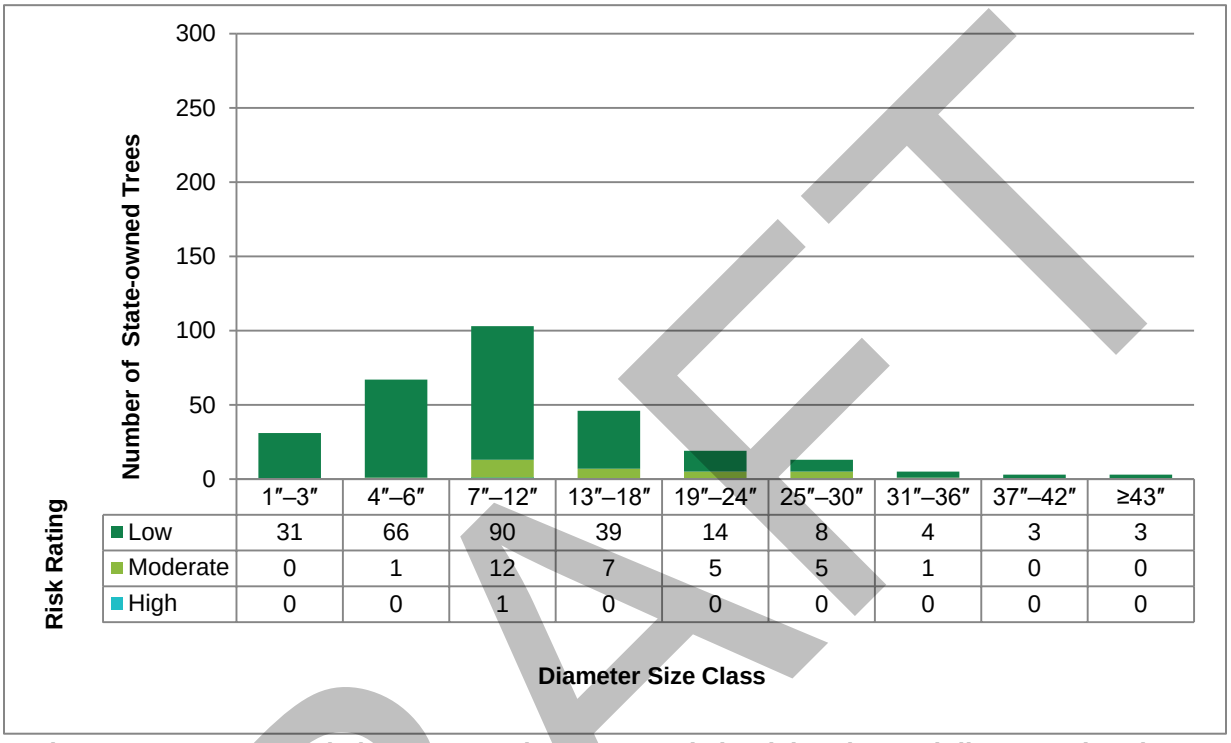
Even though large short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety.

In the 2018 tree inventory (see *Section 2: Somerville's Trees*), 864 (out of 11,484 total) City-owned trees (street and City-owned open spaces) and 290 (out of 2,120 total) State-owned trees were recommended for removal. Figures 3.4 presents the City-owned trees that were recommended for removal by risk rating and diameter size class (diameter measured at breast height), and Figure 3.5 presents the State-owned trees recommended for removal by risk rating and diameter size class.



	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Low	123	180	202	86	41	17	3	1	0
Moderate	0	0	68	78	30	17	5	2	0
High	0	0	1	5	4	1	0	0	0

Figure 3.4. Recommended City-owned tree removals by risk rating and diameter size class.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Low	31	66	90	39	14	8	4	3	3
Moderate	0	1	12	7	5	5	1	0	0
High	0	0	1	0	0	0	0	0	0

Figure 3.5. Recommended State-owned tree removals by risk rating and diameter size class.

City-owned Tree Findings (ROW and City-owned open spaces)

The 2018 tree inventory identified 11 High Risk, 200 Moderate Risk, and 653 Low Risk City-Owned trees that are recommended for removal. There are no Extreme Risk trees in the inventory.

The diameter size classes for the High Risk trees ranged between 13 inches diameter at breast height (DBH) and 30 inches DBH. These trees should be removed immediately based on their assigned risk. High Risk removals and High Risk pruning can be performed concurrently.

Most of the City-owned Moderate Risk trees were smaller than 31 inches DBH. These trees should be removed as soon as possible after all High Risk removals and prunings have been completed.

Low Risk trees pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects, reduce disease host potential, and will increase the aesthetic value of the area. Healthy trees of an undesirable species or those growing in poor locations are also included in this category. All Low Risk trees should be removed when convenient and after all High and Moderate Risk removals and prunings have been completed.

Of the City-owned trees recommended for removal, 32 are ash trees which are susceptible to Emerald Ash Borer infestation (see *Section 3.3: Invasive Insects and Disease Management Strategy*).

The inventory also identified 231 stumps recommended for removal on City-owned land. Almost all of these stumps were larger than 5 inches in diameter. Stump removals should occur when convenient.

State-owned Tree Findings

On State-owned land, the inventory identified 1 High Risk tree, 31 Moderate Risk trees, and 258 Low Risk trees that are recommended for removal. There are no Extreme Risk trees in the inventory.

The State-owned High Risk tree is approximately 11 inches diameter at breast height (DBH). This tree should be removed immediately based on its assigned risk.

Most State-owned Moderate Risk trees were smaller than 31 inches DBH. These trees should be removed as soon as possible after all High Risk removals and prunings have been completed.

As detailed in the City-owned Tree Findings, Low Risk trees present little threat to public safety, and should be removed when convenient and after all High and Moderate Risk removals and prunings have been completed.

The inventory recommended the removal of 6 State-owned ash trees.

The inventory identified 24 stumps recommended for removal on State-owned land. Almost all of these stumps were larger than 10 inches in diameter. Stump removals should occur when convenient.

B. Tree Pruning

High and Moderate Risk pruning generally requires cleaning the canopy of both small and large trees to remove defects such as dead, diseased, and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and reduce risk associated with the tree.

Figure 3.6 presents the number of City-owned High and Moderate Risk trees recommended for pruning by size class. Figure 3.7 presents the number of State-owned High and Moderate Risk trees recommended for pruning by size class.

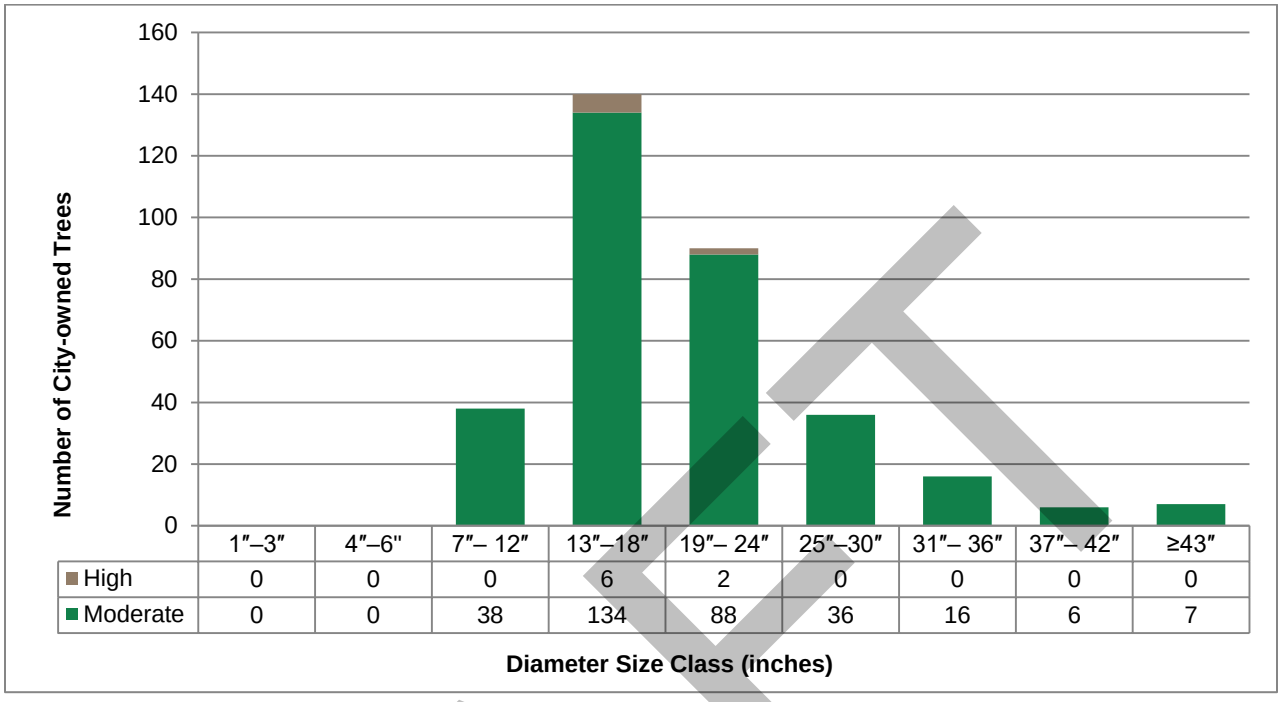


Figure 3.6. High and Moderate Risk pruning by diameter size class for City-owned trees.

City-owned Tree Findings (ROW and City-owned open spaces)

The inventory identified 8 High Risk, and 325 Moderate Risk City-owned trees recommended for pruning.

The High Risk trees ranged in diameter from 13 to 24 inches DBH. Pruning should be performed immediately based on assigned risk and may be performed concurrently with other High Risk removals. Moderate risk trees ranged in size from 7 inches DBH to over 43 inches DBH.

Most of the City-owned trees (over 10,000) were categorized as Low Risk trees recommended for pruning. These trees should be included in a proactive, routine pruning cycle after all the higher risk trees are addressed.

	1″–3″	4″–6″	7″– 12″	13″–18″	19″– 24″	25″–30″	31″– 36″	37″– 42″	≥43″
High	0	0	0	0	1	0	0	0	1
Moderate	0	0	5	8	5	4	5	1	4

Figure 3.7. High and Moderate Risk pruning by diameter size class for State-owned trees.

State-owned Tree Findings

The inventory identified 2 High Risk and 32 Moderate Risk State-owned trees recommended for pruning. Trees with High Risk pruning needs were in the 19–24 inches DBH and 43+ inches DBH diameter size classes. Trees with moderate risk pruning needs ranged from 7 inches DBH to over 43 inches DBH.

PROACTIVE MAINTENANCE

Proactive tree maintenance that actively mitigates elevated-risk situations will bolster tree health and public safety. These maintenance activities may include pruning, young tree training, tree planting, other tree care, and inspections.

A. Pruning Cycles

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. Pruning cycles should begin after all Extreme and High Risk trees are corrected through removal or pruning. Due to the long-term benefits of pruning cycles (Figure 3.8), these pruning cycles should be implemented as soon as possible. To ensure that all trees receive the type of pruning they need to mature with better structure and lower associated risk, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the target tree, and length of time of the cycle.

The recommended number of trees in the pruning cycles will need to be continually modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they become established. As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed and eliminated from the RP Cycle.

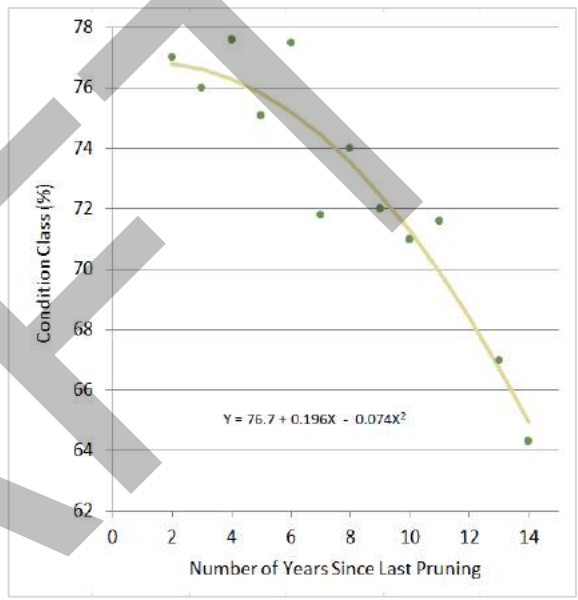


Figure 3.8. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981). The yellow trend line shows that a tree's condition decreases as the length of time between pruning cycles increases.

Why Prune Trees on a Cycle?

Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They found that as the length of the pruning cycle increased, the health and condition of the trees decreased. When pruning was not completed for more than 10 years, the average tree condition was 10% lower than trees that had been pruned within the last several years. Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

For many communities, a proactive tree management program is considered unfeasible. An on-demand (reactive) response to urgent situations is the norm. However, research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester 1981). Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which helps detect and eliminate most defects before they escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program include: increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs. Although historically Somerville has not had a proactive maintenance program, one of the goals of this Management Plan is to put forth a feasible method of achieving this type of program.

Young Tree Training Cycle

Young Tree Training (YTT) is a type of pruning performed to improve tree form or structure and encourage a wind-resistant urban forest. Younger trees sometimes have poor branch structures that can lead to problems as the tree ages, including codominant leaders, multiple limbs attaching at the same point on the trunk, and crossing/interfering limbs. These problems can be remedied easily and inexpensively while trees are small and immature. If not alleviated while trees are young, these potential problems can lead to poorly attached branches and/or wood decay. Thus, as they grow, trees with poor branching can become safety risks and create potential liability for Somerville.

Young tree training consists of correcting structural problems though the removal of dead, dying, diseased, interfering, conflicting, and weak branches, as well as selective trimming to direct future branch growth. YTT pruning is also performed to provide adequate pedestrian and vehicular clearance, as trees that have insufficient clearance are prone to having their branches torn or ripped off.

Trees included in the YTT Cycle are generally less than 8 inches DBH and less than 20 feet in height. YTT pruning is relatively inexpensive since the work can generally be performed from the ground with a pole pruner or pruning shears. YTT pruning is species-specific, since many trees, such as *Betula nigra* (river birch), may naturally have more than one leader. For such trees, YTT pruning is performed to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree.

Recommendations for YTT Cycle

A YTT program would be extremely beneficial for the overall health and quality of the Somerville's urban forest in both the short- and long-term. Somerville should implement a three-year YTT Cycle that includes all existing young trees. In the 2018 inventory, 2,483 City-owned trees smaller than 12 inches DBH were identified and recommended for young tree training (Figure 3.9). Since the number of existing young trees is relatively small, and the benefit of beginning the YTT Cycle is substantial, an average of 828 trees (one-third) can be structurally pruned each year over 3 years, beginning in Year One of the maintenance program.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. As trees are planted, they will need to enter the YTT Cycle after establishment. Training pruning should not be done immediately after a tree is planted since it is already under stress from transplanting and needs as much of its leaf canopy as possible in order to manufacture food for proper establishment in its new site. Only dead or broken branches should be removed at the time of planting. Newly planted trees should receive their first training prune three years following planting and continue on a 3-year cycle.

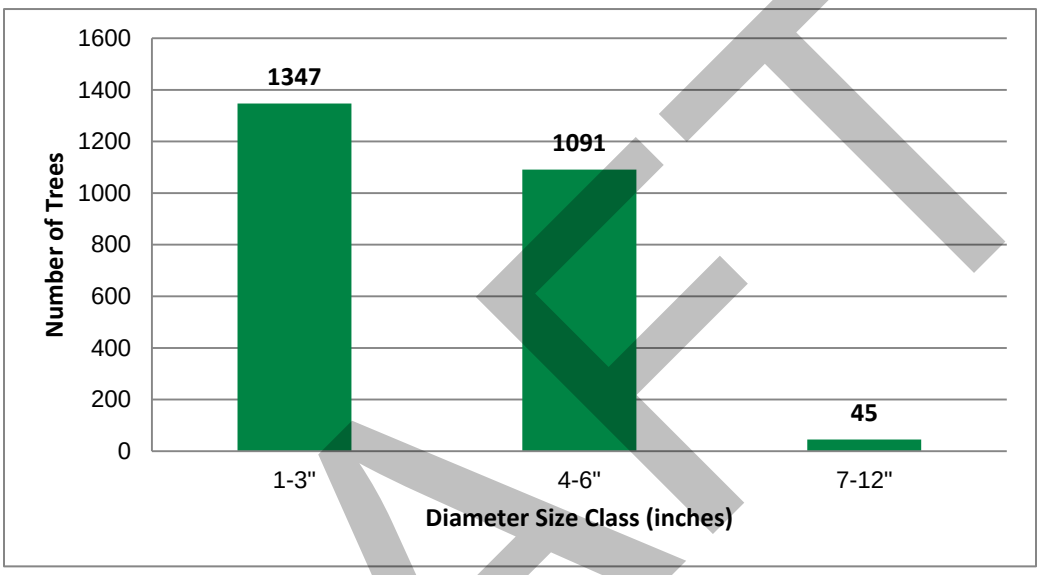


Figure 3.9. City-owned trees recommended for the Young Tree Training Cycle by diameter size class.

Routine Pruning Cycle

Routine Pruning (RP) involves the pruning of established, maturing, and mature trees that need canopy cleaning, crown raising, and/or crown reducing to remove deadwood and improve structure. Over time, routine pruning can decrease the amount of reactive maintenance required and minimize instances of elevated risk, thereby providing the basis for a more defensible risk management program. Included in this cycle are Low Risk trees that require pruning and pose some risk but for which the tree or the defect is of smaller size and/or has less potential for impacting a target. The defects found within these trees can usually be remediated during an RP Cycle.

Routine Pruning Cycle Length

The length of the RP Cycle is based on the size of the tree population and an assumption as to a reasonable number of trees to prune per year. Generally, the RP Cycle recommended for a tree population is five years (Vogt, Hauer and Fischer, 2015), but may extend to seven years if the population is large. On average, based on Davey Resource Group's experience with urban forests and cities in the United States, a 7 to 10-year routine pruning program is an acceptable rotation time to efficiently sustain an urban forest.

Recommendations for RP Cycle

Based on the current number of trees that require routine pruning and the estimated funding level, it is recommended that the City establish a six-year RP Cycle in which approximately one-sixth of the tree population is pruned each year. The 2018 tree inventory identified approximately 7,600 City-owned trees that should be pruned during the RP Cycle. Thus, an average of 1,267 trees should be pruned each year over the course of the six-year cycle. It is recommended that the RP Cycle begin in Year Two of this seven-year plan, after all High and Moderate Risk trees are pruned and the YTT Cycle is underway.

This six-year RP cycle does not incorporate trees that will be planted in the future. As newly planted trees are added to the routine maintenance cycle, the City should evaluate whether a seven or ten year cycle is more realistic.

B. Tree Planting

Tree planting is an important facet of maintaining and expanding the City's urban forest. The City's goal is to plant 350 trees on public property each year. Planting new trees help to mitigate the loss of trees due to necessary removals. See *Section 3.1: Tree Planting Plan* for more details.

C. Other Tree Care

The urban environment is a challenging place for trees to grow, and sometimes additional types of tree maintenance can help maintain or improve tree health. Examples of other tree care include:

- Water: Trees need regular watering, particularly during the establishment period (first 3-5 years after planting). Supplemental watering may also be needed during periods of drought and/or extreme heat.
- Mulch: Applying mulch or other types of groundcover to suppresses competition from grass and weeds, and hold moisture in the surface of the soil where most of the feeder roots are. Mulch also create a zone where mowing is not needed, thereby keeping mowers and string trimmers safely away from trees (thus preventing mechanical damage to the trunk and roots).
- Soil Amendments: Arboricultural fertilizers are essentially used to replacing soil elements or minerals that are lacking or in short supply for a variety of reasons. Soil analysis, particularly when combined with a foliar analysis, can determine if any soil nutrients are in short supply.
- Root Pruning: Girdling roots or circling roots that have the potential to become girdling can decrease the lifespan of a tree. Pruning these types of roots can help a tree live longer.
- Soil Decompaction: Decompaction of Heavily compacted soil can promote tree health.
- Pest management: Pest damage on trees should be assessed, and in some cases treatment may be warranted. For more details see *Section 3.3: Invasive Insect and Disease Management Strategy* and *Appendix G*.
- Cabling and bracing: Cables and/or braces can be installed in trees to reduce stress damage from high winds, the weight of ice or snow, and heavy foliage. They are used to help strengthen weak branches or limbs so that they are able to better withstand sever weather and to reduce potential risk.

The City should assess trees and apply these types of maintenance as needed. Many of these maintenance tasks can be expensive; thus, the City may only be able to perform these tasks on a limited number of trees.

D. Inspections

Inspections are essential to uncovering potential problems with trees. They should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Somerville has a large population of trees that are susceptible to pests and diseases, such as ash, oak, and maple.

Trees along the street ROW should be regularly inspected and attended to as needed based on the inspection findings. Some trees may need to be inspected more regularly than others. For example, unless already slated for removal, trees noted as having Poor wood condition (*Section 2: Somerville's Trees*) should be inspected on a regular basis. In the 2018 inventory, 1,177 City-owned trees and 276 State-owned trees had Poor wood condition ratings. A good rule of thumb would be to inspect these trees on a yearly basis or after major storm events. Corrective action should be taken when warranted. If their wood condition worsens, tree removal may be required.

When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate.

Maintenance Schedule

Utilizing data from the 2018 tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year over the course of 7 years. Budget projections were made using industry knowledge and public bid tabulations, along with estimates for contractor work provided by Somerville staff. A complete table of estimated costs for Somerville's seven-year tree management program is presented in Table 3.1.

The schedule provides a framework for completing the inventory maintenance recommendations over the next seven years. Following this schedule can shift tree care activities from an on-demand (reactive) system to a more proactive tree care program.

To implement the maintenance schedule, the city's tree maintenance budget should be no less than $633,140 for the first year of implementation, no less than $643,855 for the second year, and no less than $551,000 for the final year of the maintenance schedule (Table 3.1). Annual budget funds are needed to ensure that high risk trees are remediated and that crucial YTT and RP Cycles can begin. An increase in funds is needed for the second year of the program in order to initiate the RP Cycle. Please refer to *Section 4.2: Funding Analysis*, for a more through discussion of the City's budget.

If routing efficiencies and/or contract specifications allow for the completion of more tree work, or if the schedule requires modification to meet budgetary or other needs, then the schedule should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

Table 3.1. Estimated Costs for Seven- Year Urban Forestry Maintenance Program

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
Activity	Diameter	Estimated Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	To
High Risk Removals	1-9.9"	$100	1	$100	0	$0	0	$0	0	$0	0	$0	0	
	10-19.9"	$600	6	$3,600	0	$0	0	$0	0	$0	0	$0	0	
	20-29.9"	$780	4	$3,120	0	$0	0	$0	0	$0	0	$0	0	
	30-39.9"	$1,280	0	$0	0	$0	0	$0	0	$0	0	$0	0	
	40" +	$1,360	0	$0	0	$0	0	$0	0	$0	0	$0	0	
Activity Total(s)			**11**	**$6,820**	0	$0	0	$0	0	$0	0	$0	0	
Moderate Risk Removals	1-9.9"	$100	0	$0	35	$3,500	0	$0	0	$0	0	$0	0	
	10-19.9"	$600	75	$45,000	51	$30,600	0	$0	0	$0	0	$0	0	
	20-29.9"	$780	32	$24,960	0	$0	0	$0	0	$0	0	$0	0	
	30-39.9"	$1,280	7	$8,960	0	$0	0	$0	0	$0	0	$0	0	
	40" +	$1,360	0	$0	0	$0	0	$0	0	$0	0	$0	0	
Activity Total(s)			**114**	**$78,920**	**86**	**$34,100**	0	$0	0	$0	0	$0	0	
Low Risk Removals	1-9.9"	$100	0	$0	0	$0	0	$0	100	$10,000	200	$20,000	139	
	10-19.9"	$600	0	$0	0	$0	100	$60,000	73	$43,800	0	$0	0	
	20-29.9"	$780	0	$0	37	$28,860	0	$0	0	$0	0	$0	0	
	30-39.9"	$1,280	0	$0	4	$5,120	0	$0	0	$0	0	$0	0	
	40" +	$1,360	0	$0	0	$0	0	$0	0	$0	0	$0	0	
Activity Total(s)			0	$0	**41**	**$33,980**	**100**	**$60,000**	**173**	**$53,800**	**200**	**$20,000**	**139**	
High Risk Pruning	1-9.9"	$125	0	$0	0	$0	0	$0	0	$0	0	$0	0	
	10-19.9"	$250	8	$2,000	0	$0	0	$0	0	$0	0	$0	0	
	20-29.9"	$500	0	$0	0	$0	0	$0	0	$0	0	$0	0	
	30-39.9"	$750	0	$0	0	$0	0	$0	0	$0	0	$0	0	
	40" +	$1,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	
Activity Total(s)			**8**	**$2,000**	0	$0	0	$0	0	$0	0	$0	0	

Moderate Risk Pruning	1-9.9"	$125	0	$0	17	$2,125	0	$0	0	$0	0	$0	0	
	10-19.9"	$250	100	$25,000	89	$22,250	0	$0	0	$0	0	$0	0	
	20-29.9"	$500	90	$45,000	0	$0	0	$0	0	$0	0	$0	0	
	30-39.9"	$750	20	$15,000	0	$0	0	$0	0	$0	0	$0	0	
	40" +	$1,000	9	$9,000	0	$0	0	$0	0	$0	0	$0	0	
Activity Total(s)			**219**	**$94,000**	**106**	**$24,375**	0	$0	0	$0	0	$0	0	
Priority Work Activity Grand Total(s)			**352**	**$181,740**	**233**	**$92,455**	**100**	**$60,000**	**173**	**$53,800**	**200**	**$20,000**	**139**	**$**
Routine Pruning and Monitoring	Starting in Year 2	$100,000	0	$0	1	$100,000	1	$100,000	1	$100,000	1	$100,000	1	$
Activity Total(s)			0	$0	**1**	**$100,000**	**1**	**$100,000**	**1**	**$100,000**	**1**	**$100,000**	**1**	**$**
Young Tree Training Pruning (3-year cycle)	Training	$50	828	$41,400	828	$41,400	827	$41,350	828	$41,400	828	$41,400	827	
Activity Total(s)			**828**	**$41,400**	**828**	**$41,400**	**827**	**$41,350**	**828**	**$41,400**	**828**	**$41,400**	**827**	
Ash Tree Treatments	Treatment	$60,000	1	$60,000	1	$60,000	1	$60,000	1	$60,000	1	$60,000	1	
Activity Total(s)			**1**	**$60,000**	**1**	**$60,000**	**1**	**$60,000**	**1**	**$60,000**	**1**	**$60,000**	**1**	
Proactive Work Activity Grand Total(s)			**829**	**$101,400**	**830**	**$201,400**	**829**	**$201,350**	**830**	**$201,400**	**830**	**$201,400**	**829**	**$**
New Tree Planting & Maintenance	Planting	$1,000	350	$350,000	350	$350,000	350	$350,000	350	$350,000	350	$350,000	350	$
Planting Activity Total(s)			**350**	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**350**	**$**
Activity Grand Total			**1,531**		**1,413**		**1,279**		**1,353**		**1,380**		**1,318**	
Cost Grand Total				**$633,140**		**$643,855**		**$611,350**		**$605,200**		**$571,400**		**$**

Inventory and Plan Updates

Keeping the tree inventory data and maintenance plan up to date can streamline work load management and lend insight into setting accurate budgets and staffing levels. Regular updates are important so that the City can sustain its program and accurately project future program and budget needs. Specific recommendations include:

- Conduct inspections of trees after all severe weather events. Record changes in tree condition, maintenance needs, and risk rating in the inventory database. Update the tree maintenance schedule and acquire the funds needed to promote public safety. Schedule and prioritize work based on risk.
- Perform routine inspections of public trees as needed. Windshield surveys (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* (ANSI 2011) will help city staff stay apprised of changing conditions. Update the tree maintenance schedule and the budget as needed so that identified tree work may be efficiently performed. Schedule and prioritize work based on risk.
- If the recommended work cannot be completed as suggested in this plan, modify maintenance schedules and budgets accordingly.
- Update the inventory database electronically using TreeKeeper® 8.0 or similar computer software as work is performed. Add new tree work to the schedule when work is identified through inspections or resident reports (i.e. 311 requests).
- Re-inventory the street ROW, and update all data fields in seven years, or re-inventory a portion of the population ($1/7^{th}$) every year over the course of seven years.
- Revise the *Tree Maintenance Program* after seven years when the re-inventory has been completed.

3.3 INVASIVE INSECT AND DISEASE MANAGEMENT STRATEGY

Throughout the United States, urban and community forests are under increased pressure from exotic and invasive insects and diseases. Exotic pests that arrive from overseas typically have no natural predators and can become invasive when our native trees and shrubs do not have appropriate defense mechanisms to fight them off. Mortality from these pests can range from two weeks, as is the case with oak wilt (*Ceratocystis fagacearum*), to at least seven years, as seen with emerald ash borer (EAB) (*Agrilus planipennis*).

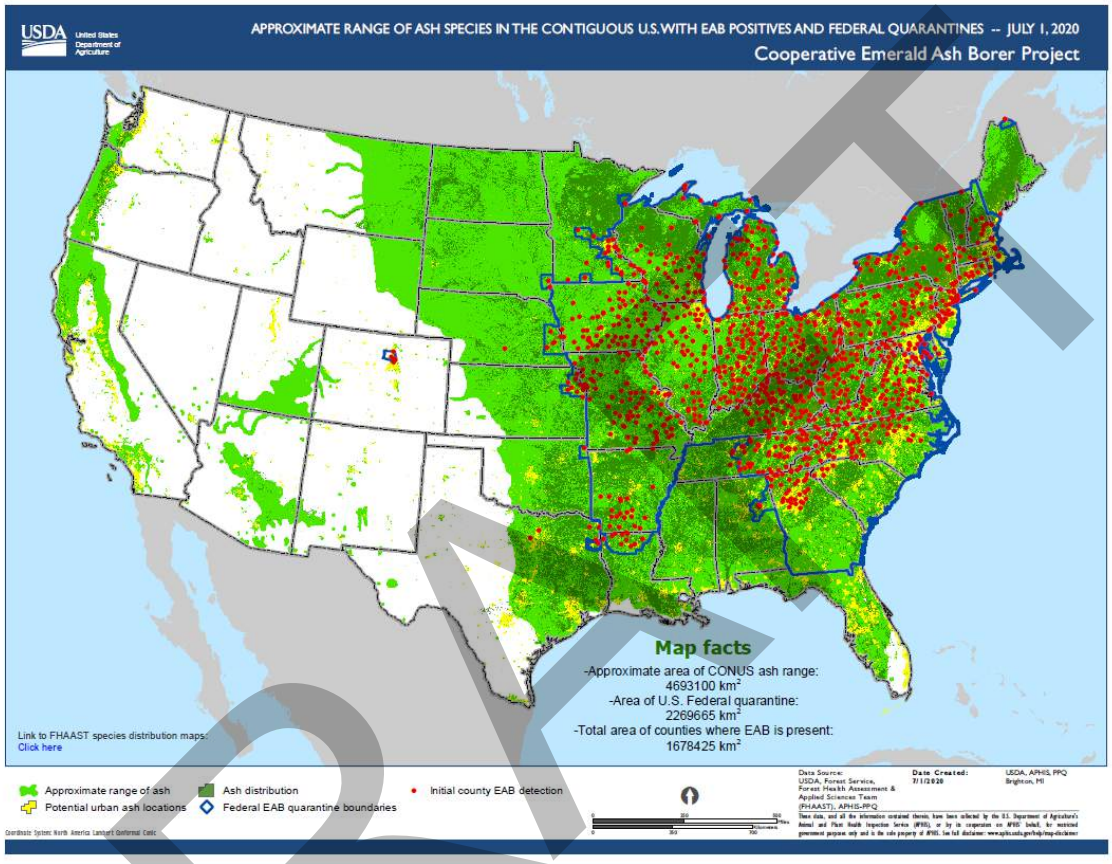
An integral part of tree management is maintaining awareness of invasive insects and diseases in the area and knowing how to best manage them. Depending on the tree diversity within Somerville's urban forest, an invasive insect or disease has the potential to have a striking negative impact on the tree population.

EAB is the focus of this section as it is currently the most damaging and prevalent pest in Somerville. Because of the increasing severity of damage to ash species caused by EAB, this section provides different management strategies for dealing with this pest, including details on how to effectively monitor EAB, increase public education, handle ash debris, approach reforestation, work with stakeholders, and utilize ash wood. Additional EAB reference materials can be found in *Appendix G* and on the City of Somerville's Urban Forestry webpage (https://www.somervillema.gov/departments/ospcd/psuf/urban-forestry).

Other potential threats such as Asian longhorned beetle (ALB, *Anoplophora glabripennis*), spotted lanternfly (SLF, *Lycorma delicatula)*, and oak wilt *(Ceratocystis fagacearum)* are also discussed in this section, but in less detail. These additional pests are a concern as they pose real threats to trees across Somerville. If residents or staff members of Somerville notice specific signs and symptoms of any type of pest or disease, it should be monitored and inspected. Early diagnosis of a disease/pest is critical and could save thousands of trees.

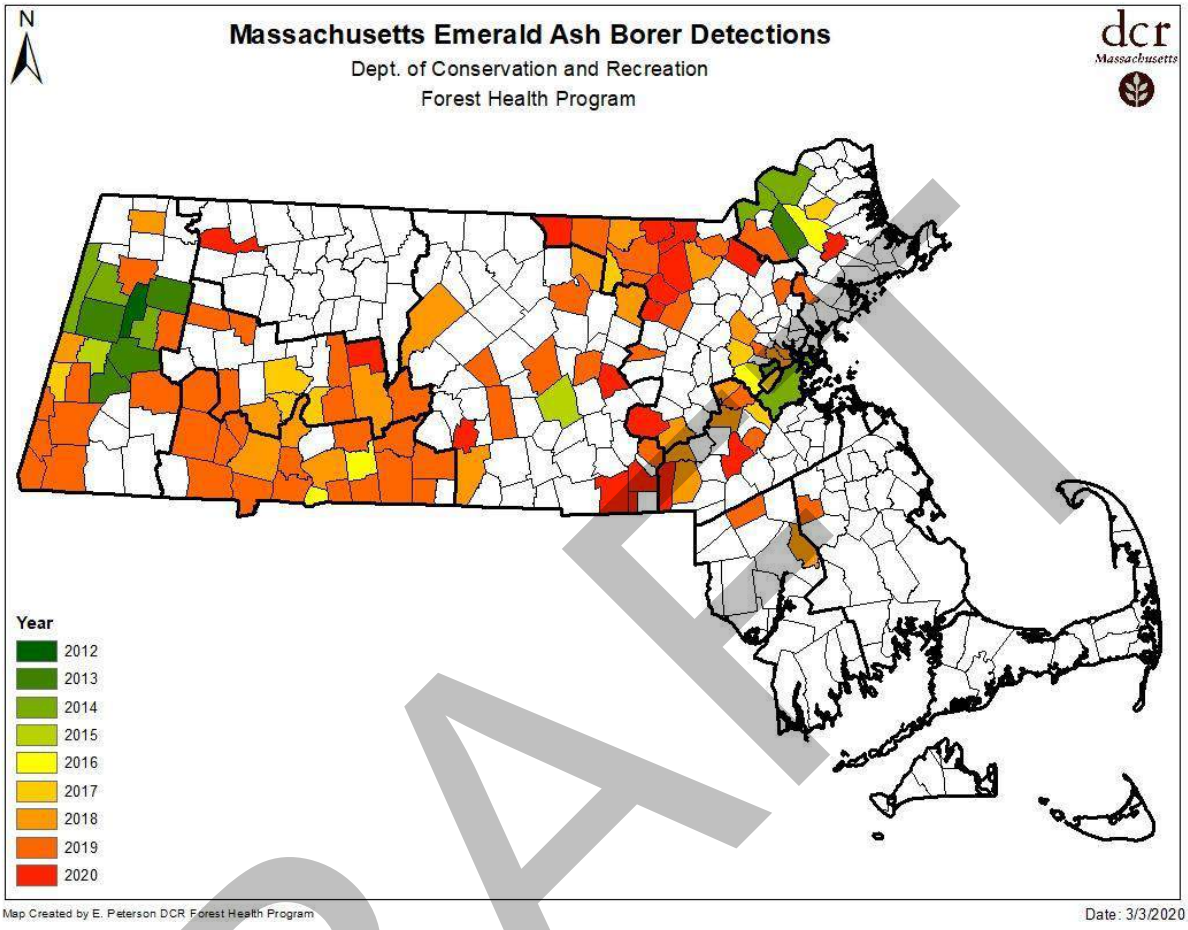
Emerald Ash Borer (EAB)

Emerald ash borer (*Agrilus planipennis*) is a small insect native to Asia. In North America, EAB is an invasive species that is highly destructive to all ash tree species in its introduced range, including all ash species that are native to the United States.



Map 3.2. EAB detections throughout North America as of July 1, 2020. Map by United States Department of Agriculture, Animal and Plant Health Inspection Service.

EAB is thought to have been introduced to North America in the 1990s, but it was not positively identified in this continent until 2002 in Canton, Michigan. The presence of EAB has been confirmed in 35 states (Map 3.2). EAB has killed at least 50–100 million ash trees in the U.S. and threatens another 7.5 billion ash trees throughout North America. EAB has been identified in Massachusetts—including in the greater Boston area—and poses a serious threat to the health and condition of ash trees in Somerville's urban forest. See Map 3.3 for areas in Massachusetts with known EAB infestations. EAB was first positively identified in Somerville in the Fall of 2018, with a single beetle caught in one of 10 traps that were hung around the city. In 2019, EAB was found on 7 of the 10 traps, for a total of 25 beetles.



Map 3.3. Massachusetts EAB Detections as of May 2019.
Map by the Department of Conservation and Recreation, Forest Health Program

The potential damage of EAB rivals that of chestnut blight and Dutch elm disease. For perspective, chestnut blight is caused by a fungus that was introduced in North America around 1900. By 1940, chestnut blight wiped out virtually all of the mature American chestnut trees across the country. Chestnut blight is believed to have been imported by chestnut lumber or through imported chestnut trees. Dutch elm disease (DED) is caused by a fungus and is spread by the elm bark beetle and transmitted underground between roots of infected trees. DED was first reported in the United States in 1928 and was believed to have been introduced by imported timber. Since its discovery in the United States, it has killed millions of elm trees.

Identification

The adult EAB beetle is elongate, metallic green and 3⁄8- to 5⁄8-inch long. The adult beetle emerges from late May until early August, feeding on a small amount of foliage. The adult females then lay eggs on the trunk and branches of ash trees and, in roughly a week, the eggs hatch into larvae, which then bore into the tree. Larvae are creamy white in color and can grow up to an inch long and are found underneath the bark of the trees. The larvae tunnel and feed on the inner bark and phloem, creating winding galleries as they feed. This cuts off the flow of the water and nutrients to the tree, causing dieback and death.

EAB adults grow to 5/8 inch in length (photograph credit www.wisconsin.gov).

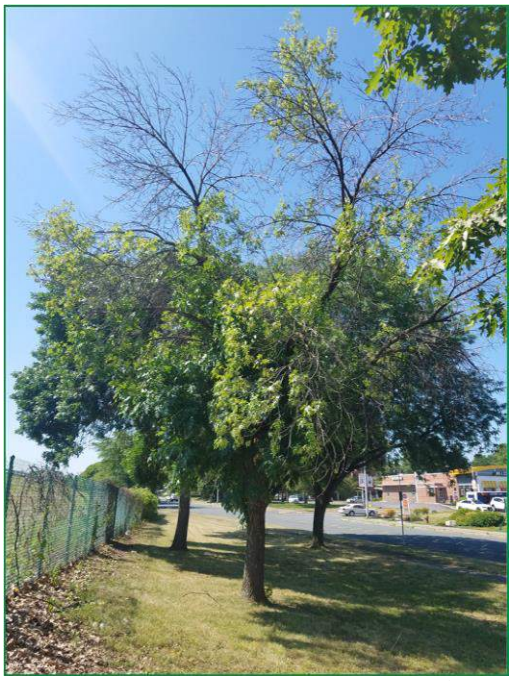
EAB larvae (photograph credit www.emeraldashborer.info).

EAB can be very difficult to detect. Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting. The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree base or on branches. Woodpecker injury is often apparent on branches of infested trees, especially in late winter, as they feed on the larvae. Removal of bark reveals tissue callusing and frass-filled serpentine tunneling. The S-shaped larval feeding tunnels are about 1⁄4 inch in diameter. Tunneling may occur from upper branches to the trunk and root flare. Adults exit from the trunk and branches in a characteristic D-shaped exit hole that is about 1/8 inch in diameter. The loss of water and nutrients from the intense larvae tunneling can cause trees to lose between 30% and 50% of their canopies during the first year of infestation. Trees often die within two years following infestation.

EAB larvae consume the cambium and phloem, effectively girdling the tree and eventually causing death within a few years.

This ash tree is experiencing blonding of the bark (from woodpeckers trying to eat the EAB larvae) and epicormic shoots. Epicormic shoots are a result of dormant buds which are simulated to grow due to tree stress.

These trees contain the D-shaped borer holes created by EAB when the adult beetle exits the tree.



This ash tree is declining from EAB infestation. The loss of water and nutrients from intense larvae tunneling can cause the trees to lose between 30% and 50% of their canopies during the first year of infestation (Photograph courtesy of Elizabeth McKinley, Davey Resource Group).

State and Federal Response

The Department of Conservation and Recreation (DCR) is the leading agency responsible for control of invasive pests in Massachusetts. DCR has declared EAB a public nuisance in Massachusetts and has enacted a quarantine restricting the movement of ash trees and non-coniferous firewood across state lines.

The United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) is a federal agency that assists with regulatory and control action of invasive pests. USDA-APHIS and other state and federal agencies have been actively researching integrated management control measures, including the use of biological controls, developing resistant ash species, and testing various insecticides. Since 2003 scientists have been searching for natural enemies of EAB in the wild. This has led to the discovery of several parasitoid wasps native to China, namely *Tetrastichus planipennisi*, a gregarious larval endoparasitoid, *Oobius agrili*, a solitary, parthenogenic egg parasitoid, and *Spathius agrili*, a gregarious larval ectoparasitoid. These parasitoid wasps have been released into various states to evaluate their potential as a possible biological control of EAB. States that have released parasitoid wasps include Colorado, New York, Indiana, Michigan, and Minnesota. The wasps will not eradicate the beetle but may be able to help keep EAB populations low, particularly in dense stands of ash. Determining the success of these parasitoid wasps on being effective biological control agents will take many

years of research due to the long life cycle of ash trees and the large population numbers spread across the country.

Ash Population

With EAB expanding into Somerville, it is crucial that the City maintain its current action plan. Some of the most important questions Somerville has addressed include:

- How many ash trees do we have?
- Where are they located?
- What actions should we take?

Somerville was able to answer these questions by maintaining an up-to-date inventory, knowing what resources were available, and understanding the City's priorities.

Based on the current public tree inventory, there are 1036 ash trees distributed throughout the City's urban forest (including those in state-owned public areas), 836 of which are on city-owned property (right-of-way and open spaces). Of these trees, 32 were recommended for removal based on health or safety concerns identified during the 2018 inventory. It should be noted that a prior inventory of ash trees was conducted in 2016, and many of the Dead or Poor condition ash trees were removed before this latest inventory. The majority of the city-owned ash trees in the 2018 inventory were rated to be in Fair condition (53%), followed by those in Good condition (39%), and a significantly smaller percentage in Poor or Dead condition (8%). Table 3.2 presents the diameter class of each ash tree by condition class. Of the 836 city ash trees inventoried, 3 were identified as having shown potential signs and symptoms of EAB, and additional 16 had signs of other boring insects.

Table 3.2. Ash Tree Condition by Diameter Class Matrix

	1–3.9	4–6.9	7–10.9	11–12.9	13–19.9	20–29.9	30–39.9	40 +	Total
Good	3	17	54	48	131	13	1	0	**267**
Fair	1	37	124	102	206	25	0	1	**496**
Poor	1	17	18	13	13	5	0	0	**67**
Dead	5	1	0	0	0	0	0	0	**6**
Total	**10**	**72**	**196**	**163**	**350**	**43**	**1**	**1**	**836**

Ash Tree Risk Reduction Pruning and Removals

As infestation of EAB becomes more prevalent in Somerville, the City should continue to focus on budgeting funds and personnel to manage and preserve the ash tree population. Somerville should perform both treatment for EAB management and safety-related activities on ash trees.

Somerville should proactively remove ash trees that are in Poor condition or are in poor locations during road reconstruction projects and other public works associated activities.

By proactively removing ash trees during construction, the cost and impacts related to EAB infestation are predicted to be lower.

As a continued proactive measure, Davey Resource Group (DRG) recommends that Somerville first remove all ash trees less than 7 inches DBH, along with ash trees that are Dead or in Poor condition. Trees in Fair condition that are between 7 and 12.9 inches should also be removed. These trees provide little benefit and/or have current health problems.

EAB Management

Somerville should explore different options for managing EAB. With the City striving to be proactive in EAB management before an infestation occurs, Somerville has developed multiple management strategies. Currently the City is treating all of the 705 City-owned ash trees that are healthy enough to treat. The treatment process consists of the selected ash trees being injected with TreeAzin (an organic insecticide) directly into their xylem. The xylem is what transfers nutrients and water throughout the tree, and unfortunately, it is what the EAB eats. This is the reason why only healthy trees are considered for treatment. An ash tree with a damaged xylem will not transport the TreeAzin throughout its system very well, which can cause the treatment to fail. Since 2016, Somerville has conducted biannual ash tree treatments, treating approximately 50% (by caliper inch) of the heathy ash tree population each year. As time goes on and financial strains increase with the continued treatment, the City may choose to treat fewer trees. The graphs below (Figures 3.10 and 3.11) present a unique tool for deciding viable management options for varying levels of EAB infestations (risk benefit relationship). These figures are based on a “Do Nothing” strategy (i.e. no treatments). Considering that EAB was found in Somerville in 2018, and the City’s proximity to confirmed infestation, Somerville’s tree population can be approximated at Year Two on both graphs after first EAB infestation. At this position, the City has time to prepare and improve its management options. The more time that passes after an infestation occurs the more the options for management decrease (Figure 3.11).

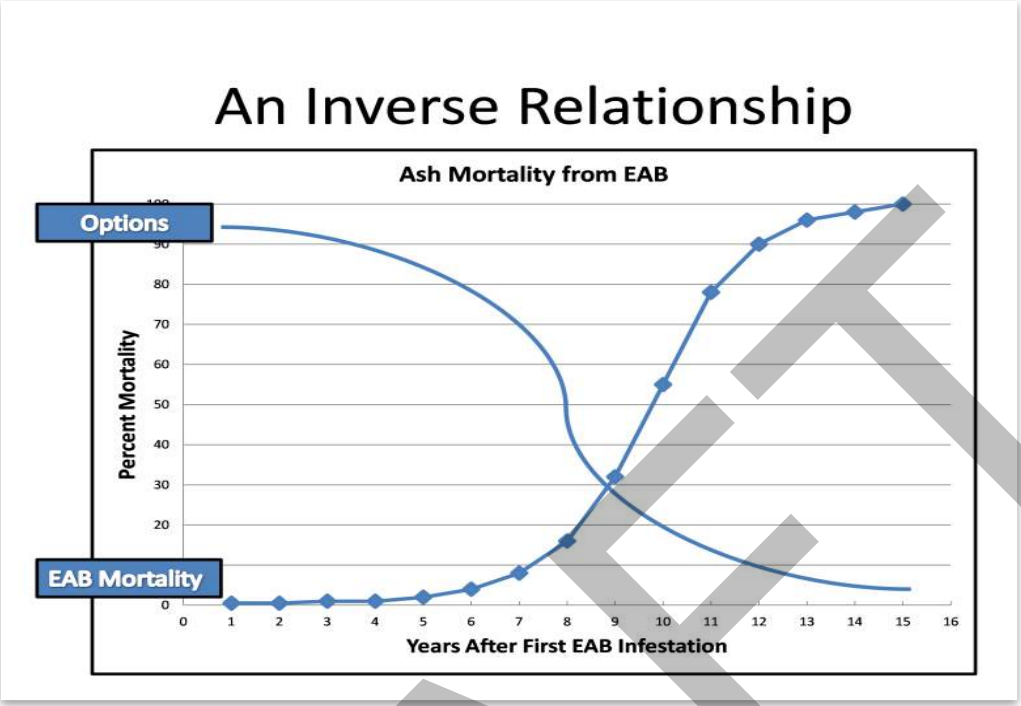
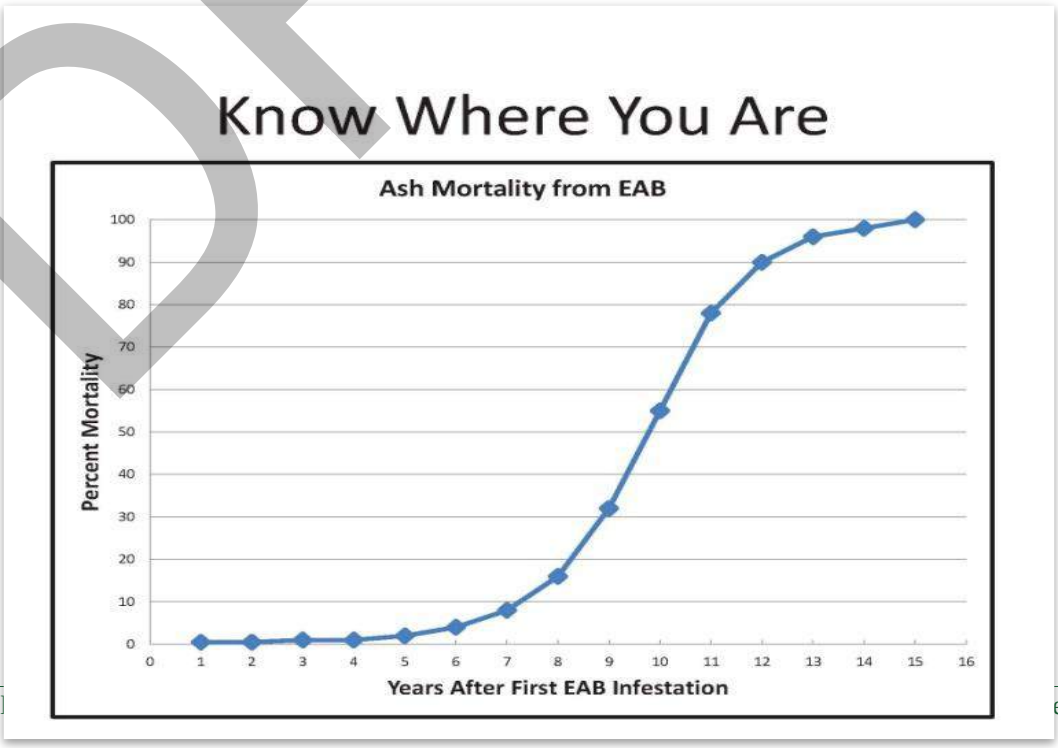


Figure 3.10: Percent of Ash Tree Morality Versus Years of EAB Infestation. Figure source: **Emerald Ash University (**www.emeraldashborer.info**)**

Figure 3.11: Number of Management Options Versus Number of Years of EAB Infestation. Figure source: **Emerald Ash University (**www.emeraldashborer.info**)**



Alternative EAB Management Strategies

Somerville should continue to explore strategies for managing EAB that provide the most economic benefit and increase public safety. EAB management strategies include doing nothing, removing and replacing all ash trees, using insecticides to treat all ash trees, or any combination of these strategies. Details about these strategies and the costs associated with them are provided below.

EAB Strategy 1: Do Nothing

This strategy involves not removing and not treating any ash trees. This means stopping any insecticide treatments, letting EAB run its course, and having no strategy for dealing with EAB. This strategy is economical in the beginning of an infestation because it doesn't cost the city any money, but it would become an extreme public safety issue within a few years. This strategy would also lead to the continued spread of EAB to neighboring communities, counties, etc. as EAB adults are good fliers. This management strategy is NOT recommended.

EAB Strategy 2: Remove and Replace All Ash Trees

By the end of 2020, remove and replace all 836 of the City-owned ash trees. This strategy would benefit public safety from the EAB infestation but would have an impact on the City's budget. In order to achieve this strategy and remove all of the ash trees by 2020, the City would most likely have to contract out at least some of the work. Moreover, removing mature ash trees in Good and Fair condition would take away all of the valuable benefits that these trees provide to the City and would leave some areas that have a full canopy of ash with no moderate- or large-sized trees at all. By increasing public safety, this strategy ultimately benefits the City but requires high upfront cost. Replacing all of these ash trees once they have been removed will be very important.

The total approximate cost for this strategy would be $1,208,460 (Table 3.3).

Table 3.3. Cost to Remove and Replace All City-owned Ash trees

Management Strategy	Management Action	# of Trees	Cost
Remove and Replace All Ash Trees	Remove trees	836	$372,460
	Replace trees	836	$836,000
	Total		**$1,208,460**

EAB Strategy 3: Treat all Ash Trees

Treating all of Somerville's ash trees could reduce the annual mortality rate, stabilize removals, and would be less expensive than removing and replacing all ash trees. Treating all ash trees would enable these trees to continue providing the city with the environmental benefits that they provide. On the other hand, treating all ash trees is not an ideal practice because some of the trees eventually become infested with EAB and

some are less desirable to retain. Ash trees that are treated can still become infested with EAB (especially trees that are not in healthy condition) when they are not effective at taking up the chemical treatment. This weakens the tree's defense and allows the beetle to penetrate into the tree.

The current treatment that Somerville is using needs to be applied every two years. The two-year cost for treating all 836 ash trees is approximately $115,000 (Table 3.4). To spread out this cost, the City treats half of the ash trees every year, meaning that to treat all 836 ash trees, the City would spend approximately $57,500 every year on ash tree treatments.

During the 2018 inventory ash trees were recommended for treatment or not based on condition (not size). A total of 705 trees were recommended for treatment in this inventory. This means it would cost the city approximately $100,000 to treat these ash trees every two years (i.e. approximately $50,000 per year; Table 3.4). Currently treating these 705 trees is what the city is doing.

Table 3.4. Cost to Treat All or Most of the City-owned Ash Trees

Management Strategy	Management Action	# of Trees	Total DBH (inches)	Cost
Treat All Ash Trees	Treat all of the City-owned ash trees	836	10,654	$114,960
Treat All Ash Tree Recommended for Treatment	Treat the City-owned ash trees recommended for treatment in the 2018 inventory	705	9,243	$99,730

EAB Strategy 4: Combination of Removals and Treatment

This strategy is intended to give the City options for a combination of removing and treating ash trees to stabilize annual removals, annual budgets, and prolong the life of ash trees in Good and Fair condition. Table 3.5 is an EAB matrix table intended to organize trees that should be considered for removal and trees that should be considered for treatment. The following sections explain why certain ash trees should be considered for removal and treatment.

Table 3.5. EAB Matrix Table. Trees in the categories highlighted in orange are recommended for removal, and those in green are recommended for treatment. Trees in the categories highlighted in yellow should be considered for treatment (low-moderate priority).

		1–3.9	4–6.9	7-10.9	11–12.9	13–19.9	20-29.9	30-39.9	40+	Total
Condition Class	Good	3	17	54	48	131	13	1	0	267
	Fair	1	37	124	102	206	25	0	1	496
	Poor	1	17	18	13	13	5	0	0	67
	Dead	5	1	0	0	0	0	0	0	6
	Total	10	72	196	163	350	43	1	1	**836**

Based on the number of trees in the different size class and condition categories, DRG makes the following recommendations:

357 Trees for Removal

- Trees in the Poor and Dead condition class are recommended for removal because they are more susceptible to EAB infestation and do not take up the treatment well. If these trees are not removed, they could pose a public safety issue in the future. A total of 73 Poor and Dead trees are recommended for removal and replacement.
- The remaining 58 trees that are less than 7 inches DBH, as well as the 226 trees in Fair condition and between 7 inches and 12.9 inches DBH, are recommended for removal and replacement. These trees do not provide as many benefits to the community compared to mature ash trees, and thus the treatment costs outweigh the benefits. It would be in the best interest of the City to remove these trees and replace them with a more diversified mix of trees.

232 Candidate Trees for Chemical Treatment (Low–Moderate Priority of Treatment)

- The intent here is to defer removal of a large block of Fair conditioned trees between 13 inches and 43+ inches DBH. These 232 trees are considered to be low–moderate priority for chemical treatment. Eventually, many of these trees may become infested with EAB if treatments stop, meaning these trees would have to be removed. Treating these trees could help minimize short-term budgets due to removals. Treatment can be economically beneficial and reduce the chance for a public safety issue in the near future.

247 Candidate Trees for Chemical Treatment (High Priority of Treatment)

- Candidates for chemical treatment should be in Good condition or better with no more than 30% dieback. Such trees should be located in an appropriate site (i.e., not under overhead utilities). Continually treating these 247 ash trees will help keep these trees around for a long time; the City will profit from the monetary benefits these ash trees provide.

This ash tree in Somerville is being treated against EAB. Until EAB leaves the area, the tree will require treatment every two years.

For maximum retention of a healthy urban tree canopy, DRG recommends that the City of Somerville treat all 479 (57%) City-owned ash trees that are Low-Moderate and High priority candidates for treatment, and that the rest of the ash trees be removed. DRG also recommends that as the ash trees are removed, the stumps are also removed such that replacement trees can be planted immediately. Table 3.6 shows that the total cost for removal, treatment, and replanting will be approximately $538,110 over a two-year period. This is significantly less than the cost to remove all ash trees, and this option means that many beautiful, shade-producing trees will be saved. Under this scenario, ash tree treatment costs will be less than $39,005 every year (treating all recommended ash trees over the course of two years), depending on ash tree mortality. Treating only the larger, healthier ash trees saves the city over $10,000 per year in treatment costs compared to treating all healthy ash trees.

Table 3.6. Estimated Costs Associated with Combination Treatment and Removal EAB Strategy

Activity	Diameter	Estimated Cost/Tree	# of Trees	Total DBH	Total Cost
Removal	1-3.9"	$100	10		$1,000
	4-6.9"	$100	72		$7,200
	7-10.9"	$100	142		$14,200
	11-12.9"	$600	115		$69,000
	13-19.9"	$600	13		$7,800
	20-29.9"	$780	5		$3,900
	30-39.9"	$1,280	0		$0
	40"+	$1,360	0		$0
Activity Total (removal)			357		$103,100
Treatment	1-3.9"	$10.79 per	0		$0

(over two years)	4-6.9"	inch of DBH	0		$0
	7-10.9"		54	496.7	$5,359
	11-12.9"		48	576.3	$6,218
	13-19.9"		337	5201.5	$56,124
	20-29.9"		38	874	$9,430
	30-39.9"		1	32.8	$354
	40+		1	48.7	$525
Activity Total (treatment)			479		$78,010
Replanting		$1,000	357		$357,000
Activity Total (replanting)			357		$357,000
Option Totals			**1,193**		**$538,110**

Ash Trees on Private Property

EAB will also impact trees located on private property. The number of ash trees on private property in Somerville is unknown. The cost to remove ash trees on private property will likely be higher than the cost to remove ROW ash trees because these areas are more inaccessible. It is crucial that the City promotes public education about EAB to reduce the potential of having dangerous trees on private property and to lower the infestation rates of EAB throughout the City. Public education will also help to reduce the potential of City involvement with regulating tree removals on private properties. The City should consider providing residents with fact sheets (ex. Massachusetts Department of Conservation and Recreation's *Emerald Ash Borer* fact sheet) and other information about treatment options (ex. Herms et al., 2019).

Door hangers will help raise awareness among private homeowners of the management options available for EAB.

Dying and infested ash trees on private property pose a threat to human and public safety. Somerville should consider amending the current Tree Preservation Ordinance such that EAB is specifically acknowledged as a public nuisance and treated in similar fashion as Dutch elm disease and other insect pests or plant diseases. In the event that City officials have to get involved with private property owners about a potential infested ash tree, Somerville could consider utilizing the City's Tree Preservation Ordinance. Please refer to *Section 4.3: Ordinance/Policy Review* for more information on Somerville's Tree Preservation Ordinance.

Public Education

It is crucial for Somerville property owners to be well informed about EAB. Their assistance and cooperation will be vital in detecting the spread of EAB, managing ash trees on private property, and expediting reforestation after removals of infected ash trees are complete. A well-informed community is more likely to cooperate with the City's requests. The City of Somerville's Urban Forestry website (www.somervillema.gov/urbanforestry) has detailed information on EAB and the treatment strategy for the City's public trees. When EAB was first discovered in Somerville (in 2018), the City issued a press release and held a public meeting. To further the public education process, the City should continue to inform the public about EAB in the following ways:

- Additional press releases
- City newsletter articles
- Radio and TV programs
- Posting on social media
- Keep City's website up to date

Posting information about EAB on ash trees around the City could encourage private homeowners to become more proactive in managing their ash trees.

It is vital for Somerville to educate the public on how to detect EAB, provide information about treatment options, and relay the importance of reforestation to allow the public to make informed and proactive choices about managing infested ash trees. This could help put City officials at ease by having fewer private trees become a public safety issue.

Property owners may want to keep their ash trees because of the benefits they receive from them. If so, the City should provide information about treatment options so that their trees can last for years to come. For property owners that prefer to remove their ash trees, it is important for the City to inform them about reforestation, the important benefits trees provide to neighborhoods, and how trees increase real estate value. The following are examples of ways the City can inform the public about all of these issues:

- Display information packets at public buildings
- Postcard mailings to homeowners in Somerville
- Door hangers explaining ash tree maintenance options
- Presentations to community groups
- Post information about EAB on the City's website
- Tie ribbons around ash trees and place tags on the trees with information about EAB

Reforestation

As the ash tree population is being reduced in Somerville, the City is working towards replanting a diversity of tree species where ash trees have been removed. Ash trees are one of the more common genera in Somerville (see *Section 2: Somerville's Trees*); the City could potentially lose up to 5% of its tree population due to EAB. These ash trees provide numerous benefits to the community (see *Section 1.2: Ecosystem Services of Somerville's Street Trees*), and thus prompt reforestation is essential. Benefits include removing pollutants from the air, helping moderate temperatures, reducing stormwater runoff, and providing social and psychological benefits.

Replacing all of the City-owned ash trees that are recommended for removal would cost the City approximately $357,000. It is important that these trees be replaced despite the financial burden on the City. The cost of replanting ash trees could be spread out over multiple years by establishing a goal that a certain amount of trees need to be planted each year. For example, if the City were to plant 60 trees a year where ash trees were removed (at a cost of approximately $60,000 per year), Somerville could replace all of the trees recommended for removal within 6 years. This cost could be reduced if the City comes up with a plan to work with private property owners and/or volunteers. This could include giving private property owners the option of paying for the tree and getting to pick the tree they want from a list of recommended species. Organizing volunteer groups to participate in planting trees can decrease the cost of tree planting. Somerville should also explore the possibility for obtaining grants for funding reforestation efforts.

It is important to consider diversification when replacing ash trees. Without diversification, a community is much more vulnerable to catastrophic losses due to increased susceptibility to pest and disease which impacts budgets and community appearance. An urban forestry best practice is that no one species represents more than 10% and that no one genus comprises more than 20% of the total public tree population.

Asian Longhorned Beetle (ALB)

Asian longhorned beetle (*Anoplophora glabripennis*) is a serious threat to a large number of America's hardwood tree species. Like EAB, this invasive pest arrived from Asia within the last few decades. However, unlike EAB, ALB targets many common species (maple, birch, horse chestnut, poplar, willow, elm, and ash) and is, for the most part, untreatable. Over 34% of Somerville's publically-managed trees consist of these species (Table 3.7).

Adult Asian longhorned beetle. Photograph courtesy of New Bedford Guide 2011.

Table 3.7. Species in Somerville's 2018 tree inventory that are subject to ALB infestation

Genus	Common Name	Number of Trees	Percentage of Tree Inventory
Acer	maple	3,784	28%
Aesculus	horsechestnut	1	>1%
Betula	birch	173	1%
Fraxinus	ash	1,034	8%
Populus	poplar	52	1%
Salix	willow	4	>1%
Ulmus	elm	427	3%

Infestation of ALB is untreatable. The management of ALB is under state and federal regulations. If ALB is found, the USDA institutes an immediate removal of host trees and a strict quarantine of ALB host materials to stop the spread of this devastating pest. Destruction of host trees is the only acceptable control practice. Eradication is possible, but the impact of removing host trees can be devastating to a community. The most important thing to deter this pest is early detection, which requires vigilant monitoring. Proper identification of ALB is critical and educating the public and City staff on this is important.

First found in Brooklyn in 1996, ALB has since been detected in Worcester, Boston, southwest Ohio, Chicago, Central Long Island, New Jersey, and Toronto. ALB currently has been eradicated in Boston, Chicago, New Jersey, Queens, and Manhattan. Eradication efforts can vary slightly depending on the area, but it involves a ground survey crew, and/or climbers that look at all potiental host trees in the area. Any trees that are found to have ALB will be removed. This is why educating the public and City staff for signs and symptoms of this pest is so important. The earlier ALB is dected, the quicker it will likely be eradicated.

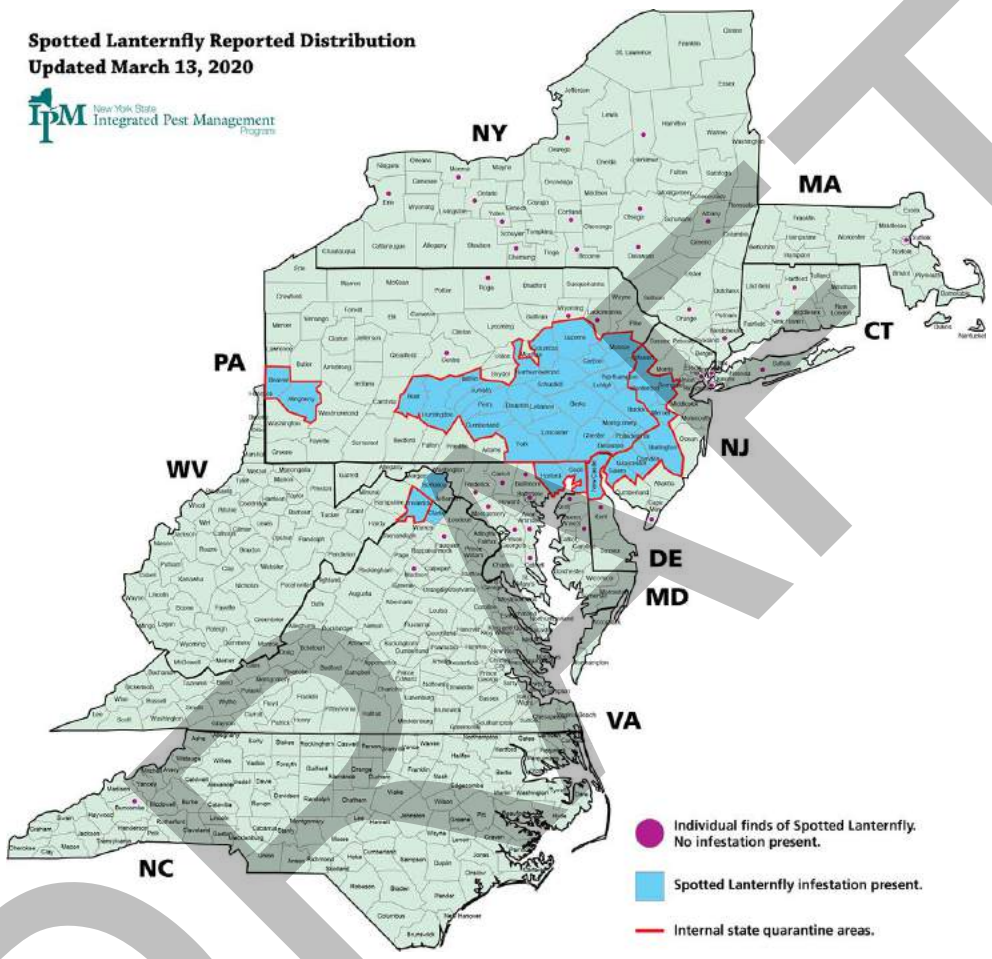
Apart from seeing the beetle itself, a tree that is infested with ALB will show distinctive signs, including perfectly round exit holes that are ¼ inch or larger, egg sites that look like little wounds on the tree and sometimes have chew marks on the edges, frass

(sawdust-like material) on the ground or on tree branches, and tunneling under the bark. Educational materials on ALB can be found at the USDA Aphis website, www.beetlebusters.info.

On the right, ALB exit hole with frass. On the left, multiple ALB egg sites along the bark of a red maple.

Spotted Lanternfly

Spotted lanternfly (*Lycorma delicatula)* is an invasive insect native to China. It was first discovered in Pennsylvania in 2014, and the infestation has since spread into New Jersey, Maryland, Deleware, Virginia, and West Virginia (Map 3.4).



Map 3.4. Spotted Lanternfly Detections in New England as of March 2020. Map by New York State Integrated Pest Management Program.

On the right, an adult Spotted Lanternfly next to an egg site. On the left, two Spotted Lanternfly nymphs

In December, 2018, a single dead adult was found in Boston, Massachusetts after being discovered in a shipment of poinsettias from Pennsylvania. Currently, this has been the only insect found in Massachusetts, and no infestation has yet been detected, but it is notable that this insect has been found in multiple counties in neighboring states. The spotted lanternfly lays it's eggs on plant surfaces, firewood, cars, and other non-host material, which can easily be transported. Somerville residents should be educated about the spotted lanternfly, because early detection and proper identification can help prevent an infestation.

Spotted Lanternfly eggs sites on a rubber spool. The color and the ability of SLF to lay on various sites makes it easy for human transportation.

Spotted laternfly prefers the host tree-of-heaven (*Ailanthus altissima*), but it feeds on a wide range of fruit, ornamental and woody trees, and agricultural crops (such as apples, peaches, grapes, and hops). While the life cycle and epidemiology of the spotted laternfly is still unfolding, removing tree-of-heaven may help slow it's spread.

Of the public trees inventoried during the 2018 tree inventory, 133 were tree-of-heaven. However, it should be noted that this is not an exact number, because a majority of these trees were in unmaintained areas, and in large clusters. When a grouping of these trees occurred during the inventory, a single point was assigned, along with a note approximating the number of trees in the area. A good example of this is behind the firestation at 651 Somerville Avenue. The unmaintained woodlot was not inventoried, but a point was placed to indicate there were dozens of tree-of-heaven trees located there.

Spotted Lanternfly infestations on two different tree-of-heavens.

The majoirty of the tree-of-heaven trees in the inventory were found along the Community Path (45%). The DBH of the inventoried tree-of-heaven trees ranged from small whips (1 inch diameter or less) to over 37 inches. To reduce the number of hosts available for spotted lanternfly, it would be most prudent to remove the largest trees first as they will disperse the most seeds. After removal, an herbicide should be applied to any remaining stumps and roots, as whips can sprout quickly from the remaining runner roots.

Oak Wilt

Oak wilt symptoms on red oak leaves. Photograph courtesy of USDA Forest Service (2011a)

Oak wilt is caused by a fast-acting fungus, *Ceratocystis fagacearum*, and is considered to be an invasive and aggressive disease. It can result in the decline and death of oak trees in as little as two weeks by clogging the tree's vascular system. Oak trees comprise 6% of Somerville's public trees and likely the same percentage of private trees.

Oak wilt has yet to be found in Massachuetts, but within New York, oak wilt has been found near Albany, Canandaigua, and in Queens. The fungus is spread from tree to tree by boring insects and through root grafts underground. This disease is most devastating to trees in the red oak subgenus, including *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q.palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). The fungus will also attack trees in the white oak subgenus, though it is not as prevalent and spreads at a much slower pace in these trees. The most resistant species to oak wilt include *Q. macrocarpa* (burr oak) and *Q. muehlenbergii* (chinkapin oak).

Control and management of oak wilt involves a thorough knowledge of preventive strategies and control measures. The best preventive strategy is to limit wounding (including pruning wounds) of oaks during warm weather when the insect vectors are flying. Immediate attention to adequately dress wounds on oak is an appropriate management strategy for protecting the tree against potential disease. Correct diagnosis is another critical element of reducing the spread of oak wilt. Trees with syptoms should be inspected by a certified arborist and samples should be sent to a lab for diagnosis. The UMass Plant Diagnostic Laboratory website (https://ag.umass.edu/services/plant-diagnostics-laboratory) contains directions on how to cut samples and submit them properly. If diganosed, it is very important to limit the spreading of oak wilt to other nearby oaks. Cutting root grafts is essential as oak wilt can move from tree to tree when they share a common root system. In some cases it may be necessary to remove nearby oak trees to prevent spreading.

Additional resources on oak wilt include Rexrode and Brown (1983) and the USDA Forest Service Pamphlet "How to Identify, Prevent, and Control Oak Wilt".

Other Diseases

There are various other diseases and pest issues that have been found to affect trees in Somerville, including anthracnose, verticilum wilt, giant tar spot, and aphids. Treatment of these diseases and pests is often unnecessary as the symptoms are mostly aesthetic and will not negatively impact the health or longevity of trees unless they are heavily infested for many years in a row. However, proper management can minimize their impact to tree

canopies. Treatment of these diseases should be done at the discretion of trained City personnel and based on severity of disease and likelihood of spread.

Anthracnose is a common foliar disease of shade trees caused by fungi. Anthracnose will periodically surface on susceptible species, and has been reported on maple, sycamore and plane trees in Somerville in past years. This disease kills leaf tissue and may cause defoliation to occur. Although this can reduce the aesthetic value and vitality of the affected trees, the trees are often able to recover. While certain management steps can be taken to reduce the prevalence of this disease (noted below), the best long-term course is to focus on planting resistant tree varieties.

Anthracnose symptoms on red maple leaves.

The Anthracnose fungus generally overwinters in infected, dead leaves on the ground. In American sycamore and London planetree, it also overwinters in infected buds or in cankers formed at the base of an infected leaf or twig. In maple trees, like Norway maple, *Anthracnose* only impacts the leaves. During cool and wet springs, minute blister-like swellings in the infected tissues release thousands of spores. These get blown around, land on newly-developed leaves, and cause infection and death of the tissue, resulting in tan to brown areas on the leaves. Varying amounts of leaf drop take place, depending upon the severity of the disease that season (the cooler and wetter the spring, the more severe *Anthracnose* will be). Conditions are then ready to repeat the cycle the following year.

Current recommendations for preventing anthracnose in shade trees include the following:

1. Rake and destroy infected leaves and prune off cankered branches. This will reduce the potential for infection.
2. Fungicidal treatments during leaf development will help prevent leaf infection and defoliation. Trunk injections of Arbortect® can also be used to manage sycamore anthracnose.
3. Plant tree species resistant to the fungus.

Although Anthracnose is highly prevalent in the landscape, the damage it causes is generally insignficant. Treatment is often not warranted, but may be considered for high-value trees or areas.

Verticillium Wilt is caused by a soil-borne fungus. Verticillium is often associated with maple but can affect several other species, including ash, Kentucky coffee tree, elm, and plum. Symptoms include yellow foliage, abnormally heavy seeding, and dieback of shoots and branches (often on one side of a tree). Streaking of vascular tissue can accompany external symptoms. The fungus will persist in the soil indefinitely. Therefore, if replacement of trees affected with Verticillium wilt is needed, replant with species not susceptible to the fungus such as birch, gingko, pear, or poplar.

Giant tar spot is caused by the fungus *Rhytisima acerinum*. This fungus primarily affects maples and sycamores; but especially Norway maples (both the fungus and tree are from Europe). The lifecycle is very similar to Anthracnose, as are the management options. Giant tar spot becomes more apparent on the leaves in the late summer. The leaves fall in the autumn, and the fungus overwinters in the fallen leaves. When the weather warms up in the spring, spores are released. These spores infect the new leaves on the trees and the cycle begins all over again. Sanitation is the best method of control. Simply raking up the fallen leaves and disposing of them will eliminate the source of giant tar spot for the following growing season. Thoroughly composting the leaf debris can break the cycle.

Giant tar spot on a fallen Norway maple leaf.

Zoomed in profile of an aphid. Aphids are about the size of a pinhead.

Aphids (*Aphidoidea*) are a sap sucking insect. While these pests aren't invasive they can be a nussicance. Aphids will suck the sap of leaves on a tree or plant, and then will discrete a sugary substance called honeydew. This sticky honeydew can be found on cars parked under trees, and can look unslightly when subsquent growth of sooty mold occurs.

Aphids are one of the most common insects founds on trees, shrubs, and ornamental plants. There are hundreds of species of aphids, and most plant species host at least one type of aphid.

On Somerville's public trees, aphids have been found to be a particular nuisance on littleleaf linden (*Tilia cordata*) and American linden (*Tilia americana*).

As trees that are stressed are more susceptible to disease and decline, one of the best preventative measures is to keep the trees healthy. Regular deep watering during the summer months is an effective way to prevent or reduce water stress in trees. If a tree is already heavily infested with aphids, one safe and effective way to remove the aphids is by washing them off with a strong blast of water. However, this is not a practical solution for large trees with dense canopies. Altneratively, natural enemies of aphids, such as ladybugs, can be used to help to control aphid populations. Systemic insecticides are not recommended for use against aphids as they also target other important beneficial insects, including bees and other pollinators.

For information on other potiental pests, please refer to *Appendix G*.

3.4 STORM PREPARDNESS PLAN

Introduction

The purpose of preparing an emergency storm preparedness plan is to mitigate, respond, and recover from an emergency or natural disaster in a timely manner. This section will focus on establishing protocols to outline the steps needed to have an effective strategy in place. Advance planning will go a long way toward minimizing the impacts of natural disasters on the urban forest.

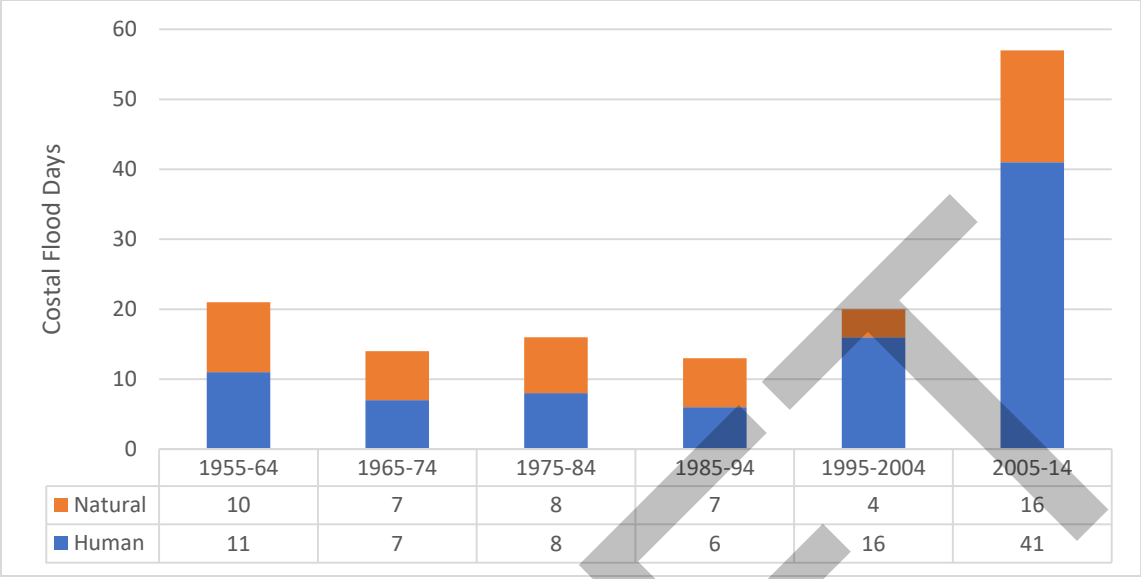
Keys of an effective Emergency Storm Preparedness Plan

- Mitigation: activities to reduce the effects of disasters
- Preparedness: plan a response prior to disaster
- Response: activities performed during a disaster to minimize hazards in effective, efficient, and equitable ways
- Recovery: returning to normal following a disaster

The City of Somerville, Massachusetts lies in a climate zone that exhibits four distinct seasons. This creates the potential for rapid changes in temperature, humidity, and barometric pressure, and sets the stage for severe weather events, such as tornadoes, thunderstorms, hurricanes, hail, high winds, ice, and snow. Northerly hurricane tracks and related deluges are ever-present threats.

The Köppen climate classification (Köppen, 1884) rates Somerville as Dfa. Dfa is characterized as a continental region, but fully humid, and the existence of a hot summer. This is similar to Dfb, an oceanic influence; whereas, the "b" qualifier suggests only a warm summer. The Dfa category is used for the following climatic conditions: the coldest month averages below 32°F, at least one month's average temperature is above 71.6°F, and at least four months averaging above 50°F. For context, annual precipitation totals for the Boston area include an average rainfall of 43.77 inches, and an average snowfall of 43.8 inches. In 2018, the Boston area received 53.32 inches (+9.55 inches above average) of rainfall, and 50.9 inches (+7.1 inches above average) of snowfall (National Weather Service Forecast Office, 2020).

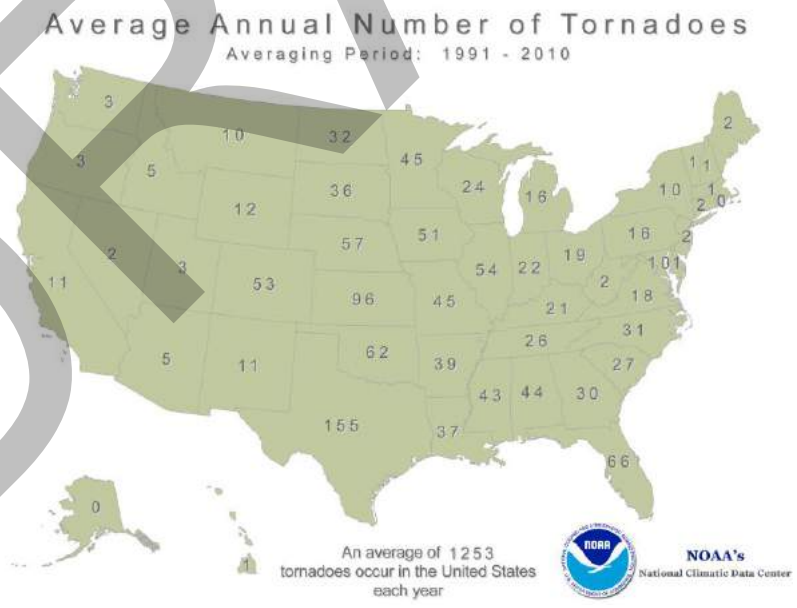
Global climate change, manifested by increased rainfall and atmospheric instability, presents a sense of urgency for urban forestry professionals. The main urban forestry concerns for this near coastal city are flooding and strong winds in the form of tropical storms, microbursts, bombogenesis events or hurricanes. Nearly every year, Massachusetts encounters remnants of, or fully seasoned, warm-water hurricanes. Somerville residents certainly remember these types of storm events from the not too distant past, such as Hurricane Sandy (2012) and Hurricane Bob (1991). Figure 3.12 demonstrates a dramatic increase in the Coastal Flood Days in Boston, Massachusetts in the last decade. Areas of particular flood concern in Somerville are those areas that are 6' or more below sea level.



	1955-64	1965-74	1975-84	1985-94	1995-2004	2005-14
Natural	10	7	8	7	4	16
Human	11	7	8	6	16	41

Figure 3.12. Days of Coastal Flooding Since 1950: Boston, Massachusetts

The National Oceanic and Atmospheric Administration reports that, on average, only 1 tornado is confirmed in the state of Massachusetts each year (Map 3.5). Thus, the threat of tornadoes, and the resulting damage that occurs, is relatively low in Somerville. But with the changing climate, the region is experiencing more frequent and severe non-tornado weather events.



Map 3.5. National Average of Tornado Confirmations Annually

Severe weather can create catastrophic damage and significant volumes of debris that needs to be processed. Therefore, proactive cities have developed emergency response and recovery plans for sever weather events. Traditionally, these plans address serious public safety and health issues, but commonly overlook trees and woody debris in the mitigation efforts.

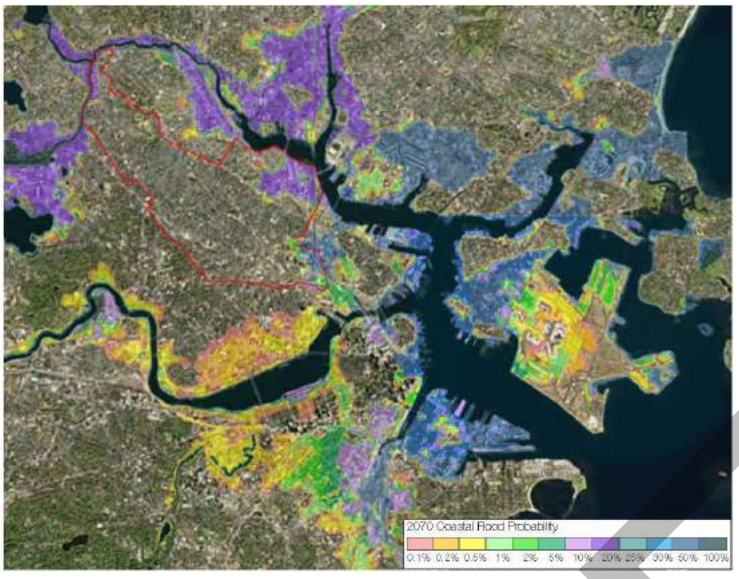
When catastrophic disasters such as tornadoes, ice storms, and severe straight-line winds strike a metropolitan center, thousands to millions of cubic yards of debris are produced. Trees and vegetation can account for approximately 30% of this debris volume.

Beyond the task of collecting and disposing of this debris are additional urban forest management considerations, including increased threat to life, hindrance to life-saving efforts, power outages, and personal and public property damage. The impacts of these additional tree-related considerations are not always quantifiable but can overwhelm city services and slow down the recovery process.

Despite a substantial tree canopy, proactive action is needed. There are a number of threats facing Somerville in the coming years that will stress the urban forest and could reduce overall canopy cover. The loss of canopy poses a threat to air and water quality and leads to higher levels of carbon in the atmosphere, more heat stress, and a degradation of quality of neighborhoods and property values. The following sections provide a summary of the most pressing potential future threats.

Sea Level Rise and Coastal Flooding

The impacts of climate change in Somerville have the potential to be severe, causing rising sea levels and flooding. There is a trend towards increasing sea levels in Boston (Figure 3.13), and, as illustrated in Map 3.6, taken from the *City of Somerville Climate Change Vulnerability Assessment* published in 2017, the annual chance of localized flooding with be significant in the next 50 years. This will cause saltwater intrusion, higher storm surges, and coastal erosion. The consequence of such events on the City's urban forest, over time, is higher tree mortality, as few trees in the Northeast can withstand lengthy exposure to saline or brackish water. There are not a lot of solutions related to preserving tree canopy in this situation except to plant species that are more tolerant to salt exposure (both from salt spray and saline soils). The following tree species are recommended for areas with the potential for increased salt exposure, particularly in the neighborhoods of Ten Hills and East Somerville: *Taxodium ascendens* (pond cypress), *T. distichum* (bald cypress), *Nyssa aquatica* (water tupelo), *N. sylvatica* (black tupelo), *Quercus bicolor* (swamp white oak), *Q. lyrata* (overcup oak), and *Magnolia grandiflora* (southern magnolia). These species have been incorporated into the recommended tree species list found in *Appendix D*.



Map 3.6. 2070 Somerville, MA Coastal Flood Probability (*City of Somerville Climate Change Vulnerability Assessment*, 2017)

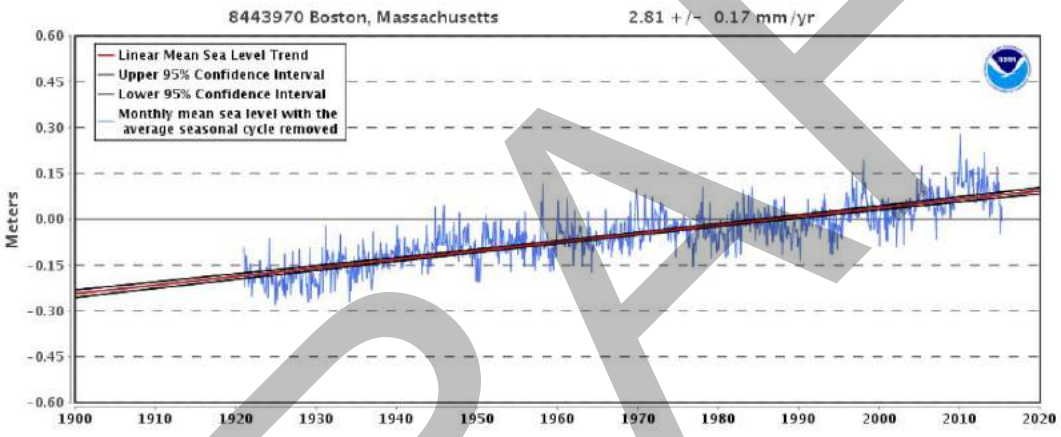


Figure 3.13. Sea Level Rise since 1920 in Boston, MA (NOAA).

More Frequent and Severe Storms

As a result of sea level changes, increases in the frequency and severity of storms are occurring throughout the East Coast. This impacts the urban forest in a number of ways:

- More storm damage and subsequent loss of trees.
  - Poorly or infrequently managed trees are more susceptible to breakage in storms.
  - Certain species are more susceptible to breakage in storms, particularly those with weak wood and/or poor branch architecture (ex. callery pear, litttleaf linden, silver maple).
  - Premature post-storm tree removals on private land tend to occur, often as a result of fear and lack of professional assessment.
- Power outages occur when the wrong trees are situated next to power lines.

- High volumes of stormwater runoff due to extensive impermeable surfaces and less green land cover can exacerbate an already difficult problem.

A comprehensive urban forest management plan greatly reduces storm hazards through proper planting and preventive maintenance. The City of Somerville now has such a plan (see *Section 3.1: Tree Planting Plan* and *Section 3.2: Tree Maintenance Program*). In addition, when disasters occur, having an emergency plan can provide solid data, facts, and protocols to ensure service continuity and timely recovery and restoration.

The Emergency Plan that follows addresses many facets of the urban forestry program, including Somerville's emergency storm response system and the role of the local, county, state, and federal government, ranging from overall management objectives to specific details. Topics range from short-term program priorities to long-term management objectives.

Tree Population Characteristics Related to Storm Damage Risks

The vulnerability of Somerville's urban forest from severe weather events can be assessed using the recent tree canopy and public tree inventory data. It is well known that certain species of trees are more prone to breaking and splitting in storms (i.e., silver maple and callery pear), trees that are under utility lines and have been poorly pruned in the past are more prone to storm damage, trees in poor condition or with crown, trunk, or root defects can fail in even moderate storms, mature trees have a higher risk of storm damage, and trees under stress from insect and disease pressures are also more likely to fail in a storm. Thus, to provide a generalized vulnerability assessment of Somerville's urban forest, we examine Somerville's urban forest data in terms of tree condition, the frequency of storm-prone species, and the susceptibility of the urban forest population to pests.

Also of note is that the timing of a storm event can have a major effect on the overall damage sustainied by the tree. The canopy of a tree can act as a sail when the tree is in full leaf out. This can make the tree subject to windfall due to high wind activity in the summer and fall months, especially combined with heavy rains and supersaturated soil condtions.

Tree Condition and Size

The Somerville 2018 citywide tree inventory collected data on 13,604 total publicly owned trees. Inventory details can be found in *Section 2: Somerville's Trees*.

To avoid road blockage along important routes, Somerville should prioritize removing trees that have been recommend for Removal (see *Section 3.2: Tree Maintenance Program*), especially those that have an elevated risk rating associated with them. Approximately 34% of the trees in the inventory are rated in Good condition, 54% of the trees are rated in Fair condition, 10% are rated as Poor condition, and less than 2% of the trees were found to be Dead (see *Section 2: Somerville's Trees*). 243 trees (1.8% of inventory) are recommended for removal and have an elevated risk rating (High or

Moderate). Trees that are removed should be replaced with species that are appropriate for the site, in terms of their mature size and wind resistance needs, among other things.

In addition to tree health, tree maturity has shown to be a risk factor during storms. Mature trees that fail during a storm can create a higher risk of causing damage and creating excessive debris. Mature trees within recent construction zones pose an increased risk due to potential for stress and damage to the tree's root system. Mature trees comprised 4% of the tree population in Somerville's 2018 tree inventory, and 14% of the City-owned mature trees were found to be dead or in poor condition (*Section 2: Somerville's Trees*).

Storm-Prone Species Frequency

Fast-growing, weak-wooded species have the highest potential to create the largest amount of debris after storms. Somerville's urban forest shows some concern for diversity, and some of the most commonly planted species are also among the species that are most prone to storm damage. Trees in the Maple genus comprise 28% of the total tree population in Somerville's 2018 inventory, exceeding the desired 20% rule (*Section 2: Somerville's Trees*). Norway maple, which can suffer severe damage in storms, makes up 14% of Somerville's public trees. Other commonly planted tree species such as callery pear (10%) and red maple (10%) are more prone to storm damage and should be monitored closely for defects and disease. When planting new trees, these species should be avoided when possible. Vacant sites and stumps account for over 6% of the inventory, providing the City with opportunities to plant additional trees that can increase species diversity and reduce the storm susceptibility of the City's urban forest. Tree species with high or medium-high wind resistance (Table 3.8) and moderate to low ice storm susceptibility (Table 3.9) are especially recommended to increase the resilience of Somerville's urban forest to storms.

Table 3.8. Wind Resistance of Tree Species to Hurricanes

High	Medium-High	Medium-Low	Low
American holly (*Ilex opaca*)	American hophornbeam (*Ostrya virginiana*)	American elm (*Ulmus americana*)	Bradford pear (*Pyrus calleryana*)
Baldcypress (*Taxodium distichum*)	black tupelo (*Nyssa sylvatica*)	black cherry (*Prunus serotina*)	Chinese elm (*Ulmus parvifolia*)
dogwood (*Cornus florida*)	red bud (*Cercis canadensis*)	boxelder (*Acer negundo*)	Leyland cypress (× *Cupressocyparis leylandii*)
southern magnolia (*Magnolia grandiflora*)	sweetgum (*Liquidambar styraciflua*)	hackberry (*Celtis occidentalis*)	tuliptree (*Liriodendron tulipifera*)
	river birch (*Betula nigra*)	red maple (*Acer rubrum*)	
	ironwood (*Carpinus caroliniana*)	red mulberry (*Morus rubra*)	
	Japanese maple (*Acer palmatum*)	silver maple (*Acer saccharinum*)	

	mockernut hickory (*Carya tomentosa*)	sycamore (*Platanus occidentalis*)	
	pignut hickory (*Carya glabra*)	weeping willow (*Salix × sepulcralis*)	
	sugar maple (*Acer saccharum*)	white oak (*Quercus alba*)	

Table 3.9. Ice Storm Susceptibility of Tree Species

High	Moderate	Low
American elm (*Ulmus americana*)	American beech (*Fagus grandifolia)*	American hophornbeam (*Ostrya virginiana*)
American linden (*Tilia americana*)	American sycamore (*Platanus occidentalis*)	American hornbeam (*Carpinus caroliniana*)
bigtooth aspen (*Populus grandidentata*)	boxelder (*Acer negundo*)	Amur maple (*Acer tataricum ginnala*)
black cherry (*Prunus serotina*)	chestnut oak (*Quercus prinus)*	baldcypress (*Taxodium distichum*)
black locust (*Robinia pseudoacacia*)	common chokecherry (*Prunus virginiana*)	balsam fir (*Abies balsamea*)
black oak (*Quercus velutina*)	douglas-fir (*Pseudotsuga menziesii*)	bitternut hickory (*Carya cordiformis*)
Bradford pear (*Pyrus calleryana* 'Bradford')	eastern white pine (*Pinus strobus)*	black walnut (*Juglans nigra*)
butternut (*Juglans cinerea*)	gray birch (*Betula populifolia)*	blackgum (*Nyssa sylvatica*)
common hackberry (*Celtis occidentalis*)	green ash (*Fraxinus pennsylvanica)*	bur oak (*Quercus macrocarpa*)
eastern cottonwood (*Populus deltoides*)	Japanese larch (*Larix kaempferi)*	Colorado blue spruce (*Picea pungens*)
honeylocust (*Gleditsia triacanthos*)	loblolly pine (*Pinus taeda)*	crabapple (*Malus* spp.)
Jack pine (*Pinus banksiana)*	northern red oak (*Quercus rubra)*	eastern arborvitae (*Thuja occidentalis*)
pin cherry (*Prunus pensylvanica)*	paper birch (*Betula papyrifera)*	eastern hemlock (*Tsuga candensis*)
pitch pine (*Pinus rigida)*	pin oak (*Quercus palustris*)	eastern redcedar (*Juniperus virginiana*)
quaking aspen (*Populus tremuloides)*	red maple (*Acer rubrum)*	European larch (*Larix decidua*)
river birch (*Betula nigra*)	red pine (*Pinus resinosa)*	European mountainash (*Sorbus aucuparia*)
Siberian elm (*Ulmus pumila*)	scarlet oak (*Quercus coccinea*)	ginkgo (*Ginkgo biloba*)
silver maple (*Acer saccharinum*)	Scotch pine (*Pinus sylvestris)*	Kentucky coffeetree (*Gymnocladus dioicus*)
slippery elm (*Ulmus rubra*)	sourwood (*Oxydendrum arboreum)*	littleleaf linden (*Tilia cordata*)
Virginia pine (*Pinus virginiana)*	sugar maple (*Acer saccharum)*	northern catalpa (*Catalpa speciosa*)
willow (*Salix* spp.)	tamarack (*Larix laricina)*	Norway maple (*Acer platanoides*)
	tuliptree (*Liriodendron tulipifera)*	Norway spruce (*Picea abies*)
	white ash (*Fraxinus americana)*	Ohio buckeye (*Aesculus glabra*)
	yellow birch (*Betula alleghaniensis)*	pignut hickory (*Carya glabra*)
	yellow birch (*Betula alleghaniensis)*	shagbark hickory (*Carya ovata*)
		swamp white oak (*Quercus bicolor*)
		sweetgum (*Liquidambar styraciflua*)
		white oak (*Quercus alba*)
		white spruce (*Picea glauca*)
		witchhazel (*Hamamelis virginiana*)
		yellow buckeye (*Aesculus flava*)

Insect and Disease Issues

Urban forests are consistently under pressure from exotic and invasive insects and diseases. The frequency and severity of pests and disease are likely to worsen throughout the U.S. as the climate warms. The best solution for local communities lies in proper proactive care (budgeting, monitoring, smart management) as well as planting of more resistant tree species. Below is a short summary of a few of the more pressing pest and disease issues facing Somerville. For more details about these and other pests and diseases see *Section 3.3: Invasive Insect and Disease Management Strategy*.

Emerald Ash Borer (EAB)

Emerald ash borer (*Agrilus planipennis*, or EAB) first arrived in the U.S. in 2002 near Detroit and has been spreading ever since (*Section 3.3: Invasive Insect and Disease Management Strategy*). It attacks all species of native ash trees, including white, green, blue, and black ash. Among the publicly-owned trees in the City, 8% (1,034 trees) are ash and thus susceptible to EAB. Treatment options exist but can be costly. However, without treatment, the mortality rate of ash trees is 100%. Management options are provided in the recommendations.

Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting. The entire canopy may die back, or symptoms may be restricted to certain branches. The loss of water and nutrients from the intense larvae tunneling can cause trees to lose between 30% and 50% of their canopies during the first year of infestation. Trees can die within two years following infestation.

Once an ash tree is infested with EAB, the branches become incredibly weak which can lead to severe limb defects from wind events or from snow loading. This can lead to a large increase in debris in less severe storms that normally wouldn't create a large problem. Eventually, if left untreated and the infestation becomes worse, whole tree failure is possible from these storm events.

The Ash genra makes up 8% of the trees in Somerville's city-wide tree inventory, including 174 white ash and 860 green ash trees. Of these 1,034 ash trees, 337 are rated "Good", 614 are rated "Fair", 75 are rated "Poor", and 8 are rated "Dead". Seven of the trees were noted to have possible physical signs of EAB present at the time of inspection in 2017. There are likely even more ash trees in the City that were not included in the inventory, particularly ash trees located on private property. With the ongoing threat of emerald ash borer, these trees deserve additional attention.

Asian Longhorned Beetle (ALB)

Asian longhorned beetle (*Anoplophora glabripennis*, or ALB) is a serious threat to a large number of America's hardwood tree species. Like EAB, this invasive pest arrived from Asia within the last few decades. However, unlike EAB, ALB targets many common species (maple, birch, horsechestnut, poplar, willow, elm, and ash) and is, for the most part, untreatable. Over 40% of the publicly owned trees in Somerville are

subject to ALB infestation (*Section 3.3: Invasive Insect and Disease Management Strategy*).

The management of ALB is under state and federal regulations. Because it is untreatable, when ALB is found, the USDA institutes an immediate removal of all host trees and a strict quarantine to stop the spread of this devastating pest. Proper identification and destruction of host trees is the only acceptable control practice. Eradication is possible, but the impact of the process can be devastating to a community. First found in Brooklyn in 1996, ALB has since been detected in Worcester, Massachusetts, southwest Ohio, and Central Long Island. The most important thing in controlling ALB is early detection, which requires vigilant monitoring.

Other Diseases and Pests

Aside from EAB and ALB there are other diseases and pest issues that can affect trees in Somerville. Refer to *Section 3.3: Invasive Insect and Disease Management Strategy* for details. Species less susceptible to certain pests have been incorporated into the recommended tree species list in *Appendix D*. In addition, *Section 4.2: Funding Analysis* provides budget recommendations for plant health monitoring and care.

Suggested Operations and Protocols

Recommended Reponses

When a storm event causes damage to publicly owned trees, Somerville must act quickly to eliminate hazards, remove tree debris, and restore access to the city's roadways, so operations can resume. Somerville's cleanup priorities are: 1) site safety; 2) providing access and ensuring operations as a community resume; and 3) systematically restoring trees. Table 3.10 lists Somerville's woody debris cleanup priorities.

Table 3.10. Prioritized Urban Forest Emergency Responses

Priority	Urban Forest Emergency Situation
1	Trees down, injured people caught in a car or home
2	Branches on power lines (report to proper utility)
3	Trees down blocking street based on priority list
4	Trees split or hanging, which have a high probability of falling, causing personal injury or property damage.
5	Trees or branches that have fallen and are blocking sidewalks or community path
6	Public trees that have fallen and are at rest on buildings
7	Trees or branches that have fallen and are blocking driveways

8	Trees or branches that have fallen and are at rest in publicly owned lawns or tree lawns, and other areas of public parks and public properties.

Storm Emergency Categories in the Urban Forest

Storm severity and resulting damage in the urban forest will vary; the degrees of response and resources need to respond will vary as well. For planning purposes, severe weather can generally be classified into three classes: Class I, II, and III. The following descriptions of these classes and the response required by the City Somerville are offered for consideration and adoption as part of an official city-wide emergency response plan.

Class I – Minor Storm Event

Class I storms are those that are moderate in severity city-wide and/or those which are more severe, but for which damage is restricted to very few locations or a small geographic area of Somerville.

Damage reports and service requests are made directly by residents and from staff inspections. Damage is corrected, and debris is disposed of by Somerville Department of Public Works (DPW) staff and contractors on site or following customary procedures.

Generally, storm damage remediation and clean-up for Class I storms can be achieved by Somerville DPW staff (Tree Crew and Buildings and Grounds) and/or contractors, requires no additional funding or special equipment, and is completed quickly.

Class I – Storm Mitigation Procedures

- Somerville DPW staff receives calls/reports from residents and other Somerville agencies.
- Somerville DPW staff inspects damages and determines appropriate mitigation; utility companies are called as required.
- Somerville DPW staff and/or contractors immediately resolve damage and dispose of debris.
- Somerville DPW staff performs a final inspection, completes work order(s) and/or otherwise notes the occurrence of tree damage in the tree inventory database, with support from Public Space and Urban Forestry (PSUF) staff.

Class II – Large Storm Event

Class II storms are those that are long in duration or are severe enough to cause widespread damage throughout the city. Damage mitigation may also include trees on private property that fall into or threaten the public right-of-way or other property. Mitigation priority areas will be major roads, public health and services facilities, and areas or sites where public safety is at risk.

Recovery from Class II storms requires assistance beyond the normal staff and resources. Damage mitigation for these storms will usually require the assistance of outside

contractors and other Somerville departments. The assistance will come in the form of additional staff and equipment, communication assistance, public safety measures, electrical hazard reduction, and customer service.

Class II Storm Mitigation Procedures

- Somerville DPW staff assesses damage and immediately communicates with police and fire to determine the extent of the damage.
- An informal Emergency Operations Center (EOC) should be convened to receive calls/reports and to coordinate mitigation response.
- Somerville DPW staff inspects damage, determines mitigation levels and needs, and sets work priorities.
- Under the guidance of the EOC leader, personnel and equipment resources are designated to the various tasks.
- Somerville DPW staff and contractors resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Somerville DPW staff, with support from PSUF, makes final inspections and updates the tree inventory database.
- Debris is processed appropriately.
- Somerville DPW staff, with support of Communications and PSUF staff, communicates with the residents about its response activities and status using the Somerville's website, social media platforms, etc.

Class III – Catastrophic Storm Event

Class III storms will be rare but can and have occurred in Middlesex County. Generally, these will result from hurricanes and widespread ice storms. Damage will be severe and widespread on both public and private property.

A "State of Emergency" will likely be called during and after a Class III storm event. A full EOC should be convened by the mayor. Other local, state, and federal emergency management agencies will be involved, as well as Eversource, National Grid, and other controlling utility companies. It may become necessary to identify additional funds that can be used to finance additional contractual services, equipment, and staff overtime for the mitigation efforts.

Mitigation priorities will be first determined by public safety, health, and welfare needs. The first priority of roads to be cleared are those primary streets and highways that provide evacuation routes and/or access to hospitals, shelters, police, fire and rescue stations, and other facilities providing vital public services. Mitigation priorities along roadways in Somerville are shown in Table 3.11.

Table 3.11. Prioritized Mitigation Priorities along Roadways in Somerville

Priority	Streets
1	Main roads, cross-town streets, bus routes and the "hospital hills"
2	The eleven (11) City squares including traffic islands
3	Side streets

Emergency road-clearing takes precedence over removal of debris. At a minimum, debris is to be moved to the side of the roadway that will allow for emergency traffic in each direction and not create conflict with future utility restoration efforts by others.

Class III Storm Mitigation Procedures

- Somerville staff assesses damage and immediately communicates with the EOC and the designated Somerville DPW staff leader to determine the extent of the damage. Other Emergency Management agencies may also be in the communication channels.
- Somerville may secure additional regional tree debris disposal site(s) as needed.
- Somerville DPW staff inspects tree-related damage, determines mitigation levels and needs, and sets work priorities.
- Somerville DPW, allied agencies, and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Somerville DPW staff, with support from PSUF staff, makes final inspections and updates the tree inventory database.
- Debris is processed appropriately.
- Somerville staff assists EOC team members and Mayor with completion of required state and FEMA forms.
- Somerville DPW staff, with support of Communications and PSUF staff, communicates with the residents about its response activities and status, and provides advice for the treatment of private trees that have been damaged using the Somerville's website, social media platforms, etc.

Working with External Contractors

Prior to any storm event, it is important for Somerville to setup contracts and agreements for any work that may be needed after a storm event. Those agreements should be scalable to each individual storm event. Both internal and external crews must be flexible in their work activities and must have the equipment and training to be able to perform the necessary work.

Recommendations:

- Establish pre-qualifications for contractors as prerequisites to working for the City during storm emergencies.
- Grow and foster relationships with contractors, arborists, utility companies, and others to support operations.
- Determine internal and external staff and equipment needs for the different storm emergency categories. For example:
    - Define operational needs for each Storm Class Level. Considerations include:
        - Staffing and equipment needs, including skills and numbers.
        - The amount and types of tools and personal protection equipment (PPE) needed.
        - A competent field supervisor and customer contact person(s) acceptable to the organization. Provide the contact information and contact method.
    - Ensure all applicable industry standard training is current, including:
        - Current OSHA safety and other training, including annual refreshers.
        - Current tree rescue and climbing certification.
        - Current first aid and CPR training.
    - Define a standard for workday (time of day and duration) and response time expectations.

Mutual Aid Agreement

Mutual Aid Agreements (MAAs), as defined by FEMA, are agreements between agencies, organizations, and jurisdictions that provide a mechanism to quickly obtain emergency assistance in the form of personnel, equipment, materials, and other associated services. The objective of an MAA is to allow for the rapid, short-term deployment of emergency assistance before, during, and after a storm event. A signed contract does not require assistance to be provided or received, but rather offers a tool for use in the event that the event dictates a need. These contracts are critical to managing large-scale storm events successfully. It is not ideal to have an MAA with nearby towns. If a natural disaster hits Somerville, it is likely to affect the surrounding area. Taking this into account it would be beneficial to look outside the immediate region to solicit a MAA.

Recommendations:

- Understand the emergency response capabilities of the surrounding communities.
- Identify additional resources that could be used in a worst-case scenario to offset any potential issues with response of contractors.

- Develop relationships with professional groups within the industry such as the Massachusetts Arborists Association and International Society of Arboriculture to lend assistance.

Suggested MAA Components include:

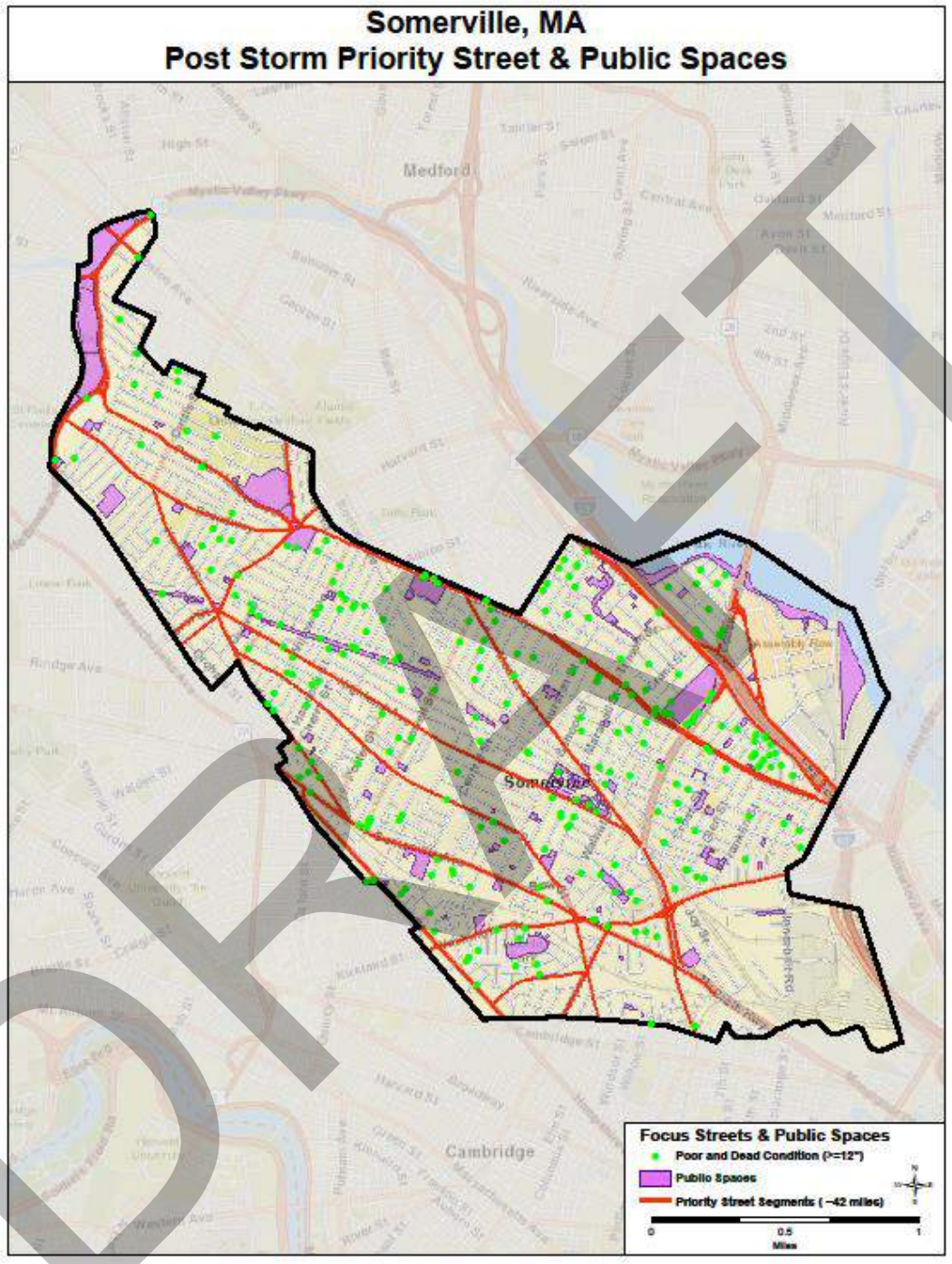
- Service and equipment types.
- Chain of command for activating the agreement.
- Communication procedures.
- Appropriate training requirement(s).
- Certifications and qualifications required.
- Insurance and indemnification requirements.

Current Resources

During and after a storm emergency and depending on the severity of the storm and the damage sustained, Somerville calls upon Highway Division (Tree Crew), Buildings and Grounds, and other DPW maintenance employees to address the community's needs. The Somerville Water & Sewer Department is staffed and equipped to address water infrastructure damage. The electric provider, Eversource, would be contacted for electric power issues, and National Grid and Eversource would be contacted for any gas line issues. Contractors are also used to supplement Somerville staff when needed and available. City staff has trucks and equipment available to manage and mitigate tree-related storm damage.

Woody vegetation debris is transported to the Somerville's City Yard 2 for temporary storage and final processing. This area has large paved areas, easy access for vehicles and heavy equipment, and is conveniently located for staff and contractors. Chippers and a tub grinder that processes wood and brush into mulch could be acquired to assist in the debris processing post storm event.

Below is a map of Somerville illustrating the functional street hierarchy and priority public spaces that can be utilized to prioritize Somerville's post storm efforts (Map 3.7).



Map 3.7. Somerville Priority Street and Public Spaces Map

Partners

Storm response and mitigation in Somerville, especially after severe events, will require the resources and expertise of a variety of external partners. Multiple partnerships are a necessity in storm response given the variety of legal, jurisdictional, and operational missions even within a municipal boundary. Partnerships can result in an effective and efficient response when the expertise and resources of each possible partner is acknowledged and properly utilized.

The following is a brief description of Somerville's major partners in a storm emergency and during recovery efforts.

1. **Utility Agencies**
   Electric distribution lines in Somerville are controlled by Eversource, who is a key partner during a storm emergency. Only Electrical Hazards Awareness Program (EHAP) trained staff are qualified to work around energized lines. They have the resources to mobilize quickly and respond appropriately to emergency situations involving trees and utilities. During a widespread storm event, Somerville will likely also need to communicate and coordinate with the Massachusetts Department of Public Utilities. Where whole trees or limbs are down or resting on energized lines, rescue and clean-up efforts cannot proceed until power lines have been addressed by the trained personnel of these agencies. Prioritization of where utility agencies respond first generally is: three-phase aerial electric lines; single-phase aerial electric lines; secondary electric lines; and then service (or residential) drops.

2. **Massachusetts Department of Transportation (MassDOT)**
   MassDOT is responsible for the safety and maintenance of interstate and state routes within and around the City of Somerville. During a storm emergency, they can respond with staff and equipment to clear such rights-of-way and assist with Somerville streets if authorized.

3. **Contractors**
   Labor and equipment for debris clearance, removal, and disposal should be available from local contractors. It is advisable to have contractors, such as tree service companies, debris processing companies, and equipment and tool rentals, already under contractual agreements with Somerville. During an emergency, Somerville could enter into new emergency contracts and modify existing contracts to supply the personnel and equipment necessary to efficiently deal with storm mitigation efforts.

4. **State of Massachusetts**
   When the response efforts appear to be beyond the capability of Somerville or the county, the State can normally provide the next level of assistance by declaring a state of emergency. The Massachusetts Department of Energy Resources (DOER) and Massachusetts Emergency Management Agency (MEMA) aids local emergency response leaders during major or complex emergencies or disasters. Both DOER and MEMA assist local jurisdictions with recovery from natural or man-made disasters, in addition to coordinating mitigation programs designed to reduce the impact of future disasters on a community. Additionally, they will typically evaluate the disaster

situation and provide advice to the governor on the availability of state resources to assist local efforts.

The Massachusetts Homeland Security Division's website, https://www.mass.gov/homeland-security-initiatives, offers a toolbox of information to assist with the process of requesting aid and making claims for reimbursement through a State-Share Grant Program.

5. **Federal Government**

The U.S. Army Corps of Engineers may be able to respond to a storm event for up to 10 days without a Presidential Declaration; the Federal Highway Administration may provide grant assistance to Massachusetts for debris clearing, tree removal, and repair of roads; and the Federal Emergency Management Agency (FEMA) provides financial and administrative assistance after storms that are declared a federal emergency.

FEMA is the major federal agency that will be a partner of Somerville in the event of a severe storm emergency. FEMA recommends that communities have an *Emergency Operation Plan* and, since debris removal is reported as the most significant storm-related problem, a *Debris Management Plan.*

FEMA will reimburse Somerville for debris removal costs if a federal disaster is declared. FEMA will also reimburse Somerville for removing certain trees during a federal disaster. Trees which sustain greater than 50% crown loss and are on the public right-of-way are eligible for removal cost reimbursement. However, trees that are completely on the ground after a storm and can be moved away with other debris are usually included in the debris estimates. FEMA often does not cover stump removal unless a hazard situation is present.

Finally, FEMA will also reimburse Somerville for hazard reduction pruning immediately following a storm during a federal disaster. In general, broken or hanging branches that are 2 inches or greater in diameter and that are still in the crown of a tree can be pruned under the hazard reduction reimbursement policy. The pruning cost is not extended to the entire tree but is limited only to the removal of branches contributing directly to the hazard.

Final reimbursement of storm-related damages from FEMA is dependent on accurate record keeping and documentation of storm-related cleanup work.

Funding and Budget for Urban Forest Emergencies

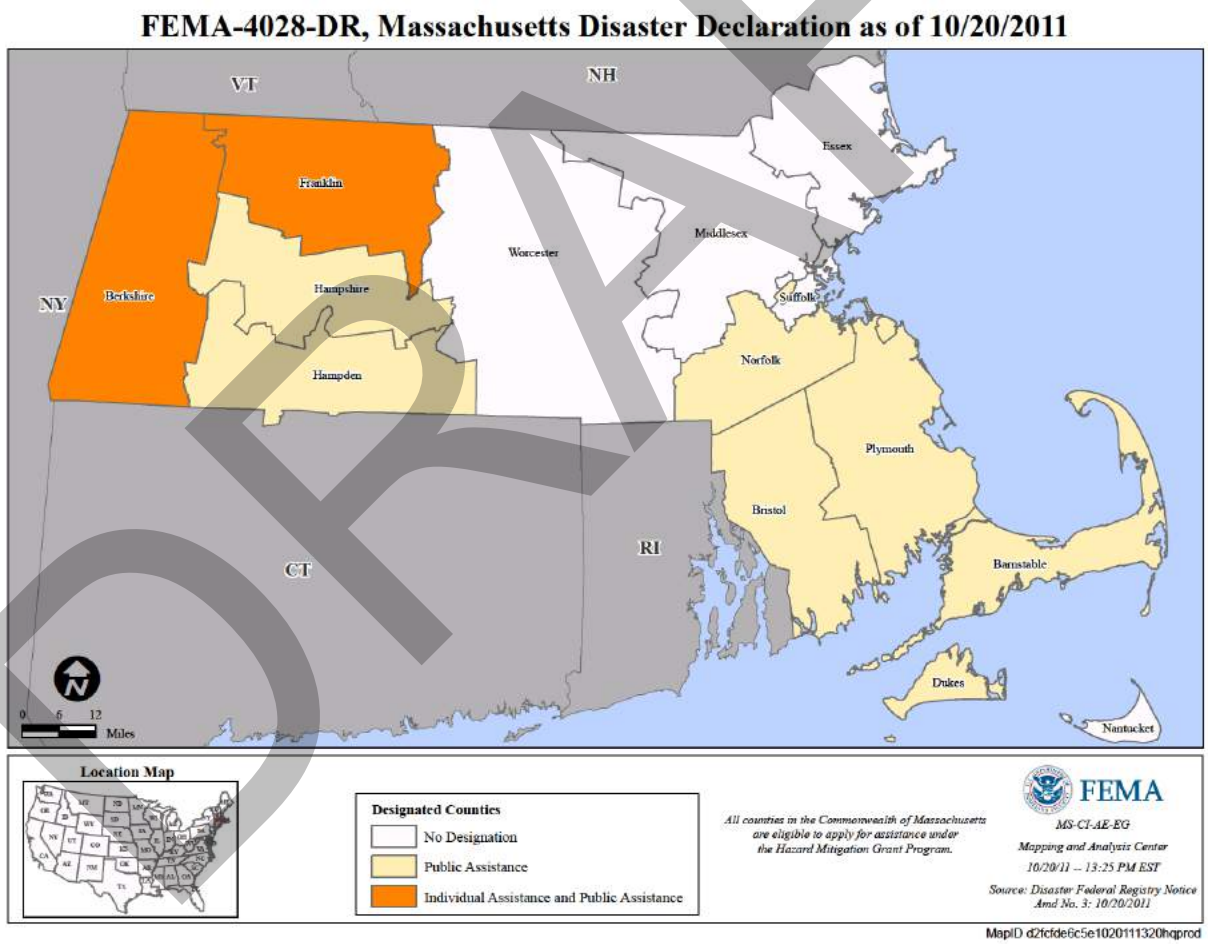
Storm and emergency response will require funding for staff overtime, contractual services, and equipment rental. Somerville is strongly encouraged to analyze past storm events (hurricanes) and provide for sufficient regular funding and contingency funding to support an adequate response for various levels of storm damage.

As mentioned previously, removal of debris from public property is eligible for reimbursement from FEMA under most cases when a federal disaster has been declared and when it constitutes an immediate threat to life, public safety, or property. This includes the removal of tree debris (downed limbs, trees) and the pruning or removal of trees to remove imminent hazards (hanging limbs or trees so damaged that they are

structurally unstable). The removal of any tree debris located on public rights-of-way is eligible for reimbursement, including material that originated on private property and has been dragged to the right-of-way by residents during a specified period.

In order to receive FEMA funding, it is critical to be prepared and fully document all losses and money spent. Most damage assessments through FEMA must be done immediately after the disaster event. The calculated dollar amount is then sent to the Emergency Management Director. FEMA has a public assistance program that is open to municipal departments and non-profit hospitals. These grants can be applied for to assist with a variety damages, including debris removal and emergency protective measures.

Historically, FEMA funding for storm damage mitigation reimbursements has been made available in Massachusetts. For example, over $30.4 million in public assistance grants on 695 individual applications were provided in the state (including adjacent Suffolk County) after a weakened hurricane Irene hit Massachusetts in August 2011 (see Map 3.8).



Map 3.8. Massachusetts Tropical Storm Irene (DR-4028) Public Disaster Declaration Areas; source: https://www.fema.gov/disaster/4028

FEMA Funding Programs

Following is a summary of key federal disaster aid programs that were offered by FEMA and administered by the state when under a presidential disaster declaration:

- Payment of no less than 75% of the eligible costs for emergency protective measures taken to save lives and protect property and public health. Emergency protective measures assistance is available to state and eligible local governments on a cost-sharing basis (Source: FEMA funded; state administered).
- Payment of no less than 75% of the eligible costs for repairing or replacing damaged public facilities, such as roads, bridges, utilities, buildings, schools, recreational areas and similar publicly owned property, as well as certain private non-profit organizations engaged in community service activities (Source: FEMA funded, state administered).
- Payment of no less than 75% for snow assistance, for a specific period of time during or proximate to the incident period. Snow Assistance may include snow removal, de-icing, salting, snow dumps, and sanding of roads (Source: FEMA funded, state administered).
- Payment of no more than 75% of the approved costs for hazard mitigation projects undertaken by state and local governments to prevent or reduce long-term risk to life and property from natural or technological disasters (Source: FEMA funded; state administered).

Training

Somerville staff should receive safety and technical training through in-the-field and classroom methods. To ensure safe and effective work, staff should receive regular and updated training sessions for first-aid, CPR, chainsaw use, tree risk assessment, and minimum approach distances for energized electric lines. These topics should be considered as basic minimum training opportunities.

Additional training should be provided to key personnel in topics that include electric hazard assessment (EHAP), aerial lift training, advanced climbing, crane operations, and aerial rescue. Consider having key staff members receive training to become ISA Certified Arborists. Develop annual “scenario training” with tree emergency response topics and situations.

Types of training and certifications:

- Safe work practices.
- Applicable OSHA regulations.
- ANSI standards.
- Incident Command Systems.
- First Aid and CPR.
- Tree risk assessments.
- Electrical hazard awareness.

- Tree pruning and felling practices during emergency conditions.
- Communications.
- Storm recognition and mitigation.
- Storm restoration practices.

Conduct Periodic Drills.

- Invite stakeholders and key individuals.
- Bring experts in to assist with training and practice if needed.

Emergency Response Public Relations

It will be essential to identify an individual to serve as a Safety Officer in preparation of an emergency to act as point person for effective and uniform communication. This person will help ensure compliance of contractors to the applicable OSHA Regulations, ANSI Standards and BMPs. Throughout the preparation and implementation phases of the plan the Safety Officer would work in cooperation with Somerville's Tree Warden and Urban Forestry staff, as well as the local Eversource utility arborist. Additionally, the Safety Officer would be responsible for identifying and training the staff needed for the process logistics.

Communication is critical to surviving disasters, especially when dealing with the public and those who have been impacted by the storm event. If information is not actively managed during tree emergencies, disorganization will complicate recovery work. Public relations should be coordinated through the Safety Officer/EOC or the mayor's office. Important aspects of storm response communication are as follows:

Communication

- Creating public safety announcements about:
  - Threats from downed conductors.
  - Non-local crews who are travelling in convoys.
  - Blind spots created by heavy equipment.
  - Traffic issues involving traffic lights, work zones, downed limbs and trees.
- Develop avenues for communication – web, television, radio and text alerts.
  - Determine threshold as to when to notify.
  - Develop a short, concise statement to be modified per the severity of the incident.
- Develop an alternate communications plan that works when large power outages shut down electronic networks.

Recommendations for General Public Relations

- Publicize the phone numbers and staff person/position for public contact.
- Work with the media early and often.
  - Take time to get accurate information out.

  - Be frank about the extent of damage and the estimated time needed for recovery.
  - Publicize your next actions and decisions. People get most upset when they do not know what is going to happen or when.

- Deliver important messages to the community.
  - "Stay safe" – watch for hangers, leaning trees, downed wires, chainsaw injuries, etc.
  - "Stay calm" – it may not be a bad as it seems, help is on the way, panic results in poor decision making.
  - "Get help from arborists who are insured, and preferably Certified Arborists."
  - "Think critically when deciding to remove a tree or not—as long as no hazard is present."
- Indicate how the public can help.
  - Placing debris at the curbside properly.
  - Keeping debris away from fire hydrants and valves.
  - Separating recyclable and flammable materials.
- Emphasize the need for careful professional damage assessment.
  - People often feel deeply about trees after a disaster, wanting either to "kill" or "save" them all, and they need to hear voices of reason from Somerville officials.
  - Trees can recover from substantial damage. Sometimes "unrecoverable" trees at first glance may be judged as much less serious by an experienced professional arborist.

Summary and Recommendations

With this Storm Preparedness plan, and other urban forest management resources available to Somerville, such as the tree inventory and the rest of this Urban Forest Management Plan, the City of Somerville is fairly well prepared to handle the severe weather events that inevitably will impact Somerville's trees. With only minor adjustments in its approach to storm response, Somerville should be able to manage future events and be better prepared to seek reimbursement for the large expenses that sometimes accompany large storm events.

Recommendations for improving storm response and recovery program and actions:

- Be sure all staff are signed up for the Emergency Alert System through www.mass.gov/alerts.

- Continue to update Somerville's street and park tree inventories. Current data will provide much needed information that can be used to maintain the urban forest and help to reduce future storm damage.
- Address High Risk trees and EAB-infested trees promptly to remove them from the population to reduce preventable damage.
- Remove Low Risk but storm prone species from the population when their service lives are over and replace with more resilient species (Tables 3.8 and 3.9).
- Practicing proper pruning techniques, eliminating codominant stems, and keeping trees as healthy as possible, all helps in the creation of a more wind resistant urban forest. This is an important facet of the Young Tree Training Program (see *Young Tree Training* in *Section 3.3 Tree Maintenance Program*).
- Utilize Homeland Security office to provide quick notification to Massachusetts Homeland Security Division and FEMA if reimbursement from disaster funds is anticipated. Develop a clear system of record keeping that will provide required information so that reimbursement is achieved where allowed. This step can save Somerville several thousands of dollars in costs for cleanup of storm debris from future storm events.
- Complete the Tree Emergency Plan Worksheet (*Appendix H*) and distribute appropriately. Review the Worksheet annually and update information as needed.
- Communicate to all appropriate Somerville staff and partners the procedures for prioritizing and managing urban forest damage after storms per the three storm categories.
- Provide staff training, particularly on tree risk and working with potential electrical hazards.
- Commit to providing residents with timely messaging about Somerville's response and recovery activities and about tree damage and correction topics. Prepare public relations materials ahead of time so that they are easily accessible when the storm strikes.

Partner Information

Department of Massachusetts Homeland Security and Emergency Services

https://www.mass.gov/homeland-security-initiatives

Disaster Relief Grants

https://www.grantwatch.com/cat/48/disaster-relief-grants.html

FEMA Disaster Management Toolkit - Debris Management Guide

https://www.fema.gov/pdf/government/grant/pa/demagde.pdf

Emergency Management Director (EMD)

https://www.mass.gov/find-your-local-emergency-management-director-emd

Massachusetts Department of Energy Resources (DOER)

https://www.mass.gov/orgs/massachusetts-department-of-energy-resources

Massachusetts Department of Public Utilities

https://www.mass.gov/orgs/department-of-public-utilities

Massachusetts State Emergency Response Commission (SERC)

https://www.mass.gov/service-details/massachusetts-state-emergency-response-commission-serc

Massachusetts State Park Police

https://www.mass.gov/orgs/massachusetts-state-police

The Massachusetts Emergency Management Agency (MEMA)

https://www.mass.gov/orgs/massachusetts-emergency-management-agency

Ready.gov – Citizen Emergency Readiness Campaign

https://www.ready.gov/

United Way Disaster Relief

https://www.unitedway.org/recovery

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4.1 OPERATIONS REVIEW

Introduction

The City of Somerville is responsible for the management of an urban forest comprised of approximately 11,484 City-owned trees growing along streets and in City-owned open space. The urban forest is a valuable community asset providing over $1 million in benefits annually to Somerville; and is the only city infrastructure that both appreciates in value over time and provides a positive return on investment for public funds allocated to its care. The City of Somerville is fortunate to have a significant tree canopy, a healthy street tree population, a tree ordinance, knowledgeable City staff and contractual resources to perform tree planting and tree care work when needed. Despite these assets, the City's forestry program does not operate as proactively as it should, and is underfunded and understaffed for the projected workload and recommended program responsibilities outlined in the *Section 3.2: Tree Maintenance Program.*

To maximize the benefits of the urban forest, and minimize its risk, it is important for Somerville to appropriately manage, maintain and allocate resources to its care.

This Operations Review evaluates the efficacy and appropriateness of Somerville's present urban forestry management practices. This review also aims to determine if there are sufficient resources allocated and available to maintain a safe, viable, and sustainable urban forest. The review provides goals, guidelines, and new strategies that can help standardize and optimize the management of Somerville's urban forestry program and arboricultural practices.

Scope & Goals

The goals of this Operations Review are to provide a better understanding of the existing care of Somerville's trees, highlight the strengths of the program overall, and to identify challenges/areas for improvement.

The 2018 tree inventory and *Section 3.2: Tree Maintenance Program* provide the City with an understanding of the current state of the urban forest and the workload necessary to maintain and enhance it over the next seven years. According to the tree inventory, the City of Somerville has approximately 11,484 City-owned trees, with 88% of them requiring some level of routine pruning (including young tree training) and approximately 801 currently available planting spaces. Accomplishing the recommended 7-year work plan outlined in the *Tree Maintenance P*rogram and continuing the proactive response to the invasive emerald ash borer (EAB) will require an average of $600,000 per year in funding over the next 7 years.

The information presented in this Operations Review was compiled from a review of the City's organizational structure, budgets, staffing levels and types, regulatory documents, and other urban forestry program information, followed by interviews with key staff. Urban forestry operations and management practices were then evaluated as they relate to staffing levels, equipment resources, and budgets, with the aim of identifying specific options for improving the efficiency and effectiveness of work.

This Operations Review presents recommendations to improve the efficiency and effectiveness of Somerville's urban forestry program. In particular, the review focuses on how to leverage existing and future resources to implement the recommendations of *Section 3.2: Tree Maintenance Program* (Table 4.1), specifically with regards to risk and liability reduction and creating a proactive maintenance program.

Table 1. Major Goals of Somerville's Tree Maintenance Program (Section 3.2)

General Urban Forest Goals	Street Tree Management Plan Goals
Minimize risk and liability related to public trees	Perform all priority tree removal and pruning work in the next 2 years
Protect trees and preserve their role in defining the City's character	Establish a preventive Routine Pruning cycle of at least 6 years
Develop a proactive management regime for public trees	Establish a Young Tree Training cycle of 3 years
Ensure tree benefits for future generations through a sustainable planting program	Plant at least 350 trees each year

Summary of Operational Strengths and Challenges/Areas for Improvement

The **operational strengths** of Somerville's current urban forestry program:

1. There is strong support for a safe and sustainable urban forest among city staff, residents, and public officials.
2. The Public Space and Urban Forestry (PSUF) division staff are highly knowledgeable, capable, and responsive to the needs of the residents and elected officials. Their high level of training, as well as familiarity with current City plans such as the Climate Forward Plan, the Open Space and Recreation Plan, the Capital Improvement Plan and others, allows them to integrate tree work into other City work and plan for trees in the future. PSUF staff use data and specialty software to support current work and proactive management.
3. The DPW Tree Department staff work hard to keep the city's residents safe, and is highly responsive to emergency work needs. The DPW crews and contractors perform tree removal, pruning, and stump grinding at a production level and a response time which has resulted in very few trees requiring high priority maintenance in the public rights-of-way as well as park land.
4. The Somerville 311 Service Center gives the public the ability to notify the City about tree work needs (service requests), and also allows the City to notify residents when a work order to address their request is undertaken and completed. The system also provides data on how quickly these work orders are completed and what the work tasks are.
5. In order to assure that work is performed correctly, the City uses specifications based on national arboricultural standards and best management practices in its contractual tree planting and maintenance services.

The operational challenges/areas for improvement in the current urban forestry program:

1. The City does not currently have a proactive tree maintenance program. Tree maintenance activities are completed on a reactive basis (request driven) due to insufficient staff and funding. Reactive management without proactive management can adversely affect the health and

condition of the urban forest and lead to residents that are dissatisfied with the care the City provides to the public trees.

2. Current funding levels are not sufficient to provide adequate staff, equipment and contractual services to execute a proactive preventive maintenance program as described in *Section 3.2: Tree Maintenance Program* and meet other program needs.
3. Although the type, condition and age of the City's forestry equipment is generally adequate for the current urban forest maintenance work being performed, it is not adequate for carrying out additional maintenance needs.
4. Data entered into the City's 311 system is occasionally incorrect/inaccurate. Data entry issues range from incorrect address of a location to improperly closing work orders.
5. Tree Department crew dispatch and deployment is not systematic leading to inefficiencies and loss in productivity.
6. The urban forestry program is overseen and managed by two divisions under two different departments. The challenge with this arrangement is that miscommunications can occur between the departments/divisions which can lead to inefficient, ineffective, or duplicative services.
7. Staff training and professional development opportunities are not formalized or required on a regular basis.

Overview of Recommendations

The operations review resulted in a variety of recommendations that vary by the effort of implementation and the level of funding required. The following recommendations can be implemented in the near term, with modest financial investment, to increase tree maintenance and planting activities and provide better service to the residents of Somerville:

- Provide regular and formal safety, equipment use, and arboricultural training to City staff performing urban forest management tasks.
- Develop standard operating procedures for inputting records and information in the 311 system.
- Train and require tree crews to use tablets (or similar mobile technology) to efficiently map out their day and access the 311 system and the tree inventory in the field.
- Continue to establish a formal communication, coordination and collaboration process between PSUF and DPW Tree Crew staff and managers.
- Discuss and coordinate quarterly or annual work plans with Eversource and other utility companies to discover efficiencies and mutually beneficial projects.
- Create formal tree protection standards to be used in all construction projects.
- Explore creating relationships with key non-profit partners to obtain funding for tree planting and young tree care.
- Begin an urban forestry internship program, or fund part-time contractual technical staff to assist the City with tree inventory data management/entry, outreach efforts, planting inspections, and minor tree maintenance tasks.

Operations Review and Discussion

The focus of the analysis was to identify the strengths of the program and determine whether there are any large operational gaps or challenges that could potentially interfere with the implementation of the recommendations in *Section 3.2: Tree Maintenance Program.* The review and analysis of Somerville's urban forestry program operations is based upon many sources of information, including staff interviews, City plans and policies, GIS and tree inventory data, and national industry standards and best management practices.

Urban Forestry Organizational Structure

Somerville's urban forest is overseen and managed by two divisions: Public Space and Urban Forestry (PSUF) and the Department of Public Works (DPW) Highway Division's Tree Crew.

- **Public Space and Urban Forestry** (**PSUF**) is a division of the Mayor's Office of Strategic Planning and Community Development (OSPCD) and is the planning arm of the urban forestry program. PSUF is responsible for design and management of the public realm, including protecting and preserving existing trees, planting new trees, communicating with city residents, and planning for the future. There are presently two full time "Urban Forester & Landscape Planner" positions dedicated to Somerville's tree program. PSUF staff are located in City Hall (93 Highland Avenue).

- **DPW Tree Crew** is a crew within the Highway Division within the Department of Public Works (DPW) and is responsible for the day-to-day field operations related to the urban forest, including pruning trees, performing tree removals, grinding stumps, picking up downed limbs, and responding to tree damage from storms. There are presently 3 full time DPW employees dedicated to tree operations. The DPW Tree Department staff at located in the DPW building (1 Franey Road).

Both DPW Tree Crew and PSUF staff conduct tree inspections based on requests by residents and other city departments, as well as self-directed assessments.

Personnel & Productivity

Currently the DPW Tree Crew has three (3) full-time staff dedicated to tree maintenance. They are available to perform other civic duties as needed or in an emergency, but their primary job responsibilities center on urban forest maintenance tasks. These positions require a hoisting license and a Commercial Driver's License (CDL); however, arboricultural certification or experience is not required, although it is preferred. Presently, no one on the crew has arboricultural certification although some of them have many years of on-the-job experience. The DPW's Highway Foreman and Superintendent of Highways instruct the tree crew on their daily work assignments and manage some of the maintenance contracts, with some advice from the PSUF Urban Foresters at City Hall, or based on 311 requests. The Superintendent of Highways is also the City's Tree Warden, who has formal, state-designated authority to protect the City's public shade trees per Massachusetts General Laws Chapter 87. This staff is supported by DPW's Administrative staff, including clerical staff that monitor, print, and forward 311 requests to Tree Crew Management. Once work orders are completed, clerical staff also close out 311 requests.

PSUF has two (2) full-time staff members who oversee tree planting and maintenance, keep track of data, staff the Urban Forest Committee and Conservation Commission, ensure compliance with the Tree Preservation Ordinance, and interact with constituents and elected officials. These positions, the

Senior Urban Forester and Landscape Planner and the Urban Forester and Landscape Planner, are relatively new positions, both created within the past 5 years. Staff in these professional urban forester positions have arboricultural certifications (i.e. Massachusetts Certified Arborist (MCA), International Society of Arboriculture Certified Arborists, etc.), but do not perform tree removal or pruning work. Both urban foresters have been designated as Deputy Tree Wardens. These urban foresters support the urban forestry management program by managing contracts related to tree planting, young tree training, and parks tree health, performing planting site reviews and planting oversight, guiding interdepartmental cooperation and partner relations, issuing permits, attending and leading community meetings, designing and supporting special events, and carrying out other administrative duties as needed.

Tree care contractors perform most of the maintenance work for trees that have branches in powerlines, as City staff do not have certifications to work around utility wires. Depending on the workload, tree care contractors are sometimes hired to assist with tree pruning and the removal of dead and dangerous trees. The City also uses a consulting arborist to help with tree assessments and appraisals. This consulting arborist works in the City an average of one day per month. The DPW's Superintendent of Highways manages the contracts for on-call tree maintenance and for the consulting arborist.

In addition, almost all tree planting in the City is performed by contractors. The PSUF urban foresters manage these planting contracts, which includes all tree planting activities as well as tree watering and maintenance during a two-year establishment period. The urban foresters also manage the newly established (2019) Parks Tree Health and Young Tree Training contracts.

The challenge with the division of the Urban Forestry staff between two departments is miscommunications can occur between the departments/divisions which can lead to inefficient, ineffective or duplicative services. This can be improved by strengthening the formal communication, coordination and collaboration process between PSUF and DPW Tree Department staff and managers.

The 2014 Urban and Community Forestry Census of Tree Activities[1] reports that the national average of dedicated urban forestry program employees for cities with populations of between 50,000 and 99,999 is 6 full-time and 3 part-time or seasonal workers. As described above, the City of Somerville currently has 5 full-time staff dedicated to urban forestry matters (two urban foresters and three laborers). For the goals and recommendations of *Section 3.2: Tree Maintenance Program* to be achieved, the City's urban forestry program would benefit by having additional crews and technical staff dedicated solely to the program. It is recommended that for each tree crew, at least one staff member be certified in arboriculture or at a minimum has extensive experience in the field. Dedicated and informed staff with clearly defined job responsibilities will provide better and faster responses to resident and interdepartmental requests. Increased responsiveness will reduce public tree risks, elevate the professionalism of the city, and increase the efficiency of the operations.

While the City recognizes the need for additional staff, they have faced challenges in attracting and retaining qualified staff in the DPW Tree Department. The City should evaluate its compensation and training package for DPW Tree Department workers and identify ways to make it more attractive for both recruitment and retention of department employees.

Seasonal and intern positions are an option for addressing program staffing capacity needs. Seasonal/intern positions could be assigned to assist the PSUF urban foresters with inspections, administrative permit reviews, utility coordination/inspections, and public education. They could also be assigned to help with inventory updates, data entry, and reporting, or to assist with the Young Tree Training program. The City of Somerville should explore recruitment options including

[1] Hauer R. J. and Peterson W. D. 2016. Municipal Tree Care and Management in the United States: A 2014 Urban & Community Forestry Census of Tree Activities. Special Publication 16-1, College of Natural Resources, University of Wisconsin – Stevens Point. 71 pp.

Massachusetts technical high schools such as Essex North Shore Agricultural & Technical School, or Norfolk County Agricultural School. These schools train students in arboriculture, teaching them basic climbing and pruning techniques and tree identification. Some students even have CDL licenses by the time they graduate.

Use of Contractors and City Personnel

Cities can use in-house staff and equipment to perform urban forestry tasks, or they can hire contractors who specialize in various arboricultural disciplines and services to do the work. To increase efficiency and lower costs, a combination of in-house personnel and contractors can be used.

The City's current practice of contracting tree crews to assist with tree pruning and removals, and consultants to assist with tree risk management and appraisals is a good approach for supplementing and complementing existing City staff. Using this combination of contracted labor, equipment, and expertise in conjunction with city staff is a viable solution to accomplish the quantity and diversity of work that the management plan outlines in the near future.

The following summary of the advantages and disadvantages of using contracted and in-house staff for urban forestry operations, technical advice, and management has been adapted from the American Public Works Association's *Urban Forestry Best Management Practices for Public Works Managers: Staffing*:

Urban Forestry Operations

In-house Crews and Work Production

Advantages

- Staff can be more knowledgeable about the community and can be motivated by pride and residency.
- Workforce is more stable.
- More flexible for other work assignments.
- May respond more quickly to emergencies.
- More control over training and specializations.
- Quality can be perfected over time through training to meet community standards.
- No administrative time is needed to write and oversee contracts.

Disadvantages

- Large investment in equipment and maintenance per crew or person.
- Workers are paid wages and benefits year-round.
- The city responsible for damage caused by crew actions.
- The city bears the costs for on-the-job injuries and workmen's compensation.
- Administrative time is required for human resources tasks

Contractual Crews and Work Production

Advantages

- Funds are only paid for work performed and when completed to specifications and the satisfaction of the city.
- Labor is available for peak demands and special projects; there is the option of cancellation and there is no cost when work is not needed or when the weather is poor.
- Contractor provides all required equipment, tools, and supplies; repair, maintenance, and downtime of equipment are not the responsibility of the city.

- All insurance and workman's compensation is the responsibility of the contractor.
- Contractor provides employee supervision, training, and certifications.
- Liability for damage to public and private property is the responsibility of the contractor.

Disadvantages

- Contractors are bound by the specifications of the contract; their work assignments are not as flexible.
- May not be as quick to respond to emergencies as in-house crews.
- Contractors still require oversight and management by City staff.
- Administrative time is required for contract writing, monitoring, and invoice processing.

Urban Forestry Technical Advice, Management, and Support

In-House Technical, Management, and Support Staff

Advantages

- If job description and requirements are written correctly, staff can be very knowledgeable and experienced.
- Has strong ties within the community.
- Has or will build "institutional knowledge".
- Is available at a moment's notice to perform a wider variety of tasks.
- Is directly accountable to the citizens and the city.

Disadvantages

- May only be experienced in limited aspects of arboriculture and urban forest management.
- Some investment in equipment must be made, such as a vehicle, computer, and diagnostic tools.
- City must invest time and funding for obtaining and maintaining certifications, licenses, and other training.
- Fringe benefit costs and long-term pension obligations could present cost barriers to staff expansion.

Contracted Technical Support Staff

Advantages

- Usually is very experienced and knowledgeable on a wide array of topics.
- Can provide a high level of knowledge in a specific area, such as hazard tree identification, tree valuation, ordinances and technical specifications, tree preservation.
- Usually is fully equipped with a vehicle, computer, and all other tools/resource needed to perform work.
- All certifications, licensing, and continuing education are already in place and separately provided.
- Contracted personnel do not require long term pension obligations from the city.
- Can be more easily released from service.

Disadvantages

- Contract agreement may limit flexibility in job assignments.
- If used regularly, and for an extended period of time, contract staff can be more expensive in the long term.

- Administrative time must be provided for contract writing, monitoring, and invoice processing.

Whether beginning the routine pruning or young tree training cycle (see *Section 3.2: Tree Maintenance Program*), increasing the number of tree planting projects, or performing public education, Somerville's need for additional staff to support the urban forest management program should be a priority in the next few years. The City should take into account needs and funding levels when deciding whether to hire more in-house staff or outside contractors.

Personnel & Productivity Recommendations

- Hire operational staff with arboricultural certifications or provide incentives for current staff to obtain certifications.
- Evaluate compensation and training package for DPW Tree Crew workers and identify ways to make it more attractive for both recruitment and retention of qualified department employees.
- Strengthen the formal communication, coordination and collaboration process between PSUF and DPW Tree Crew staff and managers.
- Explore hiring part-time/seasonal employees to provide urban forest management support.
- Consider the establishment of an internship program to assist with the urban forestry program as needed; students could come from University of Massachusetts, Tufts University, Essex North Shore Agricultural Technical School, Norfolk County Agricultural School, and/or various vocational schools in the region.
- Assess opportunities to expand the capacity of current staff, or supplement with contractual staff for specific time periods or specific projects.
- Consider combining the PSUF Urban Foresters and the DPW Tree Crew staff into one centralized facility.

Training and Staff Development

Training and staff development are important not only for on-boarding new hires and teaching them about the City's programs and operations, but also for introducing new technical concepts, practical techniques and safety principles to the field staff, and to teach administrative staff about the capabilities of any new computer software system designed for urban forest management tasks.

The City's DPW staff should have a comprehensive, ongoing, and consistent training program. A quality training program is essential for keeping staff safe, efficient in their work, and motivated about learning new skills. Currently, there is no formal arboricultural training program and no defined budget specifically for this purpose.

For staff involved with tree maintenance, planting, and urban forest management, diverse training is needed given the nature of the resource and the unique and potentially highly dangerous working conditions. At a minimum, most urban forest management programs in the country provide training to all forestry employees in these areas:

- Tree identification and basic tree physiology
- ANSI A300 pruning, maintenance, and tree protection standards
- ANSI Z133.1 safety requirements
- Job site set-up, flagging, and safety
- First Aid, CPR
- OSHA compliance
- Electrical Hazards Awareness Program

- Chainsaw safety
- Defensive driving

More advanced training, such as tree protection techniques, insect and disease diagnosis and management, and to obtain arboricultural credentials is recommended to increase the professionalism of the staff and program, and to further ensure safe working conditions and improved tree health.

The City should not only offer more training, but also formalize it. That means creating an annual training schedule for all employees and tracking the training. Documentation of safety training is especially important. Also, greater emphasis should be placed on OSHA requirements due to the associated liability/ financial risks to the City should it not be able to document training post-accident and during incident investigation. Documentation of training for each employee would also help shed light on deficiencies and aid in customizing a training program for that employee's current job description and future career path.

Training for staff involved in urban forest maintenance can be provided by a variety of sources, such as other City employees, the Massachusetts Arborists Association, the Massachusetts Department of Conservation and Recreation, equipment manufacturer representatives, and local and regional professional organizations such as the New England Chapter of the International Society of Arboriculture. Depending on the topic, training can be offered annually, seasonally, at weekly "tailgate" sessions, or as needed.

Training does more than just educate workers. Training supports professional development and job advancement, and positively influences attitudes and morale. By providing a variety of quality training programs on a consistent basis, the city can keep its staff motivated about learning new concepts and performing its work responsibilities in the best, safest, and most effective ways possible.

Training & Staff Development Recommendations

- Provide regular and formal safety, equipment use, and arboricultural training to staff performing urban forest management tasks.
- Consider providing all staff with the opportunity to become Massachusetts Certified Arborists or International Society of Arboriculture (ISA) Certified Arborists as well as ISA Municipal Specialists.
- Somerville should encourage staff to attend at least 1-2 trainings or conferences per year. Such trainings and conferences are offered by the Massachusetts Arborists Association, the Massachusetts Department of Conservation and Recreation, the New England Chapter of the International Society of Arboriculture, and other local and regional professional organizations.

Equipment

The City has a large bucket truck, chippers, and vehicles to perform routine and emergency tree pruning and removal. The City also owns and operates a stump grinder to remove stumps. When equipment needs to be repaired the City uses their central repair garage or contracted vehicle repair and maintenance vendors. Based on the current 3-person crew, the equipment and fleet are generally adequate to perform their assignments, although some equipment is outdated and should be replaced. Moreover, if additional staff and/or seasonal temporary staff are hired, additional vehicles and equipment will need to be purchased or rented. Table 4.2 provides a list of the City's current forestry equipment; the aerial truck and one of the tree chippers are over 10 years old and require replacement, and the stump grinder does not perform adequately according to the crew. Staff has also requested a smaller aerial truck for easier maneuverability around the city.

Table 4.2: List of Equipment Dedicated to Tree Maintenance

Type	Brand	Year	Comments
Tree Chipper	Morbark	2008	Replacement Suggested FY / CIP / 20
Tree Chipper	Morbark	2016	Within life expectancy cycle
Stump Grinder	Morbark	2017	Not adequate. Trade towards HD model.
Forestry / 55' Aerial Truck	International	2007	Replacement Suggested FY / CIP / 20
Pickup Truck	Ford	2019	New CIP-19 Acquisition

To accomplish the work plan outlined in *Section 3.2: Tree Maintenance Program*, any additional or specialty equipment needed may be provided by the contractual tree and landscape crews who will perform the work. The City also has a budget line item to rent necessary equipment if required.

Equipment Recommendations

- Assess fleet age, condition, and usage hours to determine when equipment used for urban forest maintenance and planting will need to be replaced; once identified, begin purchasing process at least one year prior to the projected "aging out" date.
- Consider providing the tree crew with a smaller aerial truck for easier maneuvering around the city.
- Rent or contract for specialty equipment that would not be used often for urban forest management and/or by any other department in the city. Or, consider sharing specialty equipment with other nearby cities.

Use of Technology

The Society of Municipal Arborists reports that 6.5 hours per day (or 80% of the workday) is the standard and average time spent performing assigned tree maintenance work. Somerville's Tree Crew spends up to an hour each day traveling to/from the DPW office and to different work sites throughout the City. Adding in the time for the crew to mobilize on the site, Somerville's crews may average about 5.5 hours per day on tree maintenance activities. Efficiency could be improved by providing tree crews with training and access to tablets or similar mobile technology that contains the 311 system, tree inventory data (i.e. TreeKeeper®) and their daily work assignments. This would allow the crew to more efficiently route their work day and would also allow them to see other work orders (not currently assigned to them) that they may be able to complete while in the area.

Maximizing the Use of TreeKeeper® to Increase Efficiency of Urban Forest Operations

The City uses TreeKeeper® software which makes urban forest data, mapping information, and benefit calculations available instantly to staff and residents alike. For managing its urban forestry program, TreeKeeper® also provides tools and functions that can help the City accomplish its tree maintenance and planting goals and better organize work, increase efficiency, and respond to resident requests. Select staff has received TreeKeeper® training and have access to expert technical support. Maximizing the use of TreeKeeper® should significantly enhance the efficiency and effectiveness of the urban forest management program.

Using i-Tree Tools

The U. S. Forest Service's i-Tree Tools (www.itreetools.org) offer a variety of state-of-the-art, peer-reviewed urban forestry analysis and benefits assessment tools, calculators, and reference materials. All i-Tree resources are free and available to the public. Communities of all sizes use i-Tree Tools to strengthen their urban forest management and advocacy efforts by quantifying the composition of trees and forests, and the environmental services they provide. The City can use the information, statistics, and mapping from i-Tree to gauge program success, understand where improvements are needed, and to educate the public and gain support for the urban forestry program.

In particular, i-Tree Canopy can be used to estimate the location, extent, and growth of the city's entire urban tree canopy. i-Tree Canopy uses Google Maps aerial photography within a preselected area boundary and generates random sample points. From these sample points, the type of cover is selected (impervious, grass, tree, etc.) from a pre-defined list (that is determined by the individual using i-Tree Canopy). The more sample points that are generated and completed, the better the canopy cover estimate is for the selected area. Every three years or so, the city could complete an i-Tree Canopy project to gauge the success of tree planting and preservation. Furthermore, i-Tree Streets or i-Tree Eco can use updated inventory data to project the value of ecosystem services, like air and water quality improvements, stormwater management, and energy conservation, that the street trees provide the City and its residents.

Technology Recommendations:

- Provide Tree Crew staff with adequate mobile devices/tablets or similar mobile technology to help coordinate work and efficiently route daily assignments.
- Utilize asset management software (such as TreeKeeper®) to develop work orders that city crews and contractors can access using tablets or smartphones or other mobile technology.
  - Provide asset management software training to staff.
  - Utilize work orders to prioritize and assign work to maximize efficiency.
  - Track work activities completed or to be done. Utilize software reporting tools to generate urban forestry updates to share with City managers and Council on work completed or to demonstrate program needs.
  - Use data and reports from asset management software to analyze crew productivity and contractual costs to get realistic numbers for refined budget and staffing analyses.
- Utilize i-Tree Tools every 3-5 years to evaluate the benefits of the urban forest and compare changes over time to management activities completed. Communicate changes to City leadership, Council and the public and explain how the changes (positive or negative) have been affected by urban forest management activities the City has undertaken (or other factors, e.g. invasive species, storms).
- Develop standard operating procedures (SOP) for updating tree inventory data and inputting records and information in the 311 system.

Residents and 311 System Management

The input and collaboration of residents who care about the urban forest and its impact on the "common" is an essential part of any successful municipal urban forestry program. In Somerville, external stakeholders have helped to improve the urban forest program.

Figures 4.1 and 4.2 below show the monthly tree maintenance requests and plantings generated from the public using the 311 system from July 2015 to March 2019.

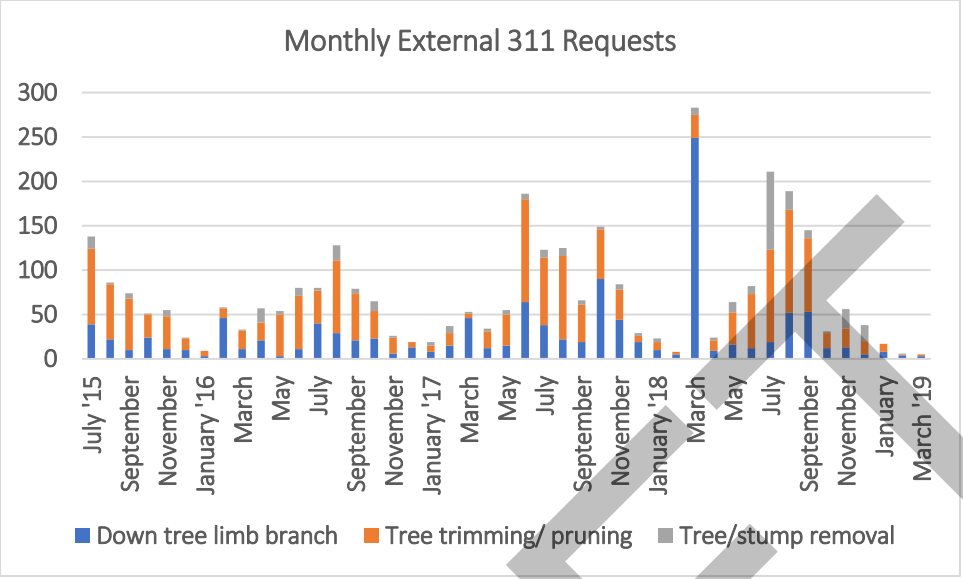

Figure 4.1: Chart of External 311 Requests for Tree Maintenance

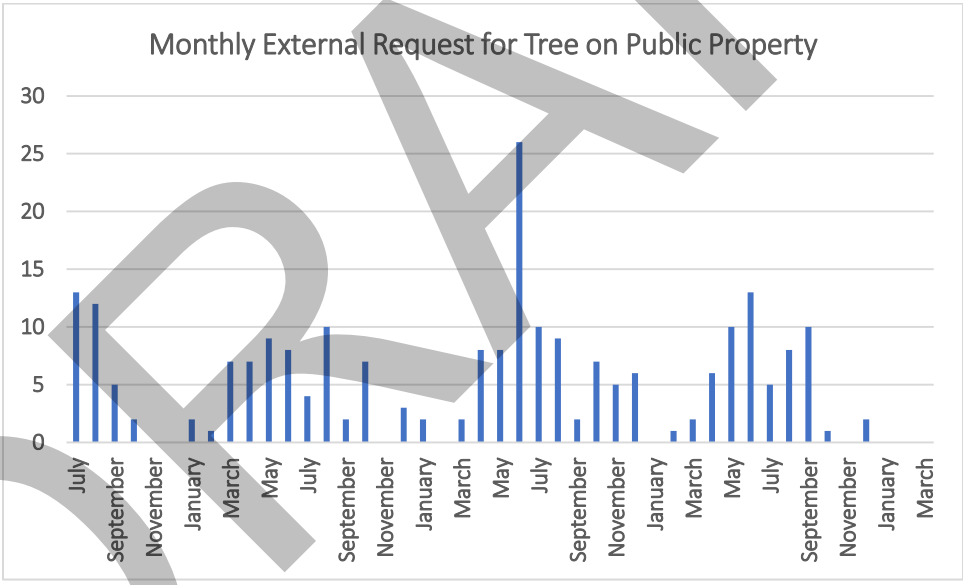

Figure 4.2: Chart of External 311 Tree Planting Requests

Residents can log 311 service requests by calling 311 (617-666-3311 outside of Somerville), emailing 311requests@somervillema.gov, or inputting their requests directly through the website (www.somervillema.gov/311) or the 311 app. The 311 system has five different types of requests related to trees: Tree trimming/ pruning, Down tree limb branch, Tree/stump removal, Arborist and tree maintenance, and Request tree on public property. The DPW responds to the tree trimming, down tree limb branch, and tree/stump removal requests. The PSUF urban foresters manage the tree planting requests. Both divisions manage and respond to the Arborist and tree maintenance requests.

The DPW has 2 dedicated fulltime administrative staff whose responsibility includes processing the requests for all DPW services in the city, including requests unrelated to tree maintenance. The DPW Tree Crew aims to respond to each call and close it out within 10 work days. Requests related to public safety are completed ASAP. Also, as the 311 system is used as a work-order system for the

Tree Crew, work that is requested outside of the 311 system may be entered in on the same day the work is completed. There are also multiple steps involved with the 311 system resulting in lost information, and some work orders are left open longer than 10 days even when the work has been completed. City staff should consider streamlining this process or standardizing it specifically for tree work.

The PSUF urban foresters aim to address urgent Arborist and tree maintenance requests within 10 days or less (depending on the nature of the request), and the remainder within one month. PSUF urban foresters also aim to close out tree planting requests within one year from the initial request (i.e. two planting seasons). Because there is no administrative staff to aid with organizing or closing out these 311 requests, the requests are often left open even when the request has been completed.

While partnerships and goals are discussed in detail in *Section 4.4: Public Engagement*, the following recommendations are suggested actions the City can take related to partners and internal and external stakeholders in order to improve the efficiency of its operations and increase the success of its public tree management program.

Resident & 311 System Management Recommendations

- Set a target timeframe (i.e. 1, 2, or 3 days) for a response (not a resolution) to a resident 311 request for service. Stick to the agreed upon timeframe for closing out the request (i.e. 10 days for down limb, tree trimming, stump removal requests, 1 month for arborist/tree maintenance requests, and 1 year for planting requests).
- Set standards for entering and closing out a tree maintenance request to ensure consistency and compliance.

Utility Relations

The residents and businesses of Somerville use a multiplicity of utility services — electricity, gas, water, sewage, telecommunications, cable television, etc. — each of which requires an extensive distribution and transmission network, both above and below ground. These networks also need space, and they are frequently under tight constraints on their placement and alignment.

The space available for both trees and utility services is often very restricted, and they frequently share the same space, above and below ground. Where they are in close proximity, there is the potential for either the tree or the utility service to be damaged by the other. If they are to co-exist, the needs of each must be understood and appropriate planning, precautions, and maintenance must be taken to minimize the risk of damage.

Over the years, municipalities have experienced conflicts over the design, location, and maintenance of utilities and the location and management of public and private trees. Cities are in the business of responding to residents' needs, ensuring public safety, and improving the quality of life for all. Utilities are in the business of delivering energy, products, and services to their customers in a safe, efficient, and reliable manner.

Trees are a vital component of a city's infrastructure, providing many economic and environmental benefits. However, safe, reliable utility services are also vital to the success of a city on many levels, and trees, particularly those that are not maintained properly, are often the cause of power outages. There are reasonable methods and policies that can help or eliminate most tree/utility conflicts.

Utility companies have a right to prune the branches of public and private trees near their power lines as long as they follow certain rules and restrictions. Massachusetts State Law (M.G.L. Chapter 87, Section 14) states that the utility company, at the request of the tree warden, must submit an annual vegetation management plan and annual hazard tree removal plan prior to completing any work.

Every year, the Tree Warden and PSUF Urban Foresters require not only that Eversource submits these documents well in advance of performing their pruning or removal work, but also that they meet with the City staff to discuss additional restrictions to their standard operating procedures. At the onset of the tree pruning work, these City Staff then meet with the tree workers in the field to ensure that they are aware of the Somerville requirements. The Tree Warden and PSUF urban foresters periodically check on utility company's tree work to ensure compliance with the City restrictions. The City's Urban Forestry website has a video explaining this type of work (see the "Tree Trimming Around Power Lines" video, here: https://www.somervillema.gov/departments/ospcd/psuf/urban-forestry).

Utility Relations Recommendations

- Eversource and the City should adopt all applicable arboricultural and utility industry standards and use them for in-house and contractual projects. Examples include: American National Standards Institute standards; American Association of Nurseryman standards; International Society of Arboriculture and Utility Arborist Association standards; Tree Care Industry Association, Inc. standards, Occupational Safety and Health standards, and others.
- Partner with Eversource to utilize additional arboricultural and utility research and techniques available to provide solutions for tree/utility conflicts. Examples of other solutions include the use of "Tree Growth Regulators," greater use of 'directional pruning' techniques, conversion of multiple aerial lines into innovative cable designs, and experimentation with different cross-arm dimensions, locations, and construction techniques.
- Analyze existing information and gather new information to plan for better and more efficient tree planting and maintenance activities between the City and Eversource. Examples include maintaining the street and public tree inventory with species, size and condition information, and using it to analyze proposed future work projects; and creating a Master Tree Planting Plan for the city to ensure proper species diversity, ensure appropriate tree planting over and under utilities, and to simplify the species selection decisions for new projects.
- Consider providing education sessions with the support and involvement of the Mayor, City Council, and agency heads explaining that utility service delivery and the presence of quality trees and landscaping are both valuable assets that improve the livability of the community.
- Eversource and the City should hold quarterly or annual meetings involving appropriate staff to discuss upcoming projects, developing issues, and to further strengthen the interagency relationship.
- Discuss and coordinate quarterly or annual work plans with Eversource and other utility companies to discover efficiencies, such as shared tree maintenance contracts, and mutually beneficial tree maintenance and planting projects.
- In the future, it may be advisable to revise the current tree ordinance specifically relating to utility pruning and maintenance activities.

Analysis of Urban Forestry Policies and Plans

Having a set of overarching guidelines for tree planting and maintenance is essential for ensuring that best practices are being consistently followed. These plans and policies can be used not only for City staff, but also for directing contractors, developers, utility companies, and even homeowners who may impact the City's urban forest.

Tree Maintenance & Planting Specifications

Incorporating specifications with bid requests and contracts should be a standard operating procedure and best management practice for a city. Without clear and detailed specifications, a city may receive bids from arborists and landscapers that have distinctly different qualifications and practices from what the city intended. Just like a builder would not consider bidding on the construction of a home without a set of plans, arborists also need a set of plans (i.e. specifications) to present a reasonable bid.

The biggest advantage of having well-written specifications is the confidence in knowing that the city has provided the contractor with detailed information on what is required to perform the job to the city's standards. Clear specifications can also help eliminate a wide range of bids, and give the city more accountability over the expenditure of public funds.

With Somerville's reliance on contractors to perform tree maintenance and planting work, there is a great need for a clearly identified scope of work. Specifications communicate needs, form the basis of bids, and serve as a standard for evaluating the quality of the completed work. In-house crews also require clearly defined expectations and objective evaluation of their work; specifications will help them too.

Specifications, especially for larger urban forest maintenance and planting projects the City intends to take on in the future, have many benefits, including:

- Promoting proven tree care practices
- Embodying professionalism
- Enhancing communication between the city, field personnel, office staff, contractors, and the public
- Reducing miscommunication between all of the above
- Educating the public and decision makers
- Facilitating contractual fulfillment
- Reducing liability exposure

Currently the City includes specifications when it solicits bids for its urban forestry projects. The city should continue making it a practice to use and reference detailed industry-based specifications for all tree removal, pruning, stump removal, tree planting and young trees care bids and contracts.

Tree Maintenance & Planting Specifications Recommendations:

- Create a library of specifications and details for different types of tree work. These documents can be easily inserted into new bid documents and contracts.
- As new projects and types of work are developed, create new specifications and details to guide that work. Add these new specifications and details to the library.

Tree Maintenance & Planting Permitting System

The City of Somerville has a variety of permits and official applications for many activities that occur within the city limits and on public property. The City has recently established a permit process for the removal of some trees on private property per the City's Tree Preservation Ordinance. See *Section 4.3: Ordinance/Policy Review* for more details. Other activities that should have the guidance of the City through a permit system include tree planting and maintenance, and road and utility construction and repair projects that affect trees.

Having even a simple tree permit that can be issued without charge has many benefits and uses:

- Documentation of what work is being perform by whom on City-owned trees.

- Ability to give professional guidance to anyone wanting to plant trees on public rights-of-way or properties.

The permit process would require all parties, including Eversource and other utility companies, developers, and residents, to submit a permit application and receive an approved permit from the appropriate city department (ex. Engineering Department or Planning and Zoning), with approval by the City's urban forester or arborist, before any public tree is pruned, removed, planted, or otherwise affected by anyone. There may or may not be a fee associated with the permit. If a public tree is damaged, affected, or planted without City approval, then the City would have the right and authority to require compensation and/or correction of the problem at no direct cost to the City. The permit system would allow the City better control over the actions of individual residents and businesses, especially related to tree planting in the vicinity of utilities.

The permit need not be seen as a "hindrance" or "obstacle" to doing tree work on public trees and property, but rather a more of an organized method of ensuring knowledge and communication between City staff and the party applying to do the work or planting. A current permit form used by the city could simply be modified to include sections or lines dedicated to tree maintenance and planting activities on the public right-of-way; or a new separate one could be created. As needed, the permit would allow for City staff to inspect the site prior to planting and give guidance as to proper species, size and final location. For tree pruning and removals, City staff could give guidance on the appropriateness of the maintenance task and ensure proper arboricultural standards were followed. For routine pruning by Eversource, a general, annual permit could be used to compliment and approve the vegetation management plan that is submitted to the City.

Tree Maintenance and Planting Permitting System Recommendation:

- Consider establishing a *Public Tree Work Permit* system by modifying an existing city permit form or creating a simple and separate tree permit form.

Planning for the Future: Priority and Proactive Pruning Cycles

Section 3.2: Tree Maintenance Program recommends a seven-year tree maintenance and planting program and details the quantities and costs of various maintenance tasks. The tree maintenance activities in Years 1 and 2 will address High and Moderate Risk priority work in anticipation of beginning a proactive, preventive maintenance program in Year 2. For example, in Year 1, approximately 125 trees will require removal and 227 trees will require pruning.

The City already has a tree planting program, and has recently set up a Young Tree Training program. However, once the priority work is addressed, the *Tree Maintenance Program* recommends the City also begin an annual routine pruning program for Years 2 – 7. It is estimated that approximately $100,000 per year will be required for the routine pruning program, in addition to the estimated $41,400 needed for the young tree training program and $350,000 per year needed to plant 350 trees. In Years 2 – 7, tree and stump removals will occur as needed.

Because of the size of the DPW Tree Crew and their workload, their focus is primarily on reactive tree work and not proactive tree work. Currently the DPW Tree Crew and contracted crews managed by DPW's Superintendent of Highways are focused on responding to 311 work orders for tree pruning, cleaning up storm damage, and performing tree and stump removals. Under the current reactive system, when a pruning work order is issued for a public tree, generally only the specific pruning needs that were requested are addressed. Often a service request requires the removal of only

select branches, such as a broken hanging branch, a branch obstructing a sign or building, or a branch hanging over the street or sidewalk, etc. In order to resolve the request as soon as possible, other "routine prune" work may be left incomplete. When planning or monitoring tree maintenance work, it should be noted that a proactive cyclical tree maintenance program addresses the needs of the whole tree.

It is difficult to calculate how much time it would take the Tree Crew to complete routine maintenance because their production rates for proactive cyclical tree maintenance are unknown. For comparison and reference, Table 4.3 provides average labor hours per tree for basic tree maintenance based on information compiled by Society of Municipal Arborists (SMA) members (Phillips, 2020).

Table 4.3. Tree Maintenance Production (adapted from SMA standards[2])

Diameter Class*	Tree Removal Average Labor Hours per Tree	Tree Pruning* Average Labor Hours per Tree	Stump Removal Average Labor Hours per Tree
1–6"	1.0	0.5 (by hand)	1.0
6–12"	2.0	0.8	2.0
12–18"	4.0	1.1	4.0
18–24"	6.0	1.6	6.0
24–30"	10.0	2.1	10.0
30–36"	10.0	2.4	10.0
37"+	10.0	3.4	10.0

*The pruning size provided in the SMA standards was extrapolated to create diameter classes. For example a 6" diameter tree in the SMA production standard equates to a diameter class of 1-6" in Table 4.3.

The City initiated a Young Tree Training program in 2019, and aims to prune approximately one-third of its young trees each year. Performing a three-year Young Tree Training Pruning cycle until the trees require more sophisticated safety and equipment requirements will help reduce the need for the more expensive maintenance requirements of mature trees. The preventative efforts associated with developing a tree with a strong structure can reduce branch breakage and improve survival in severe storms. Young Tree Training work can be accomplished throughout the year and since no bucket truck is required, City employees or contractors can perform this work at any time. This type of work is also highly suitable for properly trained summer interns, part-time employees, and/or volunteers.

Experience demonstrates that, based on the generally small size of the trees in this category, a crew of two properly trained City personnel would be capable of accomplishing all of the work in less than 20 weeks.

The Young Tree Training program is currently being performed by contractors with oversight of the PSUF urban forestry staff. In order to perform this work in-house, tree crew personnel would need to obtain proper training in young tree structural pruning. Additionally, workers must have or acquire an understanding of the growth habits of the various species being planted, as well as an understanding of basic tree anatomy and physiology. This training can be received through local urban forestry consultants and/or International Society of Arboriculture Certified Arborists. The

[2] http://gibneyce.com/10-read-about-urban-forestry-leadership.html#Urban – "Urban Forestry Standards"

tremendous benefits to be gained in the years to come due to proper structural pruning of young trees are a strong incentive for educating tree crew personnel. Additionally, the added knowledge gained by these individuals could prove to be an incentive in raising the sense of professionalism in their jobs and satisfaction in helping the community.

Program Recommendations

- In FY20 and FY21 the City of Somerville should focus its resources on the high/moderate risk tree removals and tree pruning activities identified in the tree inventory/management program. After these trees are addressed, then the city should move towards establishing a proactive routine tree pruning program.
- In FY21, the DPW Tree Crew and PSUF staff should: 1) develop a 6-year routine pruning cycle plan; 2) identify the areas of the city to be pruned in each cycle year as well as the number of trees to be pruned each cycle year, 3) identify sources of funding and the amount of work to be done in-house and through outside contracts.
- In FY20 the City established a Young Tree Training Program. In FY21, the City should develop a process for adding newly planted trees to the inventory and incorporating them into the young tree training cycle. In general, young tree training for newly planted trees should begin 2 to 3 years after planting.
- In FY21, develop a process for adding older trees from the young tree training cycle into the routine pruning cycle.
- In FY21, develop tree pruning specifications based on ANSI A300 standards to ensure that tree pruning performed as part of the pruning cycle is done to the highest standards and meets the City's pruning objectives.
- In FY22, begin Year 1 of the 6-year routine pruning cycle.
- Track maintenance activities in the public tree inventory with an asset management software program (the City currently uses TreeKeeper® software). After the first full pruning cycle has been completed, use the maintenance data to determine Somerville's optimal routine pruning cycle.

Budget Discussion

The City's FY20 budget for tree maintenance, planting and ash treatments is $681,000 (Table 4.4).

Table 4.4: FY20 Somerville Tree Care and Management Budget

Tree Care Activity	FY20 Budget
Tree Removal, Tree Pruning, Stump Removal, Emergency Tree Care (DPW Tree Department)	$180,000.00
Young Tree Training (PSUF Urban Forestry)	$41,000.00
Proactive Parks Tree Health Program (PSUF Urban Forestry)	$60,000.00
Ash Tree Treatments (emerald ash borer; DPW Tree Department)	$60,000.00
Tree Planting (PSUF Urban Forestry)	$340,000.00
TOTAL	**$681,000.00**

Section 3.2: Tree Maintenance Program recommends a 7-year tree management program to remove and prune high/moderate risk trees (Years 1 and 2) and begin a routine/young tree pruning cycle (Years 2–7). The estimated budget to implement the 7-year program is shown in Table 4.5.

Table 4.5. Estimated budget to remove and prune high/moderate risk trees and begin routine pruning and young tree training cycles (adapted from *Section 3.2: Tree Maintenance Program*).

Tree Care Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Tree Removals	$85,740	$68,080	$60,000	$53,800	$20,000	$13,900	$TBD
High/Moderate Risk Tree Pruning	$96,000	$24,375	$-	$-	$-	$-	$-
Routine Tree Pruning	-	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
Young Tree Training (pruning)	$41,400	$41,400	$41,350	$41,400	$41,400	$41,350	$41,400
Ash Tree Treatments (emerald ash borer)	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000
Tree Planting	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000
TOTAL	**$633,140**	**$643,855**	**$611,350**	**$605,200**	**$571,400**	**$565,250**	**$551,400**

Based on the FY20 budget and the estimated 7-year tree management budget it would appear that Somerville's budget resources are sufficient to implement the 7-year tree management plan. However, the 7-year budget plan does not consider costs associated with storm response and the reality that the City will still need to respond to resident requests for tree care (reactionary maintenance). There are no national standards or best management practices for budget allocation, as it depends on the community. Therefore, Somerville will need to determine what percentage of the budget should be allocated to resident request and storm response. Based on Somerville's current budget allocation and previous work activities, and recognizing that the current high/moderate risk trees will be addressed in Years 1 and 2 of the maintenance plan, an allocation 12.5% of the average annual budget ($75,000) is recommended to be allocated annually towards storm response and resident requests.

The 7-year budget plan also does not include equipment purchases, rentals, or other capital expenditures; hiring additional staffing (FTEs/seasonal/interns), expanded tree inventory work, plant health care, invasive pest management (except for EAB), staff training and development, or expanded public outreach. Somerville will need to determine the costs for these activities, and seek additional budget resources to implement them.

Budget Recommendations

- Establish a proposed annual urban forestry budget that includes implementing the 7-year management plan, resident/storm response activities, and other management activities. Identify the shortfall in the proposed budget versus the FY20 budget and utilize the *Tree Maintenance Plan* to build a business case for an increase in funding.
- Identify other potential revenue sources for urban forestry management, including grants, resource sharing with other city departments or regional municipalities, establishing a linear foot frontage fee designated for tree management and care, etc.

4.2 FUNDING ANALYSIS

According to Hauer & Peterson (2016), cities in the United States spent an average of 0.52% of their total 2014 municipal budget on public tree management. Cities with 50,000 to 90,000 residents, or cities of a size similar to Somerville (population 81,562), allocated an average of 0.53% of their municipal budgets to tree management. Compared to other regions of the US, cities in the northeast spent less, on average, on forestry activities; only 0.34% of their municipal budget. No specific information was provided by Hauer & Peterson (2016) for cities of 50,000 to 90,000 residents in the northeast, but if the relationship between the national or regional average and the national or regional average for cities with 50,000 to 90,000 people holds true, it can be assumed that cities of 50,000 to 90,000 people in the northeast generally spend around 0.34% of their municipal budgets on public tree management.

Somerville's public tree management budget of $1,061,000 represents 0.45% of the City's fiscal year (FY) 2020 total municipal budget (note that school budgets were not included in either Hauer & Peterson's numbers or Somerville's proposed budget numbers). Somerville currently spends less of its total municipal budget on public tree management than cities nationwide do, on average. However, Somerville's spending on public tree management is somewhat higher than the average spending of cities in the northeast.

Somerville's annual budget for public tree management includes $380,000 for staff salaries (see *Section 4.1: Operations Review* for details on urban forestry personnel). The remaining $680,000 of funding for the urban forestry program is split between tree planting and tree care/maintenance.

For FY2020, the City's tree planting budget was $340,000 (Figure 4.3). The funds for tree planting come from the City's municipal budget ($150,000), funds authorized by the City Council for capital improvement projects ($100,000) and a federal community development block grant ($90,000). The planting budget for FY2020 is higher than in previous years.

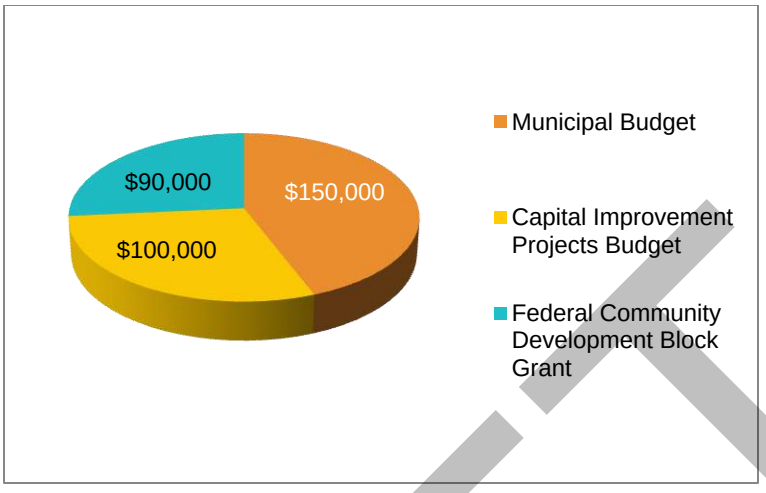

Figure 4.3. FY 2020 Tree Planting Budget Sources

The City's FY 2020 annual budget for tree care and maintenance was $341,000 (Figure 4.4). This included a budget item in the DPW Highway Division for tree care and maintenance (also known as "care of trees") of $240,000, which is primarily used for reactive public tree pruning and maintenance, including emergency response, as well as the treatment of healthy ash trees against the invasive pest, Emerald Ash Borer (EAB). New for FY2020, Somerville allotted an additional $100,000 from the City's municipal budget to the Public Space and Urban Forestry Division to start a proactive park tree health program ($60,000) and a young tree training program ($41,000).

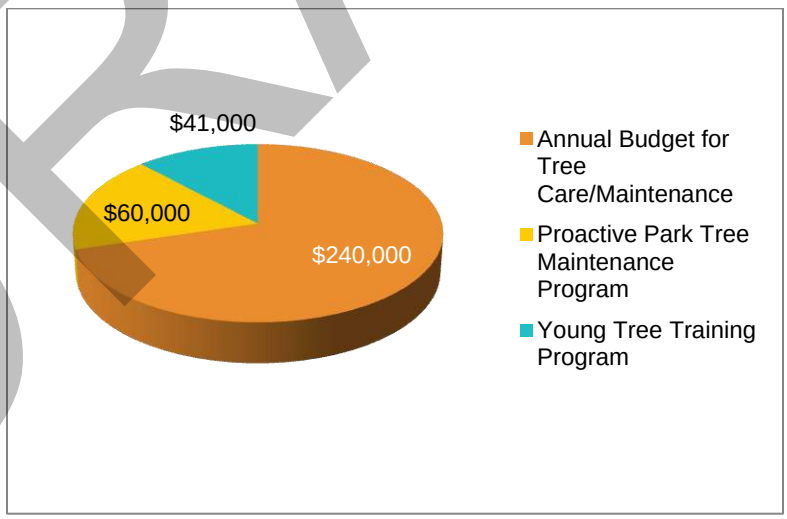

Figure 4.3. Annual Tree Care Budget

For perspective, Table 4.6 compares Somerville's urban forest management budget to national averages and peer groups.

Government	Annual Budget
Somerville	*$1,061,000*
National Average	$801,959
Northeast Regional Average	$1,122,843
National Average for Populations of 50,000-99,999	$646,501

Table 4.6. Urban Forest Management Budget Comparisons. Average statistics from Hauer & Peterson (2016).

Budget Analysis for Plan Implementation

The 2018 inventory included all public street and park trees, stumps and various potential planting sites (see *Section 2: Somerville's Trees*). Analysis reveals that an average of $247,371 (ranging from ~$200,000 to ~$300,000 per year) will be required to perform annual priority and routine maintenance, young tree care, and Emerald Ash Borer mitigation, and $350,000 should be allocated annually to meet the City's goals of planting 350 trees per year (*Section 3.2: Tree Maintenance Program*). The annual budget total for these primary and important functions is an average of $597,371 needed each year for Somerville to have a proactive urban forest management program. However, this estimate does not account for reactive tree care maintenance, nor does it account any additional urban forestry activities that may be undertaken in the future such as windshield surveys and subsequent risk assessments or any additional tree health care needs.

Currently, the FY2020 budget of $240,000 for the care of trees is not quite sufficient to accomplish all recommended priority and routine maintenance according to the budget in *Section 3.2 Tree Maintenance Program*. There is also no additional funding available for reactive maintenance activities such as storm response or additional hazard tree removal should they be discovered. Additionally, the first year of the proposed management plan will require significantly more funds than the average year in order to help mitigate the higher costs estimated for the first year of the management plan as priority removals and pruning will need to be completed before a routine maintenance plan can begin. The 7-year budget plan also does not include equipment purchases, rentals, or other capital expenditures, hiring additional staffing (FTEs/seasonal/interns), expanded tree inventory work, plant health care, invasive pest management (except for EAB), soil amendments and other tree maintenance needs, staff training and development, or expanded public outreach.

The current tree planting budget of $340,000 is nearly sufficient. An additional $10,000 may be needed to maintain the desired level of annual tree planting. Also, as costs continue to rise on a regular basis, additional funding may be needed to keep pace.

A total increase in funding of at least $17,228 may be needed in order to maintain a proactive and high-quality urban forest management program.

Funding for Additional Urban Forest Management Activities

This Urban Forestry Management Plan recommends a variety of projects and programs to enhance the City's urban forestry program with the goal of protecting and even increasing the citywide urban tree canopy. The implications of these activities on future funding should be considered. For instance:

- Many planting sites for new trees are restricted and would limit the species selection to small stature trees. Therefore, most potential tree planting sites would need to be created or redesigned to accommodate larger growing trees. Although the costs of creating or expanding existing tree pits are includes in the tree planting estimates, the costs of improving soil conditions are not. Incorporating structural soils, using Silva Cells, or other growing site improvement techniques have not would cost between $10,000 and $50,000 depending on the scale and nature of the project.

- If tree planting on public property and in parks increases, it would be fiscally prudent to have adequate funds in place for new tree care. New trees require supplemental watering, mulching, fertilization, and insect and disease control during the first three to five years of establishment. Although the current tree planting contracts include tree care for the first two years of establishment, additional funds would be needed to support these activities in the remaining years. The average cost for these activities is $10 to $20 per tree per occurrence.

- Somerville began a 6-year proactive park tree maintenance program in FY2020. The goal of this program is to assess and maintain the trees in at least six parks throughout the City every year. A number of activities should be considered and budgeted for in order to maintain healthy and beneficial park trees. Existing trees should be assessed for hazards and pruned accordingly. New plantings should enter the young tree training cycle (the FY proposed budget includes $40,000 for young tree training). An integrated pest management program should be established to protect against and manage harmful insects and diseases. Soil amendments and decompaction may be needed to ensure adequate soil conditions. Routine watering and annual mulching should also be considered. $60,000 was awarded in FY2020 for this purpose. Whether this budget will be adequate or not will be determined as the established trees are assessed and the number of new plantings is determined.

- Being prepared financially for severe weather events that affect the urban forest is also an important component of a comprehensive urban forestry program's budget. The response activities, such as clearing roads and sidewalks of debris, and hauling, processing, and disposing of the debris, and the recovery activities, such as tree planting, can require significant funds. Storm events happen unexpectedly, but regularly, in New England, so Somerville should have funds earmarked for contractual and in-house staff to perform the required tasks; particularly so the City's overall budget for routine public health and safety services, infrastructure maintenance, and administration are not adversely affected.

- The residents of Somerville are the true owners of the urban forest. As such, the City should invest in public outreach and education about this important natural resource. Activities such as conducting training events and educational programs, issuing timely tree care and planting information through printed and online materials, and holding special events to increase the awareness and appreciation of trees requires some dedicated funding so that consistent and regular messaging is performed.

Funding Recommendations and Sources

For many cities, the lack of dedicated and adequate financial resources for their urban forestry programs precludes making significant improvements to comprehensively manage and proactively maintain their urban forests to the level their residents desire and/or as needed to achieve their forest canopy goals. Funding for urban forest management can also be affected by factors such as competing departmental budgetary priorities, changes in public opinion, newly elected leadership, and severe weather events.

While Somerville's budget may be sufficient to support a basic and proactive approach to managing trees, to achieve many of the additional goals of this Urban Forest Management Plan, additional, new, and creative funding sources should be investigated. Some options to consider include:

1. **Federal and State Government Grants** – As a public agency, Somerville is in a good position to apply for and receive government grants. While U.S. Forest Service grants have become more regional and competitive, other federal grant programs have emerged that can fund tree planting, inventories, Urban Tree Canopy Assessments and even tree maintenance. Some examples include:

a. Massachusetts Department of Conservation and Recreation Urban and Community Forest Challenge Grants can be used to fund various activities. This is an Annual grant opportunity for municipalities and nonprofit groups in Massachusetts to improve and protect their urban forests. These 50/50 matching grants help develop, grow and sustain programs that plant, protect and maintain a community's public tree resources and develop partnerships with residents and community institutions. The City was awarded one of these grants to fund the creation of the Urban Forest Management Plan you are currently reading.
b. U.S. EPA grants (*Environment Justice Small Grants Program*): The Environmental Justice Small Grants Program supports and empowers communities working on solutions to local environmental and public health issues. The program is designed to help communities understand and address exposure to multiple environmental harms and risks. Environmental Justice Small Grants fund projects up to $30,000, depending on the availability of funds in a given year. All projects are associated with at least one qualified environmental statute.
c. The National Fish and Wildlife Foundation's Resilient Communities Program: It is designed to prepare for future environmental challenges by enhancing community capacity to plan and implement resiliency projects and improve the protections afforded by natural ecosystems by investing in green infrastructure and other measures.
d. For other federal grant opportunities, explore www.grants.gov to see what grants are available for specific projects Somerville wants to undertake.
e. If environmental disaster events take place within Somerville, FEMA funding may be available (See *Storm Preparedness* Section of this Urban Forest Management Plan).

2. **Corporate and Private Foundation Grants –** As a public agency with non-profit status, staff, and administrative support systems, Somerville's urban forestry program is in a good position to apply for and receive private grants. Partnering with a local non-profit can also reveal private funding sources in your area.
3. **Taxes, Assessments, and Special Tax Districts** – Asking for new taxes to support the program is a legal and viable way to fund the program, with the right amount of resident support. Alternatively, consider including urban forestry projects in Tax Increment Financing Districts, Landscape and Lighting Assessment Districts, and other Special Benefit Assessment Districts.
4. **Capital Improvement Project Budgets** – Trees are capital assets; tree planting and sometimes maintenance can be a valid expenditure of large road, utility, or facility improvement projects. Even requiring 0.5% to 1% of the capital budget

for tree planting and after-care can produce a sufficient budget for urban forestry projects related to the infrastructure project.

5. **Stormwater Utility Fees** – Many communities have established a stormwater utility fee in order to assist with stormwater mitigation efforts. The Massachusetts Division of Local Mandates conducted a Municipal Impact Study and reported their findings in the Local Financial Impact Review issued January 17, 2017 titled "Costs, Regulation, and Financing of Massachusetts Water Infrastructure: Implications for Municipal Budgets". According to these findings, over the next twenty years, municipalities foresee significant increases in capital, operating, and staffing costs—$1.58 billion statewide, including $240 million in additional personnel costs—for implementation of new federal stormwater management regulations. The Study recommends that in order to provide additional funding for stormwater-related capital and operating requirements, Massachusetts municipalities should consider the creation of dedicated stormwater enterprises similar to local water and sewer enterprises in structure, operation, and fee-based revenue streams. Stormwater mitigation is highly affected by the urban forest. Therefore, tree planting programs may be eligible for funding through a municipal stormwater program.
6. **Tree Work and Land Development Permit and Inspection Fees** – To the extent permitted under state and municipal codes, permit and inspection fees can be a source of funding for the program. Fees can help offset the personnel costs of city or contracted staff for reviewing development permits applications and plans, and for site inspections.
7. **Compensatory Payment, Land Development Mitigation, and Environmental Fines** – When trees are damaged or removed (whether by an accident or a planned economic development project), municipalities should be compensated. Generally, this requirement and the compensation method should be codified, and should be clear about its applicability to public and/or private trees. Many cities across the U.S. have ordinances that stipulate this, and as a result have "tree funds" where compensatory payments, mitigation or 'in lieu of' fees, and environmental fines are deposited for a variety of uses and urban forest management projects. Currently, Somerville has a Tree Fund. Payments for damages to public trees go into this fund, as do donations for public trees. This fund also receives in-lieu payments for private tree removal (see *Section 4.3: Ordinance/Policy Review*).
8. **Miscellaneous Funding Sources** – While providing smaller amounts to the urban forestry budget, these funding mechanisms and sources should not be ignored since every little bit of revenue can help Somerville accomplish specific projects: Adopt-A-Street and memorial and donor tree programs; wood product sales; utility bill donations; community or organizational fund-raising

events; revenues from municipally-owned concessions and recreational facilities; cash and in-kind donations.

Any or all of these funding methods could be explored by City staff to determine their legality, viability, and practicality, and how one or more of these methods would help increase budgetary resources for the urban forestry program. The City should also continue to collaborate with local and regional non-profit partners to secure funding for tree maintenance and urban forest management activities from sources that are more inclined to provide funding to nonprofit entities as opposed to the municipality directly.

With sufficient financial resources to secure professional services, equipment, and management, Somerville can accomplish its urban forestry goals, better respond to changes and challenges in the urban forest, and best serve the City's residents.

4.3 ORDINANCE/POLICY REVIEW

For a municipality to legitimately claim to have a comprehensive urban forestry program, a tree ordinance should be in place. Generally, a tree ordinance establishes standards and sets guidelines for the management of trees by the municipality and the treatment of trees by private entities. It is the legal framework within which local tree management activities are conducted for the general welfare. Tree ordinances can enhance the community-wide urban forest and ensure that it is protected to provide public health and safety as well as many other important benefits (see *Section 1: The Importance of Trees in the City*).

Somerville's Tree Preservation Ordinance is found in Article VI, Section 12 of the City's Code of Ordinances. Somerville's Tree Preservation Ordinance was established in 2009. The most recent amendment to the Ordinance was passed by the City Council in June 2019, went into effect on August 1st, 2019. Somerville's Tree Preservation Ordinance has positioned the City well to protect and expand its urban tree canopy while addressing both public health and climate resiliency. A closer look at the details of Somerville's Tree Preservation Ordinance as it is currently written may help to highlight how its intent and purpose are to be realized and how future alterations to the Ordinance may better serve the public and the environment.

Somerville's Tree Preservation Ordinance text is presented below in *grey italics*, while annotations and descriptions are presented in black text:

CITY OF SOMERVILLE

ORDINANCE NUMBER 2019-15

IN CITY COUNCIL: June 27, 2019

TREE PRESERVATION ORDINANCE

Be it ordained by the City Council, in session assembled, that Chapter 12 of the Code of Ordinances of the City of Somerville, is hereby amended by replacing the existing Article VI with a new Article VI as follows.

ARTICLE VI. - TREE PRESERVATION ORDINANCE

Section 12-100. Intent and purpose.

The preservation of the tree canopy and the planting of replacement trees is intended to enhance the quality of life and the environment of the city; to reduce energy consumption; to protect air quality; to provide protection from glare and heat; to baffle noise; to reduce topsoil erosion and stormwater runoff; to preserve and enhance habitat for wildlife; to protect and increase property values; to combat climate change through carbon sequestration; to provide natural privacy for neighbors; to enhance the overall appearance of the City; and to acknowledge the intrinsic value of the mature trees within our community.

Section 12-101. Applicability.

The terms and provisions of this ordinance shall apply to trees within the City of Somerville that are located on city owned property, on private property, or in the public right of way.

This statement of Applicability allows the City better oversite of its tree canopy by applying this ordinance not only to public trees but to private trees as well.

Section 12-102. Definitions.

Caliper: A measurement of the tree trunk diameter used when purchasing tree plantings measured at 12" above the ground.

City Tree: A tree located on property owned by the City of Somerville, including Public Shade Trees, trees in City parks, and trees on the grounds of City buildings.

DBH (Diameter at Breast Height): The diameter of a tree trunk measured in inches at a height of four and a half (4.5) feet above the ground. For multiple trunk trees, DBH is the aggregate diameter of the trunks.

Invasive Plant: A plant that is both non-native and able to establish on many sites, grow quickly, and spread to the point of disrupting plant communities or ecosystems, including but not limited to the trees listed on the Massachusetts Prohibited Plant List.

Private Tree: A tree located on private property.

Public Shade Tree: A tree located in the public way, as defined in G.L. c. 87, section 5.

Removal: The intentional cutting down of any tree, including all other acts which cause actual or effective removal through damaging, poisoning, or other direct or indirect actions that result in the death of the tree. This includes, but is not limited to, excessive pruning.

Replacement Caliper: The replacement caliper for Significant trees shall be at least equal to the DBH of the tree removed.

Significant Tree: Any living tree that is not an Invasive Plant and is 8 inches or more in DBH.

Section 12-103. Tree warden.

The Tree Warden shall be an employee of the City, appointed by the Mayor, subject to confirmation by the City Council, for a term of three years.

1. *The Tree Warden shall be qualified for the role as defined in G.L. c. 41 s. 106, and also according to the standards established and published by the Massachusetts Tree Wardens and Foresters Association.*

Massachusetts General Law, Chapter 41, Section 106 states:

"If the town provides by vote or by-law that the tree warden shall be appointed, such appointment shall be made by the board of selectmen. The term of such appointment shall be for three years.

In any city or in a town which exceeds ten thousand inhabitants and which provides by vote, by-law or by ordinance that the tree warden shall be appointed, such appointment shall be made by the mayor, with the approval of the city council or by the board of selectmen. In such city or town, the tree warden shall exercise the duties of tree warden and of insect pest control. Such tree warden shall be qualified by training and experience in the field of arborculture and licensed with the department of food and agriculture in accordance with the provisions of section ten of chapter one hundred and thirty-two B. The term of such appointment shall be for three years."

2. The duties and responsibilities of the Tree Warden shall conform to G.L. c. 87 and shall include, but not be limited to, the following:

a. Management of all trees within public rights-of-way and on City property.

b. Granting or denying and attaching reasonable conditions to all permits required under this ordinance.

c. Posting notices and holding public hearings for the Removal of Public Shade Trees and City Trees as required by this ordinance.

d. Enforcement of this ordinance.

Section 12-104. Senior urban forestry and landscape planner.

The Senior Urban Forestry and Landscape Planner shall be an employee of the city, appointed by the Mayor.

1. The Senior Urban Forestry and Landscape Planner shall be a Certified Arborist by the Massachusetts Arborist's Association, The International Society of Arboriculture, or any successor of either organization.

2. The duties and responsibilities of the Senior Urban Forestry and Landscape Planner shall include, but not be limited to, the following: a. Seeking grants or other assistance concerning the preservation and maintenance of the City's tree canopy.

b. Develop and publish policies, regulations, tree inventory, manuals, and other data and documents necessary to carry out the purposes and intent of this ordinance.

c. Supervising the planting and care of City Trees to ensure that such planting and care meets these rules, regulations and standards.

d. Assisting and working closely with the Tree Warden to help the Tree Warden fulfill their responsibilities.

Sec. 12-105. Urban forestry committee.

1. Purpose: The Urban Forestry Committee will be charged with advising with respect to the management and maintenance of all existing and new trees and shrubs on all public grounds and public ways of the City of Somerville.

2. Duties: The Urban Forestry Committee shall: a. Review planting policies for trees and shrubs on public grounds and public ways of the City of Somerville, appraise the appropriateness of such plantings, their placement, and the type of maintenance

necessary. The Urban Forestry Committee shall also review those planting proposals which it deems significant for trees and shrubs on public grounds and public ways of the City of Somerville.

b. This Committee shall have the ability to comment during any City of Somerville permitting review process.

c. This Committee may elect to review issues related to the health, effective maintenance, and protection of existing trees and shrubs on public grounds and public ways of the City of Somerville, recommend solutions to any problems identified with such plantings, update the tree inventory with detailed information, and support all public education and outreach by: i. Promoting knowledge and awareness of the benefits of trees in the City.

ii. Developing and maintaining a website;

iii. Developing and maintaining a noteworthy tree program;

iv. Developing educational materials regarding best management practices for tree care;

v. Supporting City staff in establishing a volunteer adopt-a-tree program;

vi. Supporting City staff during Arbor Day Celebrations; and

vii. Considering and recommending incentives for tree planting and maintenance.

d. Upon request of the applicant, this Committee shall consider and make recommendations to the Tree Warden on waivers for any required replantings or payments associated with the issuance of a Tree Permit.

e. This Committee may keep records of trees planted and removed within the City of Somerville and may issue regular reports on the overall status of the City's urban canopy.

3. Membership: This Committee shall consist of the following members: a. The Senior Urban Forestry and Landscape Planner

b. The Tree Warden, and

c. Nine members of the public, with at least one member demonstrating expertise in the field of urban forestry, and at least one member demonstrating expertise in the field of landscape design, and two members shall be between the ages of fourteen and seventeen at the time of their appointment or re-appointment, each serving a term of three years, selected by the Mayor, and subject to confirmation by the City Council.

Section 12-106. Criteria for removal of public shade trees.

A public hearing may not be initiated under G.L. c. 87, s. 3 to remove a healthy Public Shade Tree unless the Tree Warden finds in writing that there is a public health, safety, or welfare basis for removing the Public Shade Tree, including but not limited to hardship to a property owner, economic development, facilitating the development of affordable housing, pedestrian access enhancement, transportation improvement, or public project development. Nothing in this section shall be construed to prevent the cutting, trimming, or removal of trees in accordance with G.L. c. 87, s. 5.

Section 12. 107. Notice requirements for removal of public shade trees.

In addition to notice under G.L. c. 87 s. 3 for Removal of a Public Shade Tree, notice shall be given by the City by electronic notification when feasible and first-class mail to all property owners located within 150 feet of the Public Shade Tree proposed to be removed at least 14 days before the public hearing. To the extent feasible, the City shall notify all residents within 150 feet of the Public Shade Tree proposed to be removed by flyering at least 14 days before the public hearing. Notice shall also be given by placing notice on the City website and cable wheel at least 14 days before the public hearing. In the event that a public hearing is initiated under G.L. c. 87 s. 3 at the request of anyone other than the City, the requesting party shall pay for all costs of mailing and advertising, such costs to be determined by the City Clerk. The City Clerk may waive the costs if the requesting party demonstrates to the City Clerk that payment of the fee would cause financial hardship. Guidelines for determining financial hardship shall be established by the City Clerk. Applications for financial hardship shall be provided by the City Clerk.

Section 12. 108. Tree replacement for public shade trees.

Any healthy Public Shade Tree removed at the request of a property owner or agent thereof must be replaced within one year from the date of Removal. These replacement trees must be located at or near the location from which the tree was removed, and in no case shall trees planted in a different neighborhood qualify as replacements. The replacement trees must conform to the standards for size, species, and planting established by the Senior Urban Forestry and Landscape Planner.

Section 12. 109. Street tree stabilization fund.

1. Establishment: There shall be established a tree fund which shall be held in a separate identifiable account, and administered in accordance with applicable provisions of General Laws. Any payments required by this article shall be deposited in the Street Tree Fund and shall be used in accordance with subsection (3) below.

2. Payment for planting replacement Public Shade Trees: Where a healthy Public Shade Tree is removed at the request of a property owner or agent thereof, solely for reasons of private financial gain or personal preference, the requesting party shall make a contribution to the Street Tree Fund in an amount sufficient to pay for replacement trees as described in Section 12.108. This amount will be calculated using the schedule of costs established by the Senior Urban Forestry and Landscape Planner.

3. Maintenance of Street Tree Fund: The Street Tree Fund shall be maintained in a separate account in accordance with state law. All sums deposited into such Fund shall be used solely for the purpose of buying, planting and maintaining trees in the City. The Senior Urban Forestry and Landscape Planner shall expend these funds for tree planting, transplanting, care, and other tree-related needs.

Section 12. 110. Compliance with state law.

All public shade tree hearings shall comply with the applicable requirements set forth in G.L. c. 87 s. 3.

Section 12. 111. Criteria for removal of city trees.

1. Purpose: The purpose of this section is to extend the public notice and public hearing requirements of the Massachusetts Public Shade Tree Law G.L. c. 87 to trees on City of Somerville owned property.

2. Definitions: The following words, terms, and phrases when used in this Section shall have the following meanings ascribed to them:

a. Capital Improvement Project: A major, non-recurring expenditure that generally meets all of the following criteria: G.L. c 44, ss. 7 and 8 permit the City to issue bonds to finance the expenditure, the expenditure is a facility or object or asset costing more than $50,000, and the expenditure will have a useful life or ten years or more for infrastructure, buildings, and parks.

b. Park Project: A project involving the renovation and maintenance of existing parks and City-owned open spaces and the development of new parks and open spaces within the City of Somerville. The phrase "City-owned open spaces" includes parks, community gardens, playgrounds, school yards, library lawns, cemeteries, public plazas, triangles, and squares.

c. Tree on City-owned property: Any tree located on land owned by the City of Somerville. This does not include any tree that fits the definition of a Public Shade Tree under G.L. c. 87.

3. Applicability: This section shall apply exclusively to trees on City-owned property as defined above in section (b). Nothing in this section shall be construed to apply to Public Shade Trees within the City of Somerville, whose care, maintenance, trimming, planting, and Removal are governed by the Public Shade Tree Law, G.L. c. 87, and the City of Somerville Code of Ordinances. The public notice and meeting requirements for Public Shade Trees shall remain in full force and effect and are entirely unaffected by the language of this section.

4. Cutting down or Removal of trees: No person, including but not limited to City employees, the Tree Warden, and their deputies shall cut down or remove any tree on City-owned property without the Tree Warden first holding a public hearing.

a. The Tree Warden, or his or her designee, shall post notice of the time and place of the public hearing in two or more public places in the City and upon the tree in question at least seven days prior to the public hearing. This notice shall identify the size, type, and location of the tree to be cut down or removed, and include a brief statement of the reason for the proposed action. Notice of this public hearing shall be sent to each City Councilor, all members of the Urban Forestry Committee, and published on the City website.

b. No later than 48 hours prior to the cutting down or Removal of any tree on city-owned property, a notice on brightly colored paper will be placed upon the tree stating the anticipated date on which the action is expected to occur.

c. Nothing in this section shall prohibit the Tree Warden and his or her designee from cutting down or removing any tree which in their opinion is dead or dying or constitutes a thread to public health or safety.

5. Exceptions to the public notice and hearing requirements: No public hearing shall be necessary prior to the Tree Warden, or his or her designee, cutting down or removing trees measuring less than one and one-half inches in diameter one foot from the ground on City-owned property.

6. The following types of public projects, which have undergone a public process that includes public notification and public meetings, shall be exempt from the requirements of section (4) above.

a. Park projects and

b. Capital improvement projects.

c. This exemption shall only apply to a public project of the type listed in (a) and (b) if such public process included all of the following:

i. All public meetings at which cutting down or Removal of trees is discussed were duly noticed and advertised including but not limited to notice sent to all members of the Urban Forestry Committee.

ii. The public was provided reasonable opportunity to provide input regarding tree(s) to be cut down or removed.

iii. Reasonable notice was posted on or around any trees to be cut down or removed at least two weeks prior to such action taking place.

Section 12-112. Removal of private trees.

1. Permit Required: No person may Remove any Significant Tree from private property without first obtaining a Tree Permit from the Tree Warden.

2. Application for a Tree Permit: a. Applications must be made in writing on forms specified by the Tree Warden.

b. The Tree Warden, or his or her designee, will review applications for tree permits in accordance with the provisions of this article. The Tree Warden, or his or her designee, shall date stamp or otherwise record the date of filing of each application for a tree permit. The Tree Warden, or his or her designee, shall complete the review of each Tree Permit application no later than 30 business days after the submission of a completed application. In the event that this review is not completed within the time required by this

ordinance, and if the applicant did not request a waiver of fees or replanting, the permit shall be considered issued.

c. The application shall include a plan showing the location, species, and DBH of each tree on the property, and must indicate clearly which trees are to be Removed.

d. If replacement trees are to be planted, the plan shall indicate the planned location, species, and size of any replacement trees to be planted. In order to qualify as replacements, trees must be planted on the same or adjacent lot, and must conform to species and planting standards as defined by the Senior Urban Forestry and Landscape Planner. Trees planted in the adjacent right-of-way or otherwise located on public property shall not be considered suitable for consideration as replacement trees.

e. There shall be no fee or charge to submit an application for a tree permit.

3. Conditions for Granting a Tree Permit:

a. Removal of Significant Trees: If any Significant trees are to be removed, the plan must show planting of new trees equal to the total Replacement Caliper of those trees.

b. Payment instead of Replacement: Payment to the Street Tree Fund may be made in lieu of planting some or all of the replacement trees, according to a cost schedule established by the Senior Urban Forestry and Landscape Planner. Such fees shall be based on the actual costs associated with purchasing, planting, and maintaining the City's Public Shade Trees. Payment must be made prior to issuance of the permit.

c. Request for Waiver: The application for a Tree Permit shall allow the applicant to request a waiver of the requirement for replanting or payment.

d. Hearing of Request for Waiver: The Tree Warden, or his or her designee, shall hear requests for such waivers within 60 days of the date the application was received. This hearing may take place at a public meeting of the Urban Forestry Committee. The applicant shall have the opportunity to speak and to answer questions. The Committee may, at the request of the applicant, make a recommendation to approve or deny the waiver. Examples of reasons supporting a waiver include but are not limited to: Financial hardship associated with the care and upkeep of the trees; unreasonably high requirements for replacement or repayment, ongoing or reasonably foreseen damage or risk from the trees, and desire to create a benefit to the public. The Tree Warden shall consider such recommendation in considering whether or not to grant the waiver. If the waiver is approved, a Tree Permit will be issued within 10 business days of the close of the hearing.

e. Owner-Occupants: The owner-occupant of a lot containing a one, two, or three family dwelling, who resides at that same property as demonstrated by issuance of, or good faith application for, a valid Residential Exemption shall, at their request, be granted a waiver of the requirements for replanting or payment with no need for a hearing.

f. Departure of owner-occupant: If at any point during the 18 consecutive months following the issuance of a Tree Permit the owner no longer resides at that address; and if the requirements for replanting or payment were waived based on said owner-occupancy status as described in section (e) above; said waiver shall be revoked. In this case, the owner or, if the property has been sold, the new owner, shall be required to obtain a tree permit either for a replanting plan or to make full payment within 30 days of the fees that were waived, unless such new owner is eligible for an owner occupant waiver under Section (e) above.

This section does not make clear why owner-occupants are exempt from replanting or payment requirements. Additionally, it does not make clear that the seller must disclose the obligation of the new owner to obtain a tree permit either for a replanting plan or to make full payment when transferring property.

4. Standards for Replacement Trees: a. Replacement trees must be planted within 18 months from the date the tree permit is issued, or prior to transfer of property ownership, whichever comes first.

b. Replacement trees must be of the same or similar species and size as described in the application for the Tree Permit, and must be planted according to standards established by the Senior Urban Forestry and Landscape Planner.

Requiring replacement trees to be of the same or similar species is not necessarily in the best interest of the community and environment. Often a different species is more beneficial. Altering the phrasing to "Replacement trees must be of a species determined appropriate by the Senior Urban Forestry and Landscape Planner" would allow more options for the homeowner as well as appropriate choices for a sustainable landscape.

c. In the event that trees of the size and species that were described in the application for the Tree Permit cannot be obtained at the time of planting, multiple smaller replacement trees may be planted with the authorization of the Tree Warden.

d. If a replacement tree dies within 18 months from the date of planting, it must be replaced. The person planting the tree shall provide documentation as to the date of the planting and file the same with the Tree Warden within 15 days of the planting of said replacement tree.

5. Exceptions to the Tree Permit Requirement:

a. Emergencies: If any tree shall be determined to be in a hazardous condition so as to immediately endanger the public health, safety, or welfare or cause an immediate disruption of public services and require immediate Removal without delay, verbal authorization may be given by the Tree Warden to remove such tree, and the tree may be removed without obtaining a written permit as otherwise required by this ordinance. The Tree Warden shall record in writing each such verbal authorization, and shall present these written notes at the next meeting of the Urban Forestry Committee.

b. Waiver: The requirements of this article may be waived by the Tree Warden during the period of an emergency such as a hurricane, tornado, windstorm, flood, or similar threat to life and property.

6. Enforcement:

a. If a Significant tree is Removed without a Tree Permit, the property owner must apply for a Tree Permit within 30 days of the Removal. Each business day thereafter, until an application is filed, shall constitute a separate violation of this ordinance.

b. Stop work order: Upon notice that trees are being removed without a Tree Permit, such work shall be immediately stopped by the Director of Inspectional Services or designee. The stop work order shall be in writing and shall be mailed to the owner of record of the property and posted at the front of the property in a conspicuous location, and if possible, given to the owner of the lot involved, or to the owner's agent, or to the person doing the work, and shall state the conditions under which work will be permitted to resume.

c. Injunctive relief: Whenever there exists reasonable cause to believe that a person is violating any applicable provision of this article, the city may institute a civil action for a mandatory or prohibiting injunction in a court of competent jurisdiction ordering the defendant to correct the unlawful condition or to cease the unlawful use of the property.

7. Penalties: a. For each offense under this ordinance the person in violation shall be subject to a fine as established in section 1-11 of the Somerville Code of Ordinances.

b. Failure to make payment of any fines may result in the revocation, suspension, or denial of any local license or permit, including renewals and transfers, pursuant to section 8-3 of the Code of Ordinances and / or a municipal charges lien being placed on the violator's property located within the city pursuant to the authority and provisions of Chapter 252 of the Acts of 1996.

8. Safety of Life and Property: Nothing in this ordinance shall be construed to prevent a property owner from acting to Remove any Significant Tree, with written or oral authorization from the Tree Warden, that is an immediate and pressing health or safety hazard; that is dead or dying; or that is damaging existing structures or property; or could do so if it were to fall. In such cases, the Tree Warden may authorize immediate removal in writing or verbally, with written record to the Urban Forestry Committee as soon as practicable.

Section 12-113. Effective date.

This ordinance shall take effect on August 1, 2019.

RECOMMENDATIONS:

The following recommendations may allow Somerville to better protect both its public and private tree assets in the future.

1. Include acceptable and unacceptable basic performance standards for the treatment of public trees. The language used to define these practices should be clear and quantifiable so that the ordinance will be enforceable.
2. At a minimum, make reference to these current national arboricultural industry standards: ANSI A300 Tree, Shrub, and other Woody Plant Management – Standard Practices, ANSI Z133.1 American National Standards for Arboricultural Operations – Safety Requirements, and ANSI Z60.1 – American Standard for Nursery Stock. Somerville does require contractors to follow these standards. However, reference to these standards within the tree ordinance could require, or at least advise, residents who are replacing lost trees per the ordinance to follow appropriate arboriculture practices. Per the current tree ordinance, replacement trees that die within 18 months of planting are required to be replaced. Following ANSI standards can reduce the number of trees that die within this time period.
3. At the same time, be cautious of including too many details, as materials and methods of tree care, planting and management often change, and this would render the ordinance out-of-date. Specific details about items such as allowed species, soil volumes, plant sizes, clearance requirements over streets and sidewalks, etc. should be included in a separate manual or best practices guidance document that be updated more easily than the ordinance.
4. Include a section on "Prohibitions," such as "No person shall damage, prune, remove, or plant any tree or shrub in any public street or other public place without having first obtained a permit from the City. Damage to public trees includes, but is not limited to, construction and excavations, vehicular accidents, vandalism, adhering advertisements or electrical wires, allowing toxic substances to come in contact with soil within the dripline (gas, brine water, oil, liquid dye, or other substance) deleterious to tree life." Somerville's current ordinance does include a section prohibiting the removal of shade trees on City owned property, but it does not establish prohibitions for damage, pruning, or planting.
5. **Tree Preservation Bylaw** –clear and concise bylaw requiring residents to protect established and mature trees during construction. This bylaw could allow residents the alternative of replacing any trees removed during construction or landscaping activities. Additionally, residents could be required to pay into a tree fund if they do not wish to plant replacement trees. Somerville has established tree protection standards for contractors. These standards could be extended to the citizenry at large.
6. Include an approved tree species list that will inform residents of ecologically appropriate species to plant in the City. This list can change over time as the effects of climate change impact best management practices.
7. Require tree plantings in new developments and parking lots.
8. Include a provision that prohibits tree topping.
9. The ordinance can also be used to establish a disease and insect control plan.
10. Any fine resulting from the violation of this ordinance should be deposited into the Street Tree Stabilization Fund or other appropriate fund.

Somerville may also want to include additional provisions that are needed to reach the community's goals and address unique, local issues, such as:

- Tree planting on private property if adequate space does not exist on the right-of-way (i.e. a back of sidewalk tree planting program).
- Utility trimming: Defines requirements and responsibilities.
- Guidelines for species diversity: Sets basic standards for species diversities, and directs the community to keep updated, specific guidelines in its tree management plan.
- Invasive insect and disease response which defines the City's authority to direct removal/treatment of trees on both public and private property if a significant insect or disease threat exists in the City.
- Dying and infested ash trees on private property pose a threat to human and public safety. Somerville should consider amending the current City tree ordinance such that EAB is specifically acknowledged as a public nuisance and treated in similar fashion as Dutch elm disease and other insect pests or plant diseases. In the event that City officials have to get involved with private property owners about a potential infested ash tree, Somerville could consider utilizing the City tree ordinance. For more information on Emerald Ash Borer, please refer to *Section 3.3: Invasive Insect and Disease Management Strategy*.

The City of Somerville's tree preservation ordinance serves as a good starting point for addressing the concerns and issues of a public tree management program. Only through a strong, properly enforced ordinance will the City achieve its stated objectives. According to a 2014 Urban & Community Forestry Census of Tree activities, only 64% of communities with tree ordinances actively enforce the ordinance. Somerville should regularly review its City ordinances pertaining to street, park, and private property trees. This includes a review of permitted pruning, removal, and planting practices.

4.4 PUBLIC ENGAGEMENT

Approximately 66% of Somerville's tree canopy is located on private lands (see *Section 1.1: Somerville's Tree Canopy*). Thus success in improving or maintaining tree canopy must include a populace that understands: 1) the value of trees and tree canopy to the community; and 2) how to plant and care for trees.

There are multiple ways to engage the public to improve the care of and expanse of local tree canopy. First, topics or messages must be defined, prioritized, and limited in number. More effective communication occurs through choosing a few strong messages and repeating them over and over. After messages are chosen, avenues of targeted communication to deliver those messages can be determined and implemented.

Important topics and messages that should be considered for Somerville are as follows:

- *Current Canopy Extent and Value of Somerville Trees.* The message should present the current canopy level and benefits the canopy provides. This is typically the first message to send out to the public, as all other messages should connect back to this one. This can also be a way to "roll out" the Urban Forest Management Plan to the public. Include information such as why Somerville needs tree canopy, what the current canopy level is, and the plans to improve the management of the trees that comprise the canopy. Educating local business owners on the impact that a shady commercial district can have on sales and educating property owners about the impact that trees have on property values are other useful methods for boosting the desire for increased canopy along main thoroughfares and neighborhood streets while also engaging the public. The important value of mature trees could be also highlighted, as people often do not realize that the large tree they have is a value to their property, the community, wildlife, and the environment.

- *How You Can Get Involved.* What are the next steps you want people to take? The City should decide the answer and insert this "ask" in every outreach piece or effort. Some potential options include:
  - Give residents the choice to opt-in for a tree. This could simply be a way to request a street tree or setback tree (within 20' of the right-of-way). Alternatively, raise funds for a tree giveaway (usually saplings) at Arbor Day for people to plant on private property.
  - Encourage recycling or composting leaves on-site. An example of an educational effort the City may want to adopt or adapt is the successful "Love 'Em and Leave 'Em" public outreach campaign developed by Westchester County, New York http://www.leleny.org/. A fact-sheet such as this one created by the Greater Victoria Compost Education Centre (http://compost.bc.ca/wp-content/uploads/2015/02/FactSheet-6-Urban-Leaves_Revised-Feb-2015.pdf) can be developed and distributed.

- Join the Adopt-A-Tree program established by the Urban Forestry Committee, whereby residents sign up to take care of a street tree, including providing regular water and mulch.
- Create a Heritage Tree program where residents are encouraged to find and nominate the largest or otherwise significant trees in the City.
- Donate funds for an upcoming planting.
- Volunteer at a tree planting event (one Saturday morning commitment).
- Join a tree tenders care corps.

- *Tree Threats.* Public and private trees can die, decline, or become safety risks as a result of insect and disease infestation as well as inadequate maintenance. With education, the residents of Somerville can become aware of the common threats to the tree canopy and what they can do to help. Particularly for Emerald Ash Borer (EAB) and Oak death due to perennial gypsy moth infestations, the City should provide education on what to expect, how to identify ash and oak trees, what the City is doing about these threats on public land, and options for management on their own land. Since the majority of the trees that comprise the City's urban tree canopy are on private property, it is vital for the City to educate the public on how to detect insect and disease threats, provide information about management and treatment options, and relay the importance of reforestation in the event trees are removed due to insects and disease. For more information on potential insects and diseases, see *Section 3.3: Invasive Insect and Disease Management Strategy*.

- *General Tree Care for Property Owners.* There are several actions people take that are detrimental to trees at all stages of life, including improper mulching and pruning. Easy tips and tidbits of information to share with residents for trees on their own properties can help improve tree maintenance and increase tree health and survival rates.

Use Multiple Avenues of Communication

There are numerous avenues to convey urban forestry messages and accomplishments of the program to the residents, such as:

- *Social Media.* Social media sites such as Facebook, Instagram, and Twitter can create buzz and promote involvement in the current urban forestry activities occurring locally. The Public Space and Urban Forestry Division (PSUF) has an Instagram account (@somervilleparks) and posts regularly about urban forestry topics. To reach even more people, the City should consider coordinating with allied Community gardens, non-profits, educational institutions, and business to get messages posted on their social media sites as well.
- *Presentations to City leadership and local business and neighborhood groups.* Identify key audiences, partners, and potential champions for the urban forestry program. Making short presentations at regular or special meetings where they are relieves individuals from having to go to yet another meeting in the

evenings. PSUF staff regularly present at meetings of the Somerville Garden Club, but there are various other groups who may be interested in urban forestry matters. Initial outreach could be based on letting the audience know about Somerville's urban forest and the work called for in this plan. Be sure to have an "ask" at the end of the presentation. What do you want them to do next? This work often unearths new partners and funding sources that can otherwise go untapped.

- *Do a survey.* Once a year, create a short online survey to identify what urban forestry issues people in Somerville are concerned or care about. The survey can also be used to gauge people's reactions to new urban forest management procedures and regulations, and their willingness to participate in volunteer work or to donate funds or other resources. Questions about public trees and tree canopy can be part of the annual public survey. The City can use the new SomerVoice platform to elicit feedback about specific urban forestry topics.
- *Cultivate partnerships for communication.* Partnerships can be initiated with organizations that can help promote, enhance, and preserve Somerville's urban forest. Organizations can include local businesses, local utilities, regional non-profits, homeowner associations, neighborhood associations, and educational institutions. Other audiences to engage can include youth groups, landscape architect firms, faith-based groups, and nurseries and landscape contractors. Actions that can be taken by each partner should be defined before approaching them for support.
- *Encourage Tufts University to become a Tree Campus USA.* Tufts University borders the City of Somerville and has some land within city boundaries. The University is not yet a Tree Campus, USA. If they were to pursue this distinction and join the city's Tree City, USA legacy, then two powerful entities would be supporting Somerville's urban forest. One standard the University would need to achieve annually is for students to participate in one or more Service-Learning Projects. These projects are intended to provide an opportunity to engage the student population with trees and can be part of a larger community initiative. University students could help the City's urban forestry program perform many tasks, such as tree planting, tree care, and public outreach.
- *Publish and Promote an Annual State of the Urban Forest Report.* An annual "State of the Urban Forest Report" can be produced using updated tree inventory data, tree planting statistics, i-Tree tools, and other program information. It should provide information on the number and condition of public trees, maintenance, planting, and management accomplishments. It should also present a summary of the current year's annual work plan and identify emerging issues and budget or resource needs.

Create a Volunteer Corps

Consider implementing a "Young Tree Care" volunteer program to assist with new tree planting and new tree care such as watering, mulching, and pruning. This type of program is more involved than an "Adopt-A-Tree" program, as the young tree care volunteers are specially trained to care for young trees. Thus, this type of program

involves initial and continuing training, frequent mentoring, and overall coordination of the process and volunteers. It also provides yet another engagement opportunity and encourages partnership opportunities with a variety of groups, such as neighborhood associations, master gardeners, scout troops, church affiliated groups, high school community service programs, etc., to accomplish new and young tree care tasks.

Trees to include in a "Young Tree Care" program are generally less than 8 inches in caliper. These are the same trees recommended to be part of the young tree training program (see *Section 3.2: Tree Maintenance Program*). These younger trees sometimes have branch structures that can lead to potential problems as the tree ages, such as codominant leaders, multiple limbs attaching at the same point on the trunk or crossing/interfering limbs. If these problems are not corrected, they may worsen as the tree grows, which increases risk and creates potential liability. With direction from City staff, young tree care volunteers could be trained to carry out the young tree training program. Beyond pruning, young trees need watering and mulching to become established, and may require fertilization and other Plant Health Care (PHC) treatments until they reach maturity. This program can create "tree stewards" for Somerville and be modeled after similar and successful programs like those found in other municipalities or states, such as the Virginia Tree Stewards (https://treesvirginia.org/outreach/tree-stewards) and the Vermont Tree Stewards (https://vtcommunityforestry.org/get-involved/tree-stewards).

The "tree stewards" or a volunteer corps could also be used to support the urban forest management program in other ways. Volunteers could develop and/or staff Arbor Day and Earth Day events, post and manage tree messages on social media, help update the inventory, and/or locate planting sites in neighborhoods.

Explore Partnerships

Utility companies may be able to assist the City in completing the High Priority needs (see *Section 3.2: Tree Maintenance Program*). The City should present Eversource and National Grid with the inventory data for high priority trees under utility lines so they can consider assisting in high-priority maintenance work during their annual line clearance schedule/program.

Establish partnerships to fund and accomplish the young tree training and mature tree care program (*Section 3.2: Tree Maintenance Program*). For instance, the utility companies may support tree growth regulator applications for trees under their lines; businesses may join an "adopt-a-tree" program for significant trees in parks and in commercial areas; residents may help water mature street trees during times of drought.

Public Education

Public education is one of the true keys to reaching the goals of an urban forestry program. Only by educating the public, City officials, developers, and contractors working within City limits will a community be able to achieve urban forest protection and planting goals. Ordinances and guidelines alone will not guarantee success since builders, contractors, and

others often have their own priorities and agendas, and trees and ordinances are often nothing more than a nuisance to them.

Cooperation from all concerned parties can be improved by requesting various community stakeholders, such as City Council members and neighborhood groups, to attend educational sessions to learn about the current state of Somerville's urban forest, plans for urban forest management and planting, and the importance of all of it to the future of the community.

To gain support for Somerville's urban forestry program, various public outreach campaigns aimed at educating the residents of Somerville should be established. Where there is understanding and acceptance of the urban forestry program as a whole, there will be increased support for the planting portion of the program. Based on examples of public relations efforts by urban foresters in other communities, the following types of activities are suggested for the City to undertake:

- Hold a seminar or public meeting to discuss the tree inventory project, its results, and its importance for the City.
- Develop monthly evening or weekend seminars related to tree care and landscaping; bring in guest experts from various disciplines in the green industry.

- Write a monthly "Tree Talk" article for local newspapers or social media.
- Develop a Tree Care door hanger brochure to go to each residence where new trees are planted; educating residents about proper tree care could help eliminate trunk damage and improper mulching and pruning of new trees.
- The City could start giving away one-gallon tree seedlings to any volunteers who get involved with City projects. This is a great reward and a way to spread the word about trees. Somerville could capitalize on the idea and attach the same Tree Care door hanger brochure or a different informational brochure to each of these trees.
- Expand the annual Arbor Day celebration to help it become a community tradition. For the last 3 years Somerville staff have been running a half day event. The celebration involves a tree planting, seeding give away (with information on how to properly plant and care for the tree), information about urban forest programs, and activities for kids. The City could also do tree planting programs with the local garden club or groups like the D.A.R. (Daughters of the American Revolution). The Arbor Day celebration could be developed as an all-day Saturday event, preferably held in a popular park/public space setting in the City. Expanding on short programs on planting and pruning trees, as well as children's programs about trees, are some good ideas for increasing public interest in the City's tree programs. Additionally, the City could invite contractors to conduct demonstrations on tree planting, trimming, landscaping, species selection, etc. Organizers could also set up booths with tree information as helpful supplements for the public. Refer to the National Arbor Day Foundation (visit www.arborday.org) for publications that provide great Arbor Day ideas to assist in planning of this event.

Boston Parks and Recreation Department uses tree tags for newly planted trees to inform the public of how much water new trees need. Somerville should consider creating a similar tag place on newly planted trees or on the doors of residences next to the newly planted trees.

Somerville can help residents become more involved in the City's urban forestry program by expanding upon its public engagement. To ensure that public outreach is effective, Somerville should to determine which communication channels and tools are most used by community members. This is essential in making sure that Somerville gets word out about its urban forestry plans and polices, and programs to the public at large.

A select group of residents can be responsible for organizing and implementing a campaign of public relations, education, and community financial support. One of the purviews of the recently formed Urban Forestry Committee is to support all public education and outreach; thus, they would be an ideal group to spearhead outreach programs. This Committee is comprised of a dedicated group of local activists, landscape professionals, can community partners, and they will be a great resource to help support and guide plans and polices related to the urban forest. In their first year, the Committee has already started the City's first Adopt-A-Tree program and begun to important tree fact sheets for the community, as well as providing advice on various tree related projects. In the future, the Urban Forestry Committee can help to recruit volunteer groups to aid with any planting activities the City may hold. Volunteer organizations, such as a garden club, service organization, or Boy/Girl Scout troop, could be recruited to do the actual planting and follow-up watering and other maintenance activities.

CONCLUSIONS

Every hour of every day, public trees in Somerville are supporting and improving the quality of life. The City's street trees provide an annual benefit of $1,047,466. When properly maintained, trees provide numerous environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

Managing trees in urban areas is often complicated. Navigating the recommendations of experts, the needs of residents, the pressures of local economics and politics, concerns for public safety and liability, physical components of trees, forces of nature and severe weather events, and the expectation that these issues are resolved all at once is a considerable challenge. The City should continue to implement and improve its EAB Management Plan.

The City must carefully consider these challenges to fully understand the needs of maintaining an urban forest. With the knowledge and wherewithal to address the needs of the City's trees, Somerville is well positioned to thrive. If the management program is successfully implemented, the health and safety of Somerville's trees and citizens will be maintained for years to come.

A street well stocked with trees provides economic, environmental, and social benefits, including temperature moderation, reduction of air pollutants, energy conservation, and increased property values.

GLOSSARY

Address number (data field): The address number was recorded based on the visual observation by the Davey Resource Group arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s) and an "X" was added to the number in the database to indicate that the address number was assigned.

Adventitious root: A root growing from a location other than the underground, descending portion of the axis of a plant, as from a stem or leaf.

Aesthetic/Other Report: The i-Tree Streets Aesthetic/Other Report presents the tangible and intangible benefits of trees reflected by increases in property values in dollars ($).

Air Quality Report: The i-Tree Streets Air Quality Report quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], coarse particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, Volatile Oxygen Compounds [VOCs], SO_2) due to reduced electricity use measured in pounds (lbs.). Also reported are the potential negative effects of trees on air quality due to Biogenic Volatile Organic Compounds (BVOC) emissions.

American National Standards Institute (ANSI): ANSI is a private, nonprofit organization that facilitates the standardization work of its members in the United States. ANSI's goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and to maintain their integrity.

***ANSI A300*:** Tree care performance parameters established by ANSI that can be used to develop specifications for tree maintenance.

Arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

Area (data fields): A collection of data fields collected during the inventory to aid in finding trees, including park section number.

Benefit-Cost Ratio (BCR): The i-Tree Streets (BCR) is the ratio of the cumulative benefits provided by the landscape trees, expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

Biogenic volatile organic compounds (BVOC): Gases emitted from trees, like pine trees, which create the distinct smell of a pine forest. When exposed to sunlight in the air, BVOCs react to form tropospheric ozone, a harmful gas that pollutes the air and damages vegetation.

Canopy: Branches and foliage that make up a tree's crown.

Canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

Canopy spread (data field): Estimates the width of a tree's canopy in 5-foot increments.

Carbon Dioxide Report: The i-Tree Streets Carbon Dioxide Report presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

City-owned open spaces: all city-owned public spaces – in parks, playgrounds, around city-owned buildings, and other civic spaces

Clearance requirements (data field): Illustrates the need for pruning to meet clearance standards over streets and sidewalks, or where branches are considered to be interfering with the movement of vehicles or pedestrians or where they are obstructing signs and street or traffic lights.

Community forest: see **urban forest**.

Condition (data field): The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Excellent (100%), Very Good (90%), Good (80%), Fair (60%), Poor, (40%), Critical (20%), Dead (0%).

Cycle: Planned length of time between vegetation maintenance activities.

Defect: See **structural defect**.

Diameter: See **tree size**.

Diameter at Breast Height (DBH): See **tree size**.

Energy Report: The i-Tree Streets Energy Report presents the contribution of the urban forest toward conserving energy in terms of reduced natural gas use in winter measured in therms (th) and reduced electricity use for air conditioning in summer measured in megawatt-hours (MWh).

Epicormic shoot: sprout that arises from latent or adventitious buds.

Extreme Risk tree: Applies in situations where tree failure is imminent, there is a high likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area in order to prevent injury.

Failure: In terms of tree management, failure is the breakage of stem or branches, or loss of mechanical support of the tree's root system.

Further inspection (data field): Notes that a specific tree may require an annual inspection for several years to make certain of its maintenance needs. A healthy tree obviously impacted by recent construction serves as a prime example. This tree will need annual evaluations to assess the impact of construction on its root system. Another example would be a tree with a defect requiring additional equipment for investigation.

Genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

Geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to provide a better understanding of how it all interrelates.

Global positioning system (GPS): GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

Grow space size (data field): Identifies the minimum width of the tree grow space for root development.

Grow space type (data field): Best identifies the type of location where a tree is growing. During the inventory, grow space types were categorized as island, median, open/restricted, open/unrestricted, raised planter, tree lawn/parkway, unmaintained/natural area, or well/pit.

Hardscape damage (data field): Indicates trees damaged by hardscape or hardscape damaged by trees (for example, damage to curbs, cracking, lifting of sidewalk pavement 1 inch or more).

High Risk tree: The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or consequences are "severe" and likelihood is "likely." In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

Importance Value (IV): A calculation in i-Tree Streets displayed in table form for all species that make up more than 1% of the population. The i-Tree Streets IV is the mean of three relative values (percentage of total trees, percentage of total leaf area, and percentage of canopy cover) and can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. IVs offer valuable information about a community's reliance on certain species to provide functional benefits. For example, a species might represent 10% of a population, but have an IV of 25% because of its great size, indicating that the loss of those trees due to pests or disease would be more significant than their numbers suggest.

Invasive, exotic tree: A tree species that is out of its original biological community. Its introduction into an area causes or is likely to cause economic or environmental harm, or harm to human health. An invasive, exotic tree has the ability to thrive and spread aggressively outside its natural range. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

Inventory: See **tree inventory**.

i-Tree Streets: i-Tree Streets is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits: energy conservation, air quality improvement, CO_2 reduction, stormwater control, and property value increase.

i-Tree Tools: State-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree

Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

Location (data fields): A collection of data fields collected during the inventory to aid in finding trees, including address number, street name, site number, side, and block side.

Low Risk tree: The Low Risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.

Management Costs: Used in i-Tree Streets, they are the expenditures associated with street tree management presented in total dollars, dollars per tree, and dollars per capita.

Mapping coordinate (data field): Helps to locate a tree; X and Y coordinates were generated for each tree using GPS.

Moderate Risk tree: The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.

Monoculture: A population dominated by one single species or very few species.

Net Annual Benefits: Specific data field for i-Tree Streets. Citywide benefits and costs are calculated according to category and summed. Net benefits are calculated as benefits minus costs.

Nitrogen Dioxide (NO_2): Nitrogen dioxide is a compound typically created during the combustion processes and is a major contributor to smog formation and acid deposition.

None (risk rating): Equal to zero. It is used only for planting sites and stumps.

Notes (data field): Describes additional pertinent information.

Open Space: A ground level or upper story outdoor landscaped area including, but not limited to, natural woodlands, yards, forecourts, courtyards, green roofs and civic spaces.

Ordinance: See **tree ordinance**.

Overhead utilities (data field): The presence of overhead utility lines above a tree or planting site.

Ozone (O_3): A strong-smelling, pale blue, reactive toxic chemical gas with molecules of three oxygen atoms. It is a product of the photochemical process involving the Sun's energy. Ozone exists in the upper layer of the atmosphere as well as at the Earth's surface. Ozone at the Earth's surface can cause numerous adverse human health effects. It is a major component of smog.

Particulate Matter (PM_{10}): A major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists.

Plant Tree (Primary Maintenance Need): If collected during an inventory, this data field identifies planting sites as small, medium, or large (indicating the ultimate size that

the tree will attain), depending on the growspace available and the presence of overhead wires.

Primary Maintenance Need (data field): The type of tree work needed to reduce immediate risk.

Pruning: The selective removal of plant parts to meet specific goals and objectives.

Removal (Primary Maintenance Need): Data field collected during the inventory identifying the need to remove a tree. Trees designated for removal have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have a large percentage of dead crown.

Right-of-way (ROW): See **street right-of-way**.

Risk: Combination of the probability of an event occurring and its consequence.

Risk assessment (data fields): See Appendix B.

Risk rating: Level 2 qualitative risk assessment will be performed on the ANSI A300 (Part 9) and the companion publication *Best Management Practices: Tree Risk Assessment*, published by International Society of Arboriculture (2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.

Root collar: The area on the tree where the roots join the main stem or trunk. There is often a flare at this junction, which is referred to as a "root flare" or "trunk flare".

Runner root: A runner root is a root that contains adventitious buds. These adventitious buds can form into a new tree, and can sometimes be far from the parent stem.

Side value (data field): Each site is assigned a side value to aid in locating the site. Side values include: *front*, *side*, *median* (includes islands), and *rear* based on the site's location in relation to the lot's street frontage. The *front* side is the side that faces the address street. *Side* is the name of the street the arborist is collecting on, away or to the current addressed street. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

Site number (data field): All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street were actually a two-way street, so some site numbers will oppose traffic.

Species: Fundamental category of taxonomic classification, ranking below a genus or subgenus, and consisting of related organisms capable of interbreeding.

State-owned property: in inventory, includes state ROW and open spaces.

Stem: A woody structure bearing buds and foliage, and giving rise to other stems.

Stems (data field): Identifies the number of stems or trunks splitting less than 1 foot above ground level.

Stored Carbon Report: While the i-Tree Streets Carbon Dioxide Report quantifies annual CO_2 reductions, the i-Tree Streets Stored Carbon Report tallies all of the Carbon (C) stored in the urban forest over the life of the trees as a result of sequestration measured in pounds as the CO_2 equivalent.

Stormwater Report: A report generated by i-Tree Streets that presents the reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons (gals.).

Street name (data field): The name of a street right-of-way or road identified using posted signage or parcel information.

Street Right-of-Way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

Street tree: A street tree is defined as a tree within the Right-of-Way.

Structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

Stump Removal (Primary Maintenance Need): Indicates a stump that should be removed.

Sulfur Dioxide (SO_2): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

Summary Report: A report generated by i-Tree Streets that presents the annual total of energy, stormwater, air quality, carbon dioxide, and aesthetic/other benefits. Values are reflected in dollars per tree or total dollars.

Topping: Characterized by reducing tree size using internodal cuts without regard to tree health or structural integrity; this is not an acceptable pruning practice.

Tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

Tree benefit: An economic, environmental, or social improvement that benefits the community and results mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

Tree Clean (Primary Maintenance Need): Based on *ANSI A300 Standards*, these trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk.

Tree height (data field): If collected during the inventory, the height of the tree is estimated by the arborist and recorded in 10-foot increments.

Tree inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

Tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities.

Tree size (data field): A tree's diameter measured to the nearest inch in 1-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

Urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and greenspaces, in forests, and on private property.

Urban tree canopy (UTC) assessment: A study performed of land cover classes to gain an understanding of the tree canopy coverage, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. Typically performed using aerial photographs, GIS data, or Lidar.

Volatile Organic Compounds (VOCs): Hydrocarbon compounds that exist in the ambient air and are by-products of energy used to heat and cool buildings. Volatile organic compounds contribute to the formation of smog and/or are toxic. Examples of VOCs are gasoline, alcohol, and solvents used in paints.

Young Tree Train (Primary Maintenance Need): Data field based on *ANSI A300* standards, this maintenance activity is characterized by pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees can be up to 20 feet tall and can be worked with a pole pruner by a person standing on the ground.

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SECTION 1.1: SOMERVILLE'S TREE CANOPY

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